Naval Science 3

NAVAL KNOWLEDGE, LEADERSHIP,
AND NAUTICAL SKILLS FOR
THE NJROTC STUDENT

Third Edition

CDR Richard R. Hobbs, USNR (Ret.)

Naval Institute Press
Annapolis, Maryland

Naval Institute Press
291 Wood Road
Annapolis, MD 21402

© 2018 by the United States Naval Institute

All rights reserved. No part of this book may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage and retrieval system, without permission in writing from the publisher.

Library of Congress Cataloging-in-Publication Data
Hobbs, Richard R., author.
Title: Naval science 3 : naval knowledge, leadership, and nautical skills for the NJROTC student / Cdr. Richard R. Hobbs, USNR (Ret.).
Other titles: Naval science three | Naval knowledge, leadership, and nautical skills for the NJROTC student
Description: Third edition. | Annapolis, MD : Naval Institute Press, [2018] | Includes bibliographical references and indexes.
Identifiers: LCCN 2017026778 | ISBN 9781682471708 (hard cover : alk. paper)
Subjects: LCSH: Naval art and science—Textbooks. | Naval art and science—United States—Textbooks. | United States. Navy—Textbooks. | United States. Navy Junior Reserve Officers Training Corps—Textbooks.
Classification: LCC V103 .H63 2017 | DDC 359—dc23 LC record available at https://lccn.loc.gov/2017026778

♾ Print editions meet the requirements of ANSI/NISO z39.48-1992 (Permanence of Paper).
Printed in the United States of America.

26 25 24 23 22 21 20 19 18 9 8 7 6 5 4 3 2 1
First printing

Contents

Acknowledgments vii

Naval Knowledge 1

UNIT 1: SEA POWER AND NATIONAL SECURITY 3

1. The Importance of Sea Power 4
2. The U.S. Merchant Marine 9
3. Grand Strategy 24
4. U.S. Strategy and the Navy 36
5. National Security and Modern Conflict 42

UNIT 2: NAVAL OPERATIONS AND SUPPORT FUNCTIONS 49

6. Naval Operations 50
7. Naval Communications 64
8. Naval Intelligence 71
9. Naval Logistics 82
10. Naval Research and Development 86

UNIT 3: MILITARY LAW 93

11. Introduction to Military Law 94
12. Discipline and Punishment 99

UNIT 4: INTERNATIONAL LAW AND THE SEA 107

13. Fundamentals of International Law 108
14. International Law of the Sea 118
15. The Law of War at Sea 127

UNIT 5: NAVAL WEAPONS 135

16. Introduction to Naval Weapons 136
17. Naval Ship and Aircraft Guns 142
18. Navy Ship, Submarine, and Aircraft Missiles 149
19. Laser Weapons and Rail Guns 162

UNIT 6: MODERN NAVAL WARFARE 169

20. Cyber Warfare 171
21. Special Warfare 179
22. Mine Warfare 184
23. Chemical, Biological, and Nuclear Warfare 195

UNIT 7: SHIPBOARD ORGANIZATION AND WATCHSTANDING 203
24. Shipboard Organization 204
25. Watches 214

GLOSSARY OF NAVAL KNOWLEDGE TERMS 225

Leadership 235

LEADERSHIP 237
1. The Challenge of Leadership 238
2. Qualities of a Leader 242
3. Evaluation of Performance 250
4. How to Give Instruction 254

Naval Skills 265

UNIT 1: SHIP CONSTRUCTION AND DAMAGE CONTROL 267
1. Ship Construction, Propulsion, and Naming 268
2. Damage Control and Firefighting 289

UNIT 2: DECK SEAMANSHIP 305
3. Marlinspike Seamanship 307
4. Anchoring, Mooring, and Underway Replenishment 315
5. Small Boat Seamanship 327

UNIT 3: NAVIGATION 337
6. Introduction to Navigation 338
7. Marine Navigation 349
8. Aids to Navigation 362
9. Time 369

UNIT 4: RULES OF THE ROAD AND MANEUVERING BOARD 377
10. Nautical Rules of the Road 378
11. The Maneuvering Board 388

GLOSSARY OF NAVAL SKILLS TERMS 395

Bibliography 403

Indexes
Naval Knowledge 407
Leadership 411
Naval Skills 413

Acknowledgments

One of the most satisfying aspects of my professional career over the past three decades has been my association with the NJROTC program. I remain convinced that this program represents one of the finest and most worthwhile endeavors that exist to serve American youth.

Many thanks are due the various NJROTC headquarters staff and curriculum advisory committee members, NJROTC instructors, and various subject matter experts who made suggestions and provided material for the preparation of this edition.

The NJROTC unit at Annapolis High School in Annapolis, Maryland, supplied many of the photos of cadets engaged in various activities that appear in the leadership section in this and in the previous edition of this book. Except where otherwise credited, most of the photographs of naval ships, aircraft, ordnance, equipment, and people appearing in this book mainly came from the Navy.mil photo files website. Where available the photo credits appear beneath the captions for the various photos.

The open-source excellent monograph "The Grand Strategy of the United States" by R. D. Hooke published by the National Defense University was a valuable reference for and basis of much of the history of American grand strategy in chapter 3 of the Naval Knowledge section of this book, and Capt. Paul Tortora USN (Ret.), the Director of the Center for Cyber Security Studies at the U.S. Naval Academy, provided much helpful material for and critique of chapter 20 on cyber warfare. The article "Every Sailor a Cyber Warrior," by Capt. John Gelinne USN (Ret.) in the April 2015 edition of the U.S. Naval Institute *Proceedings,* was an excellent reference on the current state of cyber warfare in the fleet.

Finally, a special tip of the hat goes to freelance editor Mindy Conner, whose excellent editing contributed much to this edition, and Chris Robinson, the freelance commercial artist who created many of the maps and drawings appearing in it. As always, my unending thanks and appreciation goes to the staff of the Naval Institute, without whom this textbook would not have been possible.

Naval Knowledge

UNIT 1: SEA POWER AND NATIONAL SECURITY

1. The Importance of Sea Power 4
2. The U.S. Merchant Marine 9
3. Grand Strategy 24
4. U.S. Strategy and the Navy 36
5. National Security and Modern Conflict 42

UNIT 2: NAVAL OPERATIONS AND SUPPORT FUNCTIONS

6. Naval Operations 50
7. Naval Communications 64
8. Naval Intelligence 71
9. Naval Logistics 82
10. Naval Research and Development 86

UNIT 3: MILITARY LAW

11. Introduction to Military Law 94
12. Discipline and Punishment 99

UNIT 4: INTERNATIONAL LAW AND THE SEA

13. Fundamentals of International Law 108
14. International Law of the Sea 118
15. The Law of War at Sea 127

UNIT 5: NAVAL WEAPONS

16. Introduction to Naval Weapons 136
17. Naval Ship and Aircraft Guns 142
18. Navy Ship, Submarine, and Aircraft Missiles 149
19. Laser Weapons and Rail Guns 162

UNIT 6: MODERN NAVAL WARFARE

20. Cyber Warfare 171
21. Special Warfare 179
22. Mine Warfare 184
23. Chemical, Biological, and Nuclear Warfare 195

UNIT 7: SHIPBOARD ORGANIZATION AND WATCHSTANDING

24. Shipboard Organization 204
25. Watches 214

GLOSSARY OF NAVAL KNOWLEDGE TERMS 225

Unit 1

Sea Power and National Security

Sea power, as a former Chief of Naval Operations defined it, is "the sum of a nation's capabilities to implement its interests by using the ocean areas for political, economic, and military activities in peace or war in order to attain national objectives." The main components of sea power, he stated, are naval power, ocean science, ocean industry, and ocean commerce. From this broad definition it is clear that sea power has a profound effect upon nearly every aspect of national security, commercial prosperity, and social welfare. It includes our merchant marine, oceanography, ocean engineering, marine research and technology, and our naval power.

Sea power is of fundamental importance to the United States. We are first and foremost a maritime nation. We have depended upon free use of the seas since before the Revolutionary War. Even today, how well we understand the significance of the oceans and how well we use them has much to do with the welfare of our nation.

1

The Importance of Sea Power

Throughout history the oceans have always been important to humankind as a major means for travel, commerce, cultural exchange, and military power projection. Since World War II, four major developments have emphasized the importance of the oceans even more. Two of these are political, and two are technological.

The first major political development since World War II has been the rapid increase in new nations. Only 51 nations formed the **United Nations** (UN) after the war; today the UN recognizes more than 200 sovereign states. Many of these are underdeveloped Third World countries, tempting targets for more aggressive nations.

The second political development is the steady increase in the interdependence of the nations of the world. The United States today is committed by treaty or agreement to assist in the defense and development of well over half the world's nations. Through our participation in the UN we render indirect assistance to even more. Many of these nations border on oceans or seas. These oceans and seas are often the means by which any needed assistance can be delivered.

The Navy's inland reach was limited to the range of its guns until the advent of aircraft and missiles. Cruise missiles like this Tomahawk being fired by the guided-missile cruiser USS *Shiloh* have greatly extended the capabilities of modern warships.

The first of the major technological developments is the **inland reach** of sea power. The sea is no longer just a means to attack coastal targets or a shield against invasions. It has become a vast arena from which awesome weapons of mass destruction can be launched, such as nuclear-tipped ballistic and cruise missiles from nuclear-powered submarines beneath the surface, and cruise missiles and attack aircraft from surface ships. These weapons can reach not only coastal areas but also targets far inland. This has changed military strategy profoundly, for there is now no place on Earth beyond the range of direct attack from the sea.

The second major technical development is nuclear technology. Nuclear energy has both constructive and destructive uses. On the constructive side are **fission reactors** used for ship and submarine propulsion at sea and large-scale electrical power generation ashore. On the destructive side is the **thermonuclear warhead** that can be launched from land, sea, or air to obliterate any target.

Today our Navy's strength extends to the farthest corners of the globe. Mobile sea-based forces both extend the defensive perimeter around the United States and make possible military power projection and deterrence against aggression wherever needed.

Strategic Ocean Areas

As was discussed in *Naval Science 2*, there are four main ocean areas that are of prime strategic importance to the United States.

The first is the Atlantic, which includes the Mediterranean Sea, the North Atlantic, and the western approaches to Europe. This area was the main site of confrontation between the Western allies and the Soviet bloc during the Cold War.

The second area is the Pacific Ocean, extending from the Bering Strait off Alaska to the Strait of Malacca in Southeast Asia. This was the site of two wars and many other subsequent and more recent confrontations between the United States and its allies and communist states such as North Vietnam, China, and North Korea.

The third prime strategic ocean area is the Arctic Ocean, which lies north of the North American continent and separates it from Asia. The advent of the nuclear submarine made this ice-encrusted ocean into an important area of naval operations when in the mid-1960s submarines of the Soviet Union, the United States, and other North Atlantic Treaty Organization (NATO) nations began routine cruises under the polar icecap. It has also been proposed as a route for submarine transport of crude oil shipments, and more recently, with global warming and the resulting increased melting of much of its surface ice, for surface shipping along the legendary Northwest Passage.

The fourth area is the vast Afro-Asian Ocean, which includes the broad reaches of the South Atlantic and Indian Oceans as well as the Middle Eastern oil transportation routes through the Red Sea, Suez Canal, and Persian Gulf.

In these strategic ocean areas there are a number of **geographic chokepoints** (bottlenecks) through which the world's maritime traffic must pass in order to conduct international trade and deploy naval forces. Many of these chokepoints were identified in the Maritime Geography unit of *Naval Science 2*. Much of America's worldwide maritime strategy is concerned with how best to protect these chokepoints' continued use by the United States and our allies while denying their use to any prospective enemy.

The Mobility of Sea Power

In contrast to land forces, whose mobility and resupply capability is limited by the geographical features and political constraints of the terrain in which they operate, seaborne naval forces have several advantages. The open sea is a vast, level highway over which no nation can claim sovereignty. Thus naval forces can move wherever they wish and disperse whenever and however necessary. They can establish a line of defense far from their national shores, making it easier to prevent attack by enemy forces. And they can easily replenish fuel, stores, and ammunition at sea.

The presence of mobile sea forces near land areas where conflict threatens to break out can often act as a **deterrent** (discouragement of potential action). Combat-ready seaborne forces can be quickly sent to any potential problem area. Their timely arrival in an area of tension may be sufficient to calm things down and prevent a conflict from escalating to war.

Merchant Marine

A strong **merchant marine** (commercial shipping) is a vital element of sea power. This belief was part of Alfred Thayer Mahan's doctrine of sea power. The merchant fleet must be kept competitive if it is to meet the growing needs of industry and provide logistic support to our forces overseas.

Mobile sea forces like these FA-18 Super Hornets being launched from the carrier USS *Ronald Reagan* (CVN 76) can often act as a deterrent to prevent a conflict from escalating to war.

There was a time in America when it seemed that we had an unlimited supply of raw materials. We were nearly self-sufficient in most commodities and did not need to purchase or sell materials abroad. However, our increasing population, growing rate of consumption of resources and energy, and modern technological needs have changed those circumstances. In fact, for some time now we have been dependent on many other nations for much of what we need to maintain a strong economy, keep our people at work, and manufacture our products.

In order to maintain our economy, there are about eighty strategic resources that the United States cannot do without. We

rely on imports to satisfy our needs for many of these resources. For instance, we must import some 85 percent of the manganese required to produce steel. We import around 85 percent of the bauxite from which aluminum is refined. We import more than 99 percent of our nation's tin and more than 90 percent of the chromite used to toughen steel. Ninety percent of the columbite used to construct nuclear reactors, make stainless steel, and manufacture rockets and missiles is also imported. Since the late 1960s we have imported a large portion (some 25 percent in recent years and up to 70 percent before that) of our petroleum. Moreover, foreign markets for our farm products and manufactured goods have become increasingly important to the U.S. economy in recent years.

Most nations understand the doctrine of freedom of the seas under international law, though some have varying interpretations. In wartime, however, a belligerent nation will do all in its power to disrupt the passage of commercial shipping to its opponents. Throughout history, whenever powerful nations have lost control of the seas, they have fallen. There is no reason to believe that things will be different in the future.

For these reasons the United States needs a strong merchant marine. No enemy can be allowed to stop the flow of ocean-borne commerce if we are to maintain our national security as well as the health and stability of our domestic economy. Keeping the sea-lanes open is a vital mission of the U.S. Navy, for these lanes are the lifelines of America.

Oceanography

The oceans contain a wealth of animal and plant life. Every known mineral can be found on the sea bottom or suspended in seawater. The sea is the last great storehouse of food and minerals on Earth. Oceanography, covered in *Naval Science 2*, is the science that finds ways to properly exploit the resources of the sea for the benefit of the world. We must learn to use these resources fully, without depleting sea life or polluting the sea environment.

Many **littoral nations** (those with ready access to the seas) are engaged in oceanographic research. The United States has become very aware of the need for oceanographic research and consequently has completed many major projects in recent years.

We know that we must increasingly turn to the sea for resources that we previously obtained on land: food, fresh water, minerals, and energy. Vast new resources have been discovered in the **continental shelf** (a narrow, shallow belt around the continents). International agreements have given littoral nations exclusive rights to develop all the natural resources in the continental shelf adjacent to their own shores.

Minerals of all kinds can be extracted from seawater, but as yet this is cost effective for only a few chemicals and elements. Processing seawater to obtain fresh water for drinking and irrigation is being done in various places around the world where natural fresh water is in short supply. Holland, France, and Canada are already harnessing the tides for a boundless supply of energy, and some similar pilot projects are coming on line in the United States. In fact, it could be done on nearly every seacoast where the tidal range is sufficient.

The science of farming of the sea is called **aquaculture**, also discussed in *Naval Science 2*. Aquaculture may in time make possible the cultivation of plants and fish that can produce a large portion of the protein needed by the world's people.

Commercial fisheries have not begun to realize the potential of the ocean harvest. They have concentrated on only about 20 varieties of fish out of more than 20,000 known species. Almost all sea life is edible. Even tiny high-protein plankton and algae are being investigated as possible sources of food.

Humankind has barely begun its search for knowledge of the ocean's depths. U.S. efforts to increase basic and applied research in oceanography are fairly recent, and our progress has been slow. There is no question that we have the capability and scientific knowledge for this effort. What we must develop is a national awareness of the importance of the seas and the will to move ahead boldly with their exploration.

The Continuing Importance of Sea Power

No one denies the importance of space exploration to the future of humankind. But even as we gaze toward the stars, dreaming of space ships and distant worlds, we must still live on planet Earth. While expeditions to asteroids and colonies on the planets or the Moon may happen someday, it is far more practical to consider the proper use of the Earth for the sustenance of future generations. With nearly three-fourths of the globe covered by water, it is inevitable that the oceans will play a vital role in the future of the human race.

As humankind turns seaward for fresh water, food, oil, natural gas, and raw materials, it becomes very evident that no country can live in isolation from the rest of the world. The trade routes of the seas have become the arteries of life. Sea power has evolved into an essential ingredient for sustaining life, political independence, and economic prosperity.

Balanced sea power makes possible a flexible national strategy. With sea power we can use the seas for trade, energy resources, and economic development. We can project power from mobile bases at sea and bring pressure to bear with amphibious forces. We can prevent trouble from erupting, and suppress it when it does with the Navy–Marine Corps team. We can send our Sailors and Marines ashore as ambassadors of good will, making friends and allies confident of our ability to support them in times of trouble or natural disaster. Our reassuring presence promotes stability in an otherwise troubled

world. In short, sea power gives the United States the ability to carry out policy that supports our national interests and fosters peace in the world.

Sea power, however, depends on people—highly trained and dedicated people who believe in their mission. They must respond rapidly and decisively to changing world events. It is up to all Americans—service people, civilians, professional people, and students—to learn about the importance of sea power. There is one fact that we must never forget: the sea and the United States are inseparable.

Critical Thinking

1. Research how much we could reduce our dependence on imported materials if we upgrade recycling programs of all kinds and seek renewable energy alternatives to fossil fuels.

Study Guide Questions

1. What two major political developments since World War II have increased the importance of the oceans?
2. What does "inland reach" mean as related to sea power?
3. What two aspects of nuclear technology have affected sea power?
4. What four ocean areas are of prime strategic importance to the United States?
5. What is unique about naval operations in the Arctic Ocean?
6. What three benefits do our fleets gain because of their ability to move freely on the high seas?
7. Why is it important for the United States to maintain a strong merchant marine?
8. What is the importance of oceanographic research?

New Vocabulary

merchant marine
fission reactor
geographic chokepoint
littoral nation
aquaculture
inland reach of sea power
thermonuclear warhead
deterrent, deterrence
continental shelf

2

The U.S. Merchant Marine

Throughout the globe, the preferred method of transporting large quantities of raw materials and manufactured trade goods is by water, because it is the fastest, most efficient, and least costly way. Some 80 percent of all world trade goods are transported by water. The other transport systems—rail, truck, aircraft, and pipeline—support, augment, and complement waterborne transport.

The economies of all the nations of the world have become interdependent to a degree never before seen. No nation has all the resources it needs to be completely independent, nor can any nation's economy thrive if that nation does not market its goods beyond its borders. The United States, for example, must import more than one hundred vital metals and minerals from more than sixty countries, including about 25 percent of our petroleum, nearly 100 percent of ores such as aluminum and chromium, and a growing percentage of finished steel products. Grain from our farms is marketed worldwide, and income from our manufactured products sold overseas represents a vital and steadily growing part of our national economy. Some 90 percent of our domestically consumed products are produced wholly or in part using materials transported via water at some point. Altogether the United States ships some 2.6 billion tons of dry and liquid waterborne cargo domestically and internationally each year. There can be no doubt about the importance of waterborne commerce to the prosperity and high standard of living of the American people now and in the future.

Ships engaged in commerce that carry goods and liquids from one place to another over the world's oceans and waterways are called **merchant marine** ships. They range in size from huge oil tankers larger than aircraft carriers to small cargo and passenger vessels that ply coastal and inland waters and rivers. U.S. merchant marine ships are an important part of American sea power. They convey American products both to domestic and foreign markets and to our military forces around the world, and bring in foreign products and raw materials essential to our economy. During wartime, merchant shipping delivers most of the equipment and supplies needed by our forces deployed overseas.

This chapter briefly summarizes the history of the U.S. merchant marine, discusses how it supports our nation in peace and war, and describes the people and ships that make up our modern-day merchant marine.

Historical Background

The U.S. merchant marine has experienced several extremes between expansion and decline over the many years since the birth of our nation. It flourished during the early days of the American Republic and reached a peak in the 1850s, due in large measure to the superiority of American-built clipper ships. Just prior to the Civil War, our merchant marine was second in size only to that of the British.

During and after the Civil War, however, our merchant marine suffered a dramatic decline. This happened for several reasons. Chief among these was the effect of the Southern commerce raiders that preyed on Northern merchant shipping around the globe and had virtually driven it from the seas by war's end. After the war America's focus turned to westward expansion. Our depleted merchant marine suffered from European competition, noncompetitive wage scales, soaring insurance costs, and steadily increasing domestic shipbuilding costs. The latter three factors have continued to plague the U.S. merchant marine to the present day. The U.S. merchant marine has not been among the leaders in the world since before the Civil War, except when spurred by the demands of war.

By the time of World War I, the volume of American imports and exports had grown substantially, but only about 10 percent of this trade was carried in ships flying the U.S. flag. A large effort to remedy this situation during the war ultimately resulted in the construction of more than two thousand ships. Once again, however, a competitive edge could not be sustained in the postwar years. In an attempt to help the struggling American maritime industry, Congress passed the Merchant Marine Act of 1936, a landmark piece of legislation that created the U.S. Maritime Commission and provided for the payment of construction and operating subsidies so American ship owners would consider expansion.

During World War II the U.S. shipbuilding industry again went into high gear. Many new shipyards funded by the government were opened, and for the first time in our history, women were hired as shipfitters to help staff them, an innovation necessitated by wartime labor shortages. Close cooperation between the shipyards and the Navy resulted in Liberty and Victory ships being mass-produced at a phenomenal rate to meet the merchant vessel and auxiliary needs of the wartime Navy. By war's end almost six thousand of these ships had been built.

The Liberty ship *Jeremiah O'Brien*, one of only two remaining *Liberty*-class ships, moored at Pier 45 in San Francisco, California. *Mike Hofmann*

The Victory ship *Red Oak Dawn* is the only surviving operational *Victory*-class ship in the world. It was a faster and longer range successor to the earlier *Liberty* class, with about the same capacity. *Leonard G.*

The U.S. merchant marine accumulated a magnificent record during the war. Although its ships and crews were subject to every kind of enemy attack, with per capita casualties exceeded only by the Marine Corps, it nevertheless succeeded in carrying millions of tons of cargo across every ocean. After delivering their military cargoes overseas, on their return voyages the ships brought back many strategic materials essential to our wartime industries.

After World War II the government-sponsored shipyards were shut down, and the remaining commercial yards concentrated on converting Liberty and Victory ships to commercial use. Others of these ships were either sold or mothballed (laid up) at anchor in what was designated the **National Defense Reserve Fleet** (NDRF). Because of the glut of excess ships, few orders were placed for new ship construction. The U.S. merchant marine once again entered a long period of decline that has lasted to this day, caused largely by the combined effects of foreign nations subsidizing their own shipbuilding industries, and the high costs of shipbuilding and ship operations in the United States. Only a few new U.S. merchant ships have been built in recent years in U.S. shipyards, and foreign ships now carry almost all American cargo on the high seas.

National Policy and the Merchant Marine Acts

Present-day federal merchant marine policy traces its origins to the Shipping Act of 1916, enacted a year before America entered World War I. It established the U.S. Shipping Board, the first federal agency tasked with promoting a U.S. merchant marine and regulating U.S. commercial shipping. As is stated in the law, Congress established the Shipping Board "for the purpose of encouraging, developing, and creating a naval auxiliary and naval reserve and a Merchant Marine, to meet the requirements of the commerce of the United States with its territories and possessions and with foreign countries; to regulate carriers by water engaged in the foreign and interstate commerce of the United States."

When the United States declared war in April 1917, the Shipping Board created the Emergency Fleet Corporation (EFC), sometimes called the War Shipping Board, to mobilize American shipbuilding to meet wartime needs. By the time the program ended five years later, nearly 2,300 ships had been built, causing a glut that led to a lengthy depression in the U.S. shipbuilding industry. To help deal with this situation, Congress passed the 1920 Merchant Marine Act, more commonly known ever since as the **Jones Act**, enabling the sale, to American citizens if possible, of the large fleet of EFC-built merchant ships. Of far more consequence up to the present day, however, was another provision of the Jones Act requiring all cargo and passengers conveyed for hire between U.S. ports to be carried in American-owned, -operated, and -crewed ships

(this is discussed further below). In 1927 the EFC was renamed the Merchant Fleet Corporation, and in 1930 both it and the Shipping Board were absorbed into the Department of Commerce as the U.S. Shipping Board Bureau.

Six years later Congress passed the watershed Merchant Marine Act of 1936, which among other provisions created the U.S. Maritime Commission, a new regulatory body that assumed the duties, functions, and property of the Shipping Board Bureau. The act authorized the commission to design and build five hundred new merchant ships in commercial shipyards over a ten-year period, in what became known as the Long Range Shipbuilding Program. This act, together with the Jones Act, is still the basis for many of the programs that support our national merchant marine policy today.

The beginning of World War II in Europe in 1939 brought with it an increased demand for American merchant shipping. This was at first met with an acceleration in the Long Range Shipbuilding Program begun three years earlier, and then, in early 1941, by a new effort called the Emergency Shipbuilding Program. In early 1942, shortly after the United States entered the war, President Franklin Roosevelt signed an executive order splitting the Maritime Commission's responsibilities: the Maritime Commission would continue designing and building ships under the Emergency Shipbuilding Program, while a new agency called the War Shipping Administration (WSA) would acquire and operate them.

The Maritime Commission and later the WSA together managed the greatest industrial shipbuilding and ship operations effort ever seen. Between 1939 and 1945 nearly six thousand Liberty and Victory ships were constructed by the Maritime Commission in both existing commercial and new government-sponsored shipyards, with the WSA simultaneously managing their operations, repair, and maintenance. With the war's end, in 1946 the government dissolved the WSA and transferred all of its functions back to the Maritime Commission. Under the subsequent Merchant Ship Sales Act, several thousand of the ships built during the war were sold or disposed of, and the remainder were either chartered or converted for commercial use, or mothballed in the NDRF.

In 1950 Congress abolished the Maritime Commission, and its function was taken over by a new agency called the **Maritime Administration** (MARAD) within the Department of Commerce. In 1981 MARAD was transferred to the Department of Transportation, completing the consolidation of all contemporary federal transportation programs into one cabinet-level department. Since that time the mission of MARAD has been to administer federal programs to develop, promote, and operate the U.S. merchant marine, including routing, research and development, and regulation of registration. It operates the U.S. Merchant Marine Academy at Kings Point, New York, and provides and maintains training ships and funding for six state maritime academies: the State University of New York (SUNY) Maritime College, Massachusetts Maritime Academy, California Maritime Academy, Maine Maritime Academy, Texas Maritime Academy, and Great Lakes Maritime Academy in Michigan. MARAD also owns and operates two fleets of government-owned cargo vessels to support national security requirements—the Ready Reserve Force and the NDRF—both of which are discussed in more detail later in this chapter.

Several additional federal merchant marine acts were passed in 1996, 2003, and 2006, modifying and updating many of the provisions of the 1920 Jones Act and the 1936 Merchant Marine Act.

The Jones Act

In addition to the Merchant Marine Act of 1936, the other most significant and far-reaching of the merchant marine acts enacted over the last hundred years was the Jones Act of 1920. Congress passed the law because it was believed "necessary for the national defense and proper growth of foreign and domestic commerce that the United States shall have a merchant marine of the best equipped and most suitable types of vessels sufficient to carry the greater portion of its commerce and serve as a naval auxiliary in time of war or national emergency."

Pursuant to this goal, in addition to several other provisions related to subsidies and medical claims, the Jones Act contains the important stipulation, still in effect today, that all commercial waterborne cargo and paying passengers transported between two points in the United States must be carried by vessels built in the United States that are crewed by U.S. citizens, and at least 75 percent owned by U.S. citizens. Other subsequent federal regulations also mandate that at least half of all U.S. government cargos be carried by American-flag shipping, and 100 percent of all military cargos.

Currently, there are only about 90 oceangoing ships larger than 1,000 tons gross weight out of the entire 170-ship U.S.-flag merchant marine that meet the Jones Act criteria for carrying cargo and passengers between U.S. ports, or that qualify under the federally mandated criteria for transport of government and military cargos. Many of these are containerships that mostly ply routes to and from Hawaii, Alaska, and Puerto Rico and the lower forty-eight United States.

Most of the passengers and cargos transported under the Jones Act between U.S. ports are carried by small ferries, intracoastal and lake freighters, tankers, and barges towed by harbor and river tugs. Jones Act cargo vessels typically handle a combined total exceeding a billion tons of cargo annually. These cargoes are mostly bulk products such as petroleum, coal, iron ore, grain, crushed rock, and decorative stone. About three-quarters of this is transported via tugs and barges. Waterborne transportation of passengers is also an important

component of Jones Act domestic trade. Some 230 ferry operators, based in 39 U.S. states and territories, transport nearly 50 million passengers annually.

Although the president can waive the requirements of the Jones Act in time of national emergency, as President George W. Bush did during relief efforts after Hurricane Katrina in 2005 and President Barack Obama did after Hurricane Sandy in 2012, the act normally contributes to much higher shipping costs than would otherwise be the case. This is particularly true for cargos shipped between either Hawaii or Alaska and other places in the United States or its territories. For example, shipping a 40-foot container 5,700 miles from Los Angeles to Shanghai, China, on a foreign-flag cargo ship currently costs about $790, whereas it costs about $8,700 for the same container to be shipped 2,200 miles from Los Angeles to Honolulu on a U.S.-flag Jones Act–compliant cargo ship. The difference in costs is due mainly to much higher labor and operating costs of American-flag cargo ships, in addition to the paucity of oceangoing Jones Act–compliant ships and the consequent high demand for their services. For this and other reasons there have been several attempts in recent years, most recently by Senator John McCain in 2015, to modify or repeal the Jones Act. Proponents of the act have thus far been able to defeat all such efforts, however, citing possible adverse effects on national security because of the negative financial impact on the remaining U.S.-flag merchant marine fleet that could result.

U.S. Maritime Commerce

The primary commercial purpose for operating the merchant fleet is, of course, to make a reasonable profit. However, in the United States this is much easier said than done. U.S. shipping companies often have to compete with **rebates** given by foreign manufacturers to foreign shipping companies who ship their products, as well as subsidies provided by their governments. *Rebate* is a nice term for a kickback or bribe, a practice that is illegal under U.S. law but an accepted way of doing business in many foreign countries. Also, as previously noted, wages and other labor-associated costs are generally much lower on foreign-flag as opposed to U.S.-flag ships. Although somewhat offset by certain U.S. government subsidies, as will be explained later, these factors, along with the perennial problems of steadily increasing U.S. taxes and insurance costs, and higher U.S. maintenance and shipbuilding costs over the years, have caused the amount of American cargo carried in American ships to drop to only a very small percentage of the annual total. In general, it costs about three times as much to ship a cargo overseas in a U.S.-flag ship as in a foreign-flag ship.

In order to escape the high operating costs associated with U.S. registry, most merchant ships owned and operated by U.S. companies are registered and licensed in, and fly the flags of, foreign countries such as Panama, Liberia, the Marshall Islands, the Bahamas, and a dozen others. Their crews are also made up mainly of citizens from these countries. Ships in this category are said to be operating under **flags of convenience**.

Currently, there are only about 170 commercial oceangoing ships of more than 1,000 gross tons in the U.S.-flag fleet, manned by U.S. citizen merchant mariners, of some 32,000 such ships in service worldwide. Of these 170, about 50 are tankers, with the remainder being freighters of various kinds.

In the United States there are some 350 marine ports that handle freight, passengers, or both. More than 2.5 billion tons of cargo and 150 million passengers pass through these ports each year. Currently, the ten leading U.S. maritime ports, in the order of the volume of shipments handled, are the ports of south Louisiana between New Orleans and Baton Rouge; Houston, Texas; New York and New Jersey at Newark; Beaumont, Texas; Long Beach, California; Hampton Roads, Virginia; New Orleans, Louisiana; Corpus Christi, Texas; Baton Rouge, Louisiana; and Los Angeles, California.

As the world's oceangoing commercial fleet has been aging at a fairly rapid pace over the last decade, orders for new and larger merchant ships of all descriptions have been steadily increasing at building yards worldwide, with the exception of 2015, which suffered a worldwide economic depression. The pace of new orders has been especially brisk in Asia, where Japan, China, and South Korea together account for some 70 percent of the world shipbuilding market. Unfortunately, the United States does not get much of this business because of higher labor and construction costs here. Most of the large shipbuilding yards in the United States specialize in military shipbuilding, which constitutes about 60 percent of their overall business. Another 20 percent is ship repairs and overhauls,

Unfortunately, few new vessels like the U.S.-flag tanker SS *Maersk Peary* pictured here are being built and operated by U.S. companies.
Maersk Line

and the remainder is commercial shipbuilding, with most of that being mainly tugs, towboats, and barges. Hardly any large commercial ships are built in the United States.

The five largest shipyards in the United States are Newport News Shipbuilding in Newport News, Virginia, best known for its unique capability to build our large aircraft carriers; Ingalls Shipbuilding in Pascagoula, Mississippi, specializing in offshore drilling rigs, cruise ships, and smaller naval vessels; National Steel and Shipbuilding Company (NASSCO), a division of General Dynamics in San Diego, California, the primary West Coast commercial shipyard; Norfolk Naval Shipyard in Portsmouth, Virginia, specializing in overhauling and modernizing naval ships and submarines; and Electric Boat Division of General Dynamics in Groton, Connecticut, builder of most Navy submarines.

Modern Merchant Ships

Modern merchant ships include freighters, tankers, and cruise ships, as well as a host of other smaller special-purpose vessels and tugs and the like.

Freighters

Cargo ships, or **freighters**, are ships that carry cargo, goods, or materials. They include general cargo ships, dry bulk carriers, intermodal ships, multipurpose vessels, and reefer ships. Technically, tankers also fall within this category, although they are generally considered a separate type of ship. Cargo ships make up about 60 percent of the world's merchant fleets. They range in size from small single-hold ships to large multihold ore ships more than 300 meters (985 feet) long and able to carry 400,000 tons of ore. Cargo ships carry crews of ten to twenty or more, depending on their size and type.

General cargo ships carry packaged goods such as foods, machinery, clothing, and sometimes small vehicles in one or more large spaces called *holds*. Such cargo that must be loaded individually in bags, boxes, crates, drums, or barrels is called *break bulk* cargo. Like kinds of this cargo banded or otherwise fastened together and often transported and shipped on pallets is referred to as *unitized cargo*. **Dry bulk carriers** are specially designed to transport unpackaged loose *dry bulk* commodities such as grains, ore, and cement in their cargo holds.

The cargo carried by general cargo ships and dry bulk carriers is loaded and unloaded by means of large cranes. Sometimes these are installed on the ships as part of their deck equipment, but more often they are located ashore as part of large freight terminals. The dockworkers handling cargo ashore are called **longshoremen**. It usually takes several days for eighty or more longshoremen working together with the ship's deck crew to load or unload a large general cargo ship or dry bulk carrier.

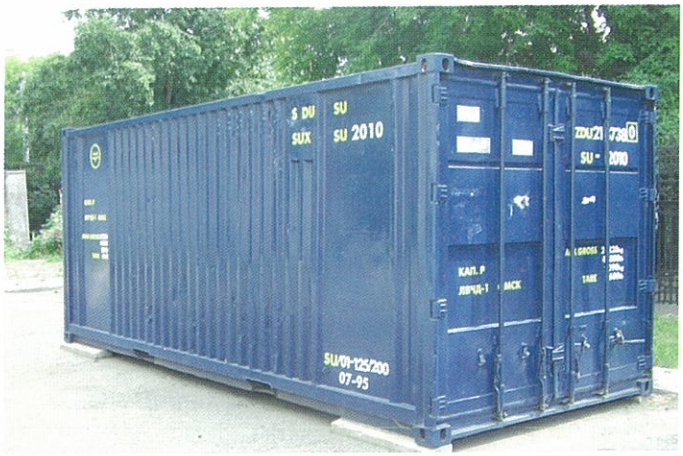
Intermodal ships are designed to interface seamlessly with modes of inland transportation such as trucks, trains, or inland waterways. Most of these are **containerships** that carry stacked, vanlike cargo containers. These ships have revolutionized waterborne freight transport worldwide and are now the most numerous ships in the U.S. merchant marine. The largest containerships range in length from 1,200 to more than 1,300 feet, can cruise at 33 knots, and carry from 8,000 to as many as 20,000 prepackaged TEU containers (described below). Containership crew sizes have decreased from forty or more to around twenty over the last decade or so, and may ultimately shrink to fewer than half a dozen as more automated ship technology becomes available in the future.

In 2015 two containerships fueled by liquefied natural gas (LNG) were placed in service, marking the first time this lower-cost and higher-efficiency fuel has been used to power large freighter-type vessels.

The **twenty-foot-equivalent-unit** (TEU) dry cargo container is the standard intermodal container by which containership capacities are expressed. They are 20 feet long, 8 feet

Cargo ships like the Portuguese dry bulk carrier SS *Sabrina I* make up about 60 percent of the worldwide merchant fleet. The ship has five holds with a total capacity of 67,500 cubic meters and four cranes.
N. Sandel

The containership *Colombo Express*, one of the largest containerships in the world, is capable of carrying more than 8,700 TEU containers. It is owned and operated by Hupag-Lloyd of Germany.
Wolfgang Meinhart



A standard twenty-foot TEU shipping container. Note the twist lock connectors at the corners.

A group of container gantry cranes at Bremerhaven, Germany. *Garitzko*

wide, and 8 feet 6 inches high, are made of corrugated steel or aluminum, and typically have a door at one end, although some have an open top or a door on the side for specialized cargos. There are fittings called *twist lock connectors* at every corner for handling, hoisting, and stacking. In recent years, however, standard forty-foot-long containers (FEUs) have become the most commonly used, rather than the TEU. Both can be readily intermixed and stacked on board a containership. There are also 45-, 48-, and 53-foot containers, though they are not as common. Specialized *reefer containers* incorporate refrigeration for shipment of perishable goods, and others are built around tanks for bulk liquid transport.

The standard size of the containers and their inherent security greatly enhance both ease of handling and protection against pilferage. One drawback of containers, however, is their susceptibility to being wrongly documented by shipping companies as to their contents and weight, to save on taxation and freight costs. Containers are often loaded and sealed far from ports, and containership operators depend on the declared contents and weight to plan their stowage on the ship. Except for general type of contents, containership crews are not privy to information about the specific cargo within each container. Containers with undeclared volatile contents in close proximity to one another can cause chemical hazards and fires, and undeclared extra weight has caused several stability-related mishaps in recent years, especially in rough seas, resulting in damage to ships and containers lost overboard.

A large containership can be loaded or unloaded in only a few hours by ten to twenty longshoremen using specialized semiautomatic container-handling equipment and gantry cranes, as opposed to the eighty-plus longshoremen required to load and unload conventional freighters. Once unloaded, containers can be placed easily on semitrailers or railroad flatcars for efficient transport overland to their destinations. This ability makes possible sea–land bridge freight transportation operations that have made international trade far less dependent on strategic waterways like the Panama Canal.

Roll-on roll-off (RoRo) ships are specialized intermodal cargo ships that have large hold openings designed to accommodate wheeled and tracked vehicles, which can be driven on and off via ramps. In contrast to the containership, this type of intermodal ship requires few facilities ashore—merely a strong ramp from the ship to a barge, pontoon bridge, or shore, usually built into the ship as part of its outfit. Most RoRo ships in commercial service today carry automobiles, with the largest able to transport six thousand to nine thousand vehicles. There are also hybrid versions called *RoPax* (roll-on roll-off passenger), designed to carry passengers on upper decks and vehicles on a lower car deck; *ConRo*, a hybrid combination of a RoRo ship and a containership with below-deck areas used for vehicle transport and topside for containers; and *RoLo* (roll-on lift-off), with vehicle decks accessed by a ramp and other cargo holds accessible only by a crane.

Multipurpose freighters are smaller vessels used to transport a variety of goods ranging from dry bulk commodities to break bulk, unitized, and heavy cargoes. They are sometimes fitted with tanks to allow simultaneous transport of liquids. A **reefer ship** is a refrigerated cargo ship used to transport perishable commodities such as fruit, meat, fish, vegetables, dairy products, and frozen foods.

Many cargo ships have accommodations for up to twelve paying passengers, who may book passage for varying lengths of time on a ship in order to cruise between various ports of call or simply to experience life or a vacation on this type of vessel. They are berthed in staterooms within the ship's superstructure, eat meals with the captain and ship's officers, and

have freedom to roam about the ship. International regulations require a medical doctor to be on board if more than twelve passengers are to be embarked, so most ships do not accommodate more than this number.

Tankers

Tankers, ships designed to carry large quantities of bulk liquids, constitute about 30 percent of all merchant ships plying the high seas. They vary greatly in size, with the largest modern **supertankers** exceeding 4.4 million tons (3.1 million barrels by volume) in capacity, with lengths in excess of 380 meters (1,246 feet). Large tankers called **crude carriers** are used to carry crude oil from oil-producing regions to refineries. Smaller ones called **product carriers** carry refined petroleum products. Many tankers belong to the major oil companies, whose ships carry their own brand name of refined products. The majority, however, are owned by independent operators who charter their ships to shipping companies.

Tankers such as the Saudi Arabian supertanker *Abqaiq*, shown here receiving 2 million barrels of crude at an offshore Iraqi oil terminal, are some of the largest ships on the high seas. *Andrew Mayers*

One type of LNG carrier is the Shell Oil SS *Galea* shown here. These ships carry either liquefied natural or petroleum gas at temperatures of –260° F. *Wolfgang Meinhart*

Even the largest oil tankers can load or unload their cargo in less than a day by hooking up to transfer piping extending from shore, either alongside a pier or at a mooring buoy offshore. The pumping process is controlled from on board the tanker. It is critical that strict safety procedures be observed during these times, as any random flame could ignite any explosive gases inadvertently released during the loading/unloading process, with disastrous results.

Tankers can and do carry other liquid cargoes besides **POL** (petroleum, oils, lubricants), including various chemicals and even wine. The most specialized types of tankers are the **liquefied natural gas** (LNG) and **liquefied petroleum gas** (LPG) **carriers**. These are sophisticated and expensive ships designed to carry natural gas and other forms of flammable gases in a liquid state at extremely high pressures and low temperatures.

Cruise Ships

Another type of commercial ship that has become increasingly important in recent years is the **cruise ship**. These ships are designed to accommodate anywhere from several hundred to several thousand passengers on pleasure cruises lasting from several days to several weeks or more, often including stops at popular vacation destinations along their cruise routes. They are outfitted to provide their guests with every amenity that would be expected in luxury resort hotels on land, including casinos, nightclubs, and swimming pools. Some of the newer cruise ships are as long as four football fields and can carry up to six thousand passengers berthed in more than two thousand staterooms. In 2015, the latest year on record as of this writing, more than 22 million passengers embarked on cruise ships worldwide, with the Caribbean and the Mediterranean regions making up about 70 percent of their areas of operation. Virtually

Royal Caribbean's *Brilliance of the Sea* at anchor at Mykonos, Greece. With a displacement of 90,000 tons and a length of 293 meters (960 feet), the ship is representative of many of the newer and larger cruise ships placed in service in recent years. Luxury accommodations can be provided for up to 2,500 passengers. *ShipParade photo by Richard Maidment*

all U.S.-owned oceangoing cruise ships sail under flags of convenience, usually Panama, the Bahamas, or Bermuda.

Special Purpose Vessels and Tugs

Special purpose vessels include tugboats, ferries, icebreakers, salvage ships, ocean research ships, hydrographic survey ships, cable-layers, weather ships, and the like. There are several varieties of **tugboats**. Large oceangoing and intracoastal tugs include those that tow barges by means of a long towline called a *hawser*; *notch tugs*, whose bows fit into notches of barges that are pushed ahead; *integral tugs* that can be rigidly connected fore and aft to a number of barges; and *articulated tugs* that use mechanical swivels to connect to their barges. These large tugs may have crews of six to eight or more. Smaller *harbor* and *river tugs* operate exclusively in internal and inland waters, and may have only one or two crewmembers.

Merchant Marine Crews

The makeup of the crew on board merchant marine vessels is somewhat different from the crews of naval ships. The ship's captain, called its **master**, is the highest-ranking member of the crew and is accountable to the operator of the ship for all activities occurring on it. The rest of the crew is divided into licensed supervisory-level officers called **mates** or **engineers**; mid-level personnel with specialized marine licenses; and several kinds and grades of unlicensed personnel, referred to as **ratings**. A typical seagoing cargo ship or tanker has a master, three mates, a chief engineer and three assistant engineers, and a dozen or more unlicensed ratings.

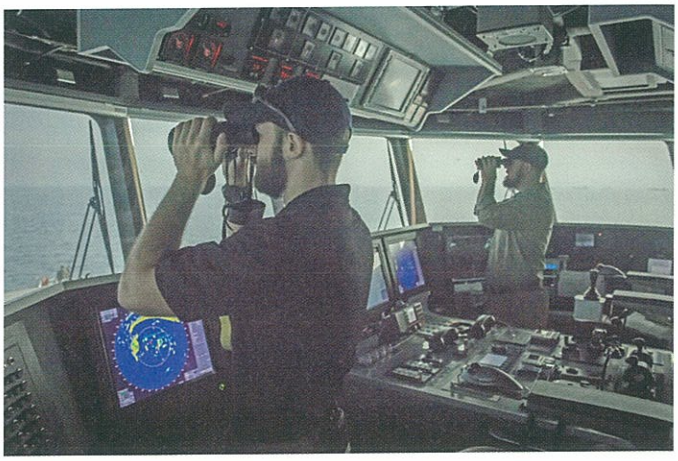
Masters, mates, and mariners with specialized licenses are roughly equivalent to Navy line officers, and the ratings are equivalent to junior petty officers and enlisted seamen. In contrast to Navy line officers, however, merchant marine mates and engineers generally have far more "hands-on" responsibility for the operation, maintenance, and repair of shipboard gear and machinery. In the U.S. Navy this is the purview of a number of grades of specialized enlisted ratings and warrant officers.

In general, the typical merchant ship's crew is divided among three departments: the *deck department*, the *engineering department*, and the *catering department*. Seafarers in the deck department have responsibility for the safe navigation of the ship, bridge watches at sea and security watches in port, cargo-handling gear, weather deck maintenance, and anchoring and mooring. Engineering department personnel are responsible for operation, maintenance, and underway repair of the ship's engines and all other machinery below deck. The catering department is responsible for meal preparation and serving, and general housekeeping services for the crew and any passengers embarked. Cruise ships also have an *administrative staff* consisting of all the personnel who care for and interact with the embarked passengers. On most cruise ships, the remainder of the crew seldom if ever has contact with passengers.

The second in command on the ship is called the *chief officer* or *first mate* and is the leading officer in the deck department. He or she supervises the crew, deck department, cargo handling, and deck seamanship evolutions, and is responsible for the welfare of any passengers, as, for example, on a cruise ship or freighter with accommodations for them. Also in the deck department are the *second officer/second mate*, usually the ship's navigator in charge of the ship's bridge and navigation, and the *third officer/third mate*, responsible for the security and safety of the ship. There may also be one or more *deck cadets*, apprentices on board for training, often from one of the various merchant marine academies in the United States or foreign countries. Deck department personnel include the *ship's boatswain*, *welder/fitters*, *cranemen*, *winchmen*, and unlicensed *able seamen* (ABs; sometimes colloquially referred to as *able-bodied seamen*) and *ordinary seamen* (OSs).

The engineering department consists of the *chief engineer* and as many as four assistants called the *second engineer* or *first assistant engineer, third engineer* or *second assistant*, and so on. Larger ships may have an electrical officer. Other more junior personnel in the engineering department include *motormen*; *boilermen*; *firemen*; *pumpmen*; and unlicensed *fitters*, *oilers*, and *wipers*.

On cruise ships and larger freighters and tankers, the catering department is headed by an officer called the *purser*, who is responsible for all administrative and supply functions. He or she keeps the ship's accounts and prepares and keeps payroll records. On smaller ships this department is headed by a licensed *chief steward*. Unlicensed personnel in the catering department, answering to the purser or chief steward, include



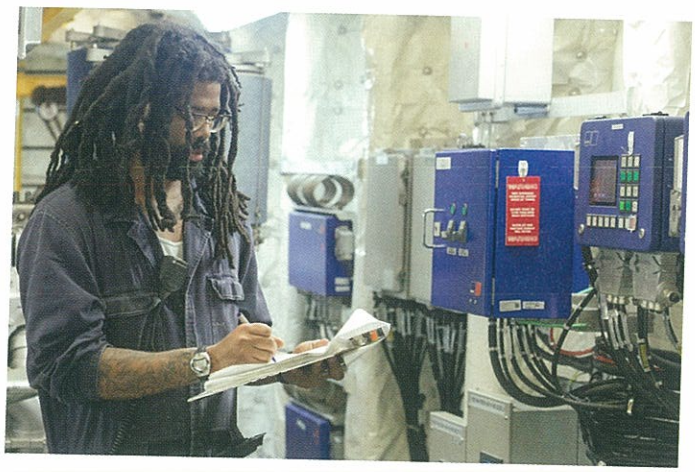
Two civil service mariners from the deck department stand bridge watches on board the USNS *Spearhead* (JHSV-1), a joint high-speed ship operated by the Military Sealift Command. *Sonny Lorrius*

the *chief cook*, *officers' cook*, and *baker* if assigned, and several unlicensed *stewards*, depending on the type and size of the ship. The latter help with meal preparation and are responsible for meal service, laundry, and other general housekeeping services within the ship.

Another big difference between a typical merchant ship crew and the crew of a naval vessel, particularly in the case of a foreign-flag ship, is that the crewmembers can be and often are citizens of several different countries and may speak several different languages, although English is considered the standard in most of the world's merchant marine. As a practical matter, this requires that the ship's master and other supervisory personnel such as the mates and engineers be conversant in several diverse languages and customs. In contrast, a naval warship or auxiliary ship is crewed by individuals of like citizenship and customs, all of whom speak the language of the nation under whose flag they sail.

Life in the Merchant Marine

While in the past life on board merchant ships could often be difficult, today living conditions on most modern merchant ships are generally fairly comfortable, with the possible exception of ships flying flags of convenience of nations not prone to undue regulation of shipboard conditions. On board most merchant ships, officers have individual staterooms, catered dining saloons, and other well-appointed facilities. Lower-ranking crewmembers bunk in one- or two-person cabins, eat meals family-style in crew dining facilities, and relax in crew lounges and libraries well stocked with DVD movies and music recordings. Most ships have exercise rooms, and some even have swimming pools. On most ships consumption of alcoholic beverages is allowed while off duty. Internet service at sea via satellite is routinely provided on most cruise ships and is becoming commonplace on many other types of merchant ships. All of these amenities are provided free of charge to the crews of most ships.



A civil service engine utilityman from the engineering department of the USNS *Spearhead* (JHSV-1) updates engineering logs.
Sonny Lorrius

The workday routine can be demanding, however, both at sea and in port. Most officers and other crewmembers have either an eight-hour or two four-hour watches or duty periods a day, in addition to performing four to six hours of often strenuous and sometimes potentially dangerous ship's work, often under demanding conditions topside or in cramped spaces below deck. In 2013 an international labor agreement called the Maritime Labor Convention of 2006 was signed into international law by thirty maritime countries worldwide. It has since been ratified by some seventy-five nations (not including the United States) representing more than 80 percent of global shipping. The convention contains provisions regulating such things as minimum age requirements (sixteen years of age minimum and eighteen for night work); working hours (not more than fourteen hours in a day or seventy-two in a week, including watches and overtime); wages (must be paid at least monthly); and availability of medical care (vessels carrying more than twelve passengers or one hundred people total must have on board a doctor, and those with fewer, a well-stocked medical chest and at least one crewmember certified in first aid and administering medications). Although the United States has not as yet ratified the convention, merchant marine vessels of the United States and other nonsignatory nations calling at ports of countries that have must abide by its regulations or be subject to seizure.

With the exception of ships' masters, who normally sign on for extended periods on board their ships, perhaps broken up periodically by several months of time off at home, other officers such as the mates and engineers usually sign contracts for tours of several months' duration. They are then free to either stay on board for another tour, hire on to another ship, or spend time at home before returning to work for another tour on either the same ship or some other. Likewise, more junior crewmembers such as able seamen and fitters sign on for tours lasting anywhere from a few months to six or nine months or more. Shipping companies will often bear the expense of their contracted personnel flying via commercial air back and forth between home ports and foreign ports of call where they can meet or depart their ships, depending on their job skills, seniority, tenure, and experience.

As was alluded to earlier in connection with shipbuilding, a significant part of the aging merchant marine fleets worldwide will have to be replaced over the next five to ten years. To crew these new ships, some 42,000 merchant mariners will need to be recruited in future years, along with an additional 15,000 masters, mates, and engineers. Young people with an interest in seafaring and traveling the world's oceans will therefore find

much opportunity for employment in the merchant marine of the United States and other maritime nations of the world throughout the next decade and beyond.

Merchant Marine and National Defense

An important auxiliary function for the U.S. merchant marine is to aid in the national defense. There are five important ways in which the merchant marine serves in this role: military sealift, transport of strategic material, direct support of military operations, use as auxiliary combatants, and support of foreign policy.

Military Sealift

The merchant marine transports most of the supplies and equipment needed to support U.S. military forces in both peace and war. This support, called **sealift**, may be intended for either U.S. or allied forces, and can be carried by either U.S. or allied ships. Airlift can complement sealift to provide initial fast response requirements, but sealift has always carried the great bulk of the total heavy lift requirements in most large-scale operations involving U.S. forces. From 1990 to 2010 in Operations Desert Storm and Iraqi Freedom in Iraq, and Enduring Freedom in Afghanistan, 95 percent of all the heavy equipment, fuel, and munitions needed was transported to the area of operations by sea. U.S. merchant shipping has continued to deliver some 90 percent of the cargoes needed to support the remaining U.S. and coalition security forces in Afghanistan and Iraq.

Shipping for U.S. national defense sealift requirements can come from the following sources:

Military Sealift Command (MSC). **MSC** is an organization within the Navy that controls most of its underway replenishment and military transport shipping. It also is one of three service component commands that report to the U.S. Transportation Command (USTRANSCOM), a unified command responsible for coordinating the movement of Department of Defense (DOD) personnel and logistics worldwide. MSC's mission is to provide ocean transportation of equipment, fuel, supplies, and ammunition to sustain U.S. forces worldwide both in peace and war, for as long as operational needs require. In support of its mission MSC routinely operates some 120 ships worldwide on a daily basis, including some 25 **prepositioning ships** loaded with contingency military supplies for all services that are maintained in key locations in the western Pacific and the Indian Ocean. Most ships operated by MSC are owned by the Navy, but some are chartered U.S.-flag commercial ships. By policy, MSC must first look to the U.S.-flag commercial market to meet all of its sealift requirements, with government-owned freighters and tankers used only when suitable U.S.-flag commercial vessels are unavailable.

Except for two hospital ships, which are painted white with large red crosses on their sides, all MSC naval ships are painted gray like U.S. Navy ships but can be identified by horizontal blue and gold bands on their stacks. They are designated U.S. naval ships (USNS rather than USS) and have type designators and hull numbers preceded by the letter T, as, for example, the MSC ship USNS *Benavidez* (T-AKR 306) pictured in this chapter. Crewmembers must be U.S. citizens licensed as civil service mariners by the Coast Guard. Chartered commercial ships retain their company color scheme, have no hull numbers, and retain their merchant marine designations, the most common being **SS** (steam ship) and **MV** (motor vessel). They must also be crewed by U.S.-citizen mariners.

Some thirty MSC ships, called **Combat Logistics Force** ships, consisting of dry cargo/ammunition ships (T-AKEs), fast combat support ships (T-AOEs), and fleet replenishment oilers

The MV *Vadm K. R. Wheeler* (T-AG 5001) is a Military Sealift Command offshore petroleum distribution system ship, one of the twenty-five ships in the Military Sealift Command's prepositioning program.

Hospital ship USNS *Comfort*.

(T-AOs), regularly engage in underway replenishment operations with the fleet. Other MSC ships include **service and command support ships**, such as the two hospital ships (T-AHs), the command ship *Mount Whitney* (LCC 20), commanded by a Navy captain with a combined civil service mariner/uniformed Navy crew, rescue and salvage ships, and fleet tugs; special mission ships such as ocean surveillance (T-AGOS) and oceanographic survey (T-AGS) ships; and thirty sealift ships such as MSC's 950-foot large medium-speed roll-on roll-off (LMSR) and newer 337-foot catamaran-hull expeditionary fast transport (EPF) ships. The LMSRs and EPFs are among the largest and fastest cargo ships in the world and can carry large quantities of wheeled and tracked vehicles at speeds up to thirty-three and forty-three knots, respectively.

The MSC prepositioning ships are a combination of government-owned LMSR, dry cargo, and dock transfer ships; chartered U.S.-flag container ships; and a few specialized ships activated from the Maritime Administration's Ready Reserve Force (described below). All prepositioning ships are crewed by U.S. civilian mariners who work for ship-operating companies under contract to the federal government. More details about these ships will be presented in chapter 9 on naval logistics.

Maritime Administration (MARAD). MARAD maintains a fleet of some fifty Ready Reserve Force (RRF) ships as a part of the previously mentioned National Defense Reserve Fleet (NDRF) established following World War II. The RRF was created in 1977 to provide a faster emergency sealift surge capability than was possible using mothballed NDRF ships. Ships for the RRF are acquired by upgrading selected ships from the NDRF, transferring merchant-type ships from MSC, or by direct purchase from U.S. or foreign owners. They are relatively well maintained and can be activated in from five to ten days. The RRF fleet currently consists of about thirty-five RoRo and fast sealift cargo ships plus a dozen crane, break bulk, and heavy lift ships and a tanker, mostly berthed at U.S. ports close to potential military load-out sites. Some are also a part of the maritime prepositioning ship force stationed overseas. They have small-cadre civilian crews augmented by additional merchant mariners when needed. Like MSC naval ships, RRF ships are painted gray, and they can be readily distinguished by the distinctive red, white, and blue bands on their stacks.

Activated RRF ships played a major role in supplying the U.S. military operations in Iraq and Afghanistan in 1990–2010. They supported Federal Emergency Management Agency (FEMA) relief efforts in the aftermath of Hurricanes Katrina and Rita in 2005, and participated in the relief efforts in Haiti following the devastating earthquake there in 2010. One RRF ship and two other NDRF training vessels provided berthing and meal service to Department of Homeland Security relief workers responding to Hurricane Sandy in New York City in late 2012.

The Military Sealift Command's large medium-speed roll-on–roll-off (LMSR) ship USNS *Benavidez* (T-AKR 306). Note the large ramp aft that can be lowered for vehicle access to barges, piers, or pontoon causeways, and the helo deck amidships.

As stated above, the RRF is a subset of the NDRF established by MARAD after World War II. At one time in the 1950s there were more than 2,200 mothballed World War II–era ships in the NDRF, plus a few more added in later years, moored at eight anchorages around the country. However, most have since been scrapped and their anchorages closed. The NRDF presently includes the fifty-odd RRF ships described above plus about two dozen old dry cargo, tanker, passenger, and naval auxiliary ships, laid up at two surviving NDRF anchorages at Beaumont, Texas, and in the James River at Fort Eustis, Virginia. They are in bad condition, and it is anticipated that most will be scrapped within the next few years. Another dozen NDRF vessels are currently used for training purposes, including seven at the various state maritime schools and the U.S. Merchant Marine Academy.

The Maritime Security Program (MSP). The MSP was enacted as a part of the Maritime Security Act of 1996, as a successor to an earlier program called the Sealift Readiness Program (SRP), under which half of all U.S.-flag merchant ships could be voluntarily conscripted for military sealift in time of national emergency. Under the MSP, forty-seven U.S. merchant ships were identified whose yearly operating costs would be subsidized by the federal government in return for an agreement that their owners would make these ships available for military sealift upon request of the Secretary of Defense during times of war or national emergency. The number of ships in the program was subsequently increased to sixty in 2003, with the additional provision that the subsidies under the program would be extended until at least 2025. The current

An underway replenishment operation with the oiler USNS *Leroy Grumman* simultaneously refueling a Navy aircraft carrier and a destroyer. The replenishment ship USNS *Supply* is steaming in the background.

annual subsidy paid under the MSP program is about $2 million per vessel. Most of these ships are among the ninety Jones Act–compliant vessels in the U.S.-flag merchant fleet described previously.

Voluntary Intermodal Sealift Agreement (VISA). In addition to the MSP program, the Maritime Security Act of 1996 also enacted a complementary program called the **Voluntary Intermodal Sealift Agreement**. Under the VISA program, contracts are prenegotiated between the federal government and the U.S. maritime industry to provide state-of-the-art commercial sealift and intermodal capacity, such as dry cargo ships and terminal facilities, to meet any future national mobilization needs. VISA would be implemented in three stages as the need increased, with stage III requiring participants to commit at least 50 percent of their capacity (a carryover from the old SRP program) and 100 percent of any dry cargo ships enrolled in the MSP program. In return, participants get priority preference when bidding on peacetime DOD cargo.

Effective U.S.-controlled (EUSC) ships. These are ships owned by U.S. citizens or corporations that are licensed by and sail under flags of convenience of other nations, mainly Liberia, Panama, and Honduras. The Department of Transportation may requisition EUSC ships for charter or purchase in time of national sealift emergency, upon authorization of the President, when requirements exceed the capability of VISA. However, there is some question about the responsiveness of these ships in all but the highest national emergencies, and some people doubt their value in a military sealift capacity because most of these ships are bulk carriers such as tankers, ore carriers, and grain carriers. Also, most of their crews are foreigners who may not choose to stay on board the requisitioned ships.

Foreign-flag ships. A final possible source of U.S. sealift assets is the charter of foreign-owned foreign-flag ships. There are obvious political drawbacks here, so the reliability of this source in time of national emergency is marginal at best.

Transport of Strategic Material

In addition to military cargoes, the merchant marine must carry the **strategic materials** (vital raw materials) and energy resources that support our national economy and defense establishment. Our allies also require such sealift. Britain, for instance, must continually import food to sustain its population, and Japan is totally dependent on imported oil, as are most of our other European allies. If the U.S. industrial complex is to support our forces and those of our allies in time of war, the movement of cargo across the oceans to and from the United States must continue uninterrupted.

However, an important concern has arisen in this area. From the commercial standpoint, in order to maximize efficiency, increasingly larger ships are needed to satisfy the ever-growing industrial demand for bulk strategic materials, particularly crude oil and metallic ores, and for carrying passengers on cruise ships. Consequently, fewer but larger and more productive ships are being built worldwide. In a wartime situation the United States and its allies could ill afford to lose many of these big commercial cargo ships and tankers because such attrition would have a serious impact on the ability to import strategic materials.

In time of a national emergency, defensive features would need to be incorporated into many of our merchant marine ships. In recognition of this, a provision exists that mandates certain defensive characteristics in ships built with government construction subsidies. The additional cost of such features is funded by the Department of Commerce on the basis of Navy recommendations. Among the features that can be incorporated into ships for better defense are improved compartmentation, helicopter pads, foundations for self-sustaining container cranes, overhead and ramp adjustments for RoRo ships, and more rugged materials than would be necessary for purely commercial use.

Direct Support of Military Operations

Ships of the merchant marine can be used in direct support of some military operations at sea. This was often done in World War II, particularly with tankers that were fitted with underway refueling rigs. Some bulk freighters were also fitted for transfer of cargo at sea. More recently there has been some design work and testing using containerships in this role, but more remains to be done.

Another example of direct fleet support is the sealift of follow-on supplies to support an amphibious operation, such as might be carried out by a modern-day Marine air-ground task force. This was also done extensively during World War II. The follow-on support should arrive within five days of the initial amphibious assault. It consists mainly of weapons and supplies that cannot be put ashore during the initial landings but are necessary to keep the offensive going. If available in theater (the local region), such support would initially be provided by ships of the MARAD prepositioning force described above. Further resupply of troops, weapons, and other war matériel thereafter would most likely be delivered by sealift by MSC and the other merchant marine shipping described earlier in this chapter.

Auxiliary Combatant Role

Merchant ships can be easily converted to perform a variety of combatant roles, in which they are called **auxiliary combatants**. The history of this adaptation goes back to the privateer in the Revolutionary War and War of 1812. Later, merchant raiders, or *Q ships* (ships that looked like cargo vessels but carried hidden weapons), were used, principally by the Germans, in the two world wars. The United States converted tankers and freighters into escort carriers in World War II. Also, most World War II amphibious troop and cargo ships were converted merchant ships. There are many possible military applications for the fast new ships now entering the merchant marine. For example, they could be fitted with defensive weapon systems or sonar, and RoRo ships with their large, clear main decks and others fitted with helo pads could support military aircraft such as helicopters, V/STOL (vertical or short takeoff and landing) planes, and UAVs (unmanned aerial vehicles).

Support of Foreign Policy

A frequently overlooked contribution of the merchant marine to national defense is its role in support of foreign policy. Historically, the British and American merchant fleets were very instrumental in developing the nineteenth-century foreign policies of those nations, and the Soviets made much use of their merchant marine to support their foreign policy toward Third World nations during the Cold War years of the twentieth century.

The United States has not actively pursued this option for a long time. The potential to promote U.S. foreign policy through the American merchant marine is great and should be more seriously considered. At present, however, most American foreign aid and trade goods are shipped in foreign-owned and -flag ships. Moreover, the trend toward ever larger ships with cargoes in containers further diminishes the opportunity to "show the flag" in underdeveloped countries. Such countries may have only small ports that lack the water depth and facilities to handle large containerships and tankers, and the local market for their goods may be too small to make port calls by such large ships profitable.

The Future

The hard fact is that the United States is an island nation that needs merchant ships at sea and trained sailors in those ships. The ships must be able to serve the needs of the nation in both commercial and defensive capacities.

The U.S. shipbuilding industry must push technology to cut costs. The nation must intensify efforts to develop modern modular weapons installations for the defense of merchant ships and to facilitate the use of containerships in support of the naval fleet.

The American people must not lose sight of the fact that the nation's prosperity and survival depend on our ability to use the seas for international trade. The combination of strong naval forces and a strong merchant marine, together serving the commercial and strategic needs of the nation, is the beginning of true sea power.

Critical Thinking

1. Obtain economic data for Japan and Great Britain from the *CIA Factbook*, the Internet, or any other economic reference. Compare and contrast these nations in regard to their imports/exports of food, fuel, other energy sources, and manufactured goods.
2. Trace the decline of the American merchant marine from Civil War days to the present, citing the major factors involved and effects on U.S. foreign trade.
3. Compare and contrast life in the U.S. Navy with life in the American merchant marine, including pay scales and normal tours of duty on the various ships of each.

Study Guide Questions

1. What is the basic means for moving vast quantities of raw materials and manufactured goods throughout the world?
2. A. How much of the domestically produced goods in the United States are produced wholly or in part using materials transported via water?
   B. What tonnage of dry and liquid waterborne cargo is shipped domestically and internationally by the United States each year?
3. Why is the U.S. merchant marine an important part of U.S. sea power?
4. Why did our merchant marine decline during and after the Civil War?
5. A. What were the two types of merchant ships mass-produced during World War II to meet the auxiliary needs of the wartime Navy?
   B. What happened to them after the war?
6. A. What act passed in 1936 created the U.S. Maritime Commission and is still the basis of many of the programs that support U.S. merchant marine policy today?
   B. What new agency took over the functions of the Maritime Commission after it was abolished by Congress in 1950?
7. Besides the U.S. Merchant Marine Academy at Kings Point, New York, what other state maritime academies are there?
8. A. What significant merchant marine act that still governs domestic maritime shipping within the U.S. today was enacted in 1920?
   B. What was its most important provision?
   C. What major negative effect has it had?
9. What are the key factors that have caused American cargo in American ships to drop to a very low percentage of the world's total?
10. A. What common practice do U.S. shipping companies resort to in order to escape the high operating costs associated with U.S. registry?
    B. What term is applied to ships operating under these foreign flags?
11. A. What are the ten leading ports in the United States?
    B. What are the five largest U.S. shipyards, and where are they located?
12. What are the main types of modern merchant ships?
13. What are the main types of freighters?
14. A. How does the containership work?
    B. What are its most significant advantages?
    C. What is now the most common size of container used on board these ships?
15. What are the major advantages of RoRo ships?
16. What do tankers carry?
17. In what regions of the world do most cruise ships operate?
18. What are the titles and ranks of merchant marine ship crewmembers?
19. What are the three departments on board a typical merchant ship?
20. In what five ways does the U.S. merchant marine contribute to national defense?
21. What is the mission of the Military Sealift Command?
22. A. How can MSC ships be visually identified?
    B. What letter prefix before their designator and hull number is used to identify them?
23. What are prepositioning ships and where are they stationed?
24. What are the MARAD Ready Reserve Force ships, and where are they maintained?
25. What is the VISA program?
26. A. Why are increasingly larger ships being constructed for the world's merchant marine?
    B. How could this be a military disadvantage in the event of war?
27. How may merchant ships be used in direct support of military operations?
28. What auxiliary combatant roles could modern U.S. merchant marine ships play?

New Vocabulary

subsidies
rebates
POL
dry bulk carriers
break bulk cargo
containership
longshoremen
RoRo ship
ConRo ship
reefer ship
crude carrier
LNG
cruise ship
notch tug
articulated tug
sealift
prepositioning ships
Combat Logistics Force
SS/MV
NDRF ships
VISA (maritime act)
strategic materials
Q ships
MARAD
flags of convenience
intermodal ship
dry bulk commodities
unitized cargo
twist lock connectors
TEU
RoPax ship
RoLo ship
tanker
product carrier
LPG
hawser
integral tug
steward
MSC
naval auxiliary ships
USS/USNS
RRF ships
MSP ships
EUSC ships
auxiliary combatant
V/STOL

3

Grand Strategy

Both civilian and military leaders must consider strategic matters at the national level. **National strategy** combines all the capabilities of a nation, during peace as well as war, to attain national interests and objectives. Within national strategy there are political, economic, diplomatic, legal, and naval and military strategies, both international and domestic. All of the national strategies together constitute **grand strategy**, the art and science of employing national power to achieve national objectives. This can be done through threats, force, rewards, diplomacy, subterfuge, and other means. The lifeblood of a nation and trillions in national treasure rely on an effective grand strategy. Since we are a government of and by the people, all Americans should be knowledgeable about U.S. grand strategy because it is our national plan for the future.

U.S. grand strategy is governed by the Constitution, U.S. law, government policy regarding international law, and the national interest as expressed by our national security policy. This direction leads to unified effort and action across our government to achieve national goals. At the strategic level, unity of effort requires coordination among government departments and agencies within the executive branch; between the executive and legislative branches; with nongovernmental organizations, intergovernmental organizations, and the private sector; and with nations in alliance or coalition.

Grand strategy is the most important aspect of our national defense, but it is by no means confined to our military forces and institutions; it is far broader than that, encompassing all forms of national power. **Military strategy** involves physical violence or the threat of such violence. It seeks to attain goals through force of arms. Grand strategy, if successful, will attain national objectives without violence. More important, grand strategy looks beyond victory to a lasting peace. Military strategy must be controlled by the grand strategy of which it is an important part. The true aim of grand strategy, then, according to British strategist Liddell Hart, is to "seek a situation so advantageous that if it does not of itself produce the decision, its continuation by a battle is sure to achieve this." Even the legendary ancient Chinese strategist, Sun Tzu, said that "to subdue the enemy without fighting is the acme [highest level] of skill."

From the earliest days, our national grand strategy has been based on four basic principles: the defense of American territory and that of our allies, protecting American citizens at home and abroad, supporting and defending our constitutional values and form of government, and promoting and securing the U.S. economy and standard of living. Although the specifics of how to achieve these goals have continually evolved over the years, these core principles have remained basically unchanged throughout American history.

The early American political and military leaders who established our nation were strongly influenced by the ideals of the American Revolution and by the Age of Enlightenment then ongoing in eighteenth-century Europe. The Enlightenment was a philosophical movement emphasizing liberty, religious tolerance, constitutional government, and separation of church and state. Ever since that time, American grand strategy and foreign policy have included that same idealistic component, often referred to as *American exceptionalism*—an enduring impulse to promote democratic values and the rule of law.

This chapter traces the evolution of grand strategy from ancient times to the present and discusses the main concepts in this evolution that have shaped U.S. national grand strategy up to the modern era.

Evolution of Grand Strategies

A study of grand strategy is such a complex and fascinating task that it is impossible to cover the subject in a brief chapter such as this. One way to study strategy would be to try to digest the concepts and principles of strategy as written and carried out by the world's greatest acknowledged strategists. This would include *The Art of War*, believed to have been written sometime in the fourth century BC by the first great mind to shape strategic thought, the Chinese general Sun Tzu. His concepts rank with the most profound of all time, and most of his ideas are just as applicable in our world today as they were in his.

Alexander the Great of Macedonia (356–323 BC) was the first Western grand strategist. He dreamed of a world empire, an idea many since him have tried to achieve without as much success. Alexander determined that war is always conducted on two levels: physical and psychological. His campaigns can be studied today as examples of how to apply every principle of war, both militarily and in other ways.

Hannibal of Carthage and Scipio Africanus of Rome, the major opponents in the Second Punic War (218–201 BC), were both exceptional military strategists. So was Julius Caesar (110–44 BC). Niccolò Machiavelli (1469–1519), the great Florentine politico-military theorist, broadened strategic thinking when he wrote on the sources, applications, and limitations of power. His unscrupulous concepts of diplomatic and military conduct would inspire the dictators of the twentieth century.

Karl von Clausewitz (1780–1831). His book *Vom Kreige* (*On War*) is generally acclaimed as the most influential writing on strategy ever published.

During the sixteenth century, knowledgeable thinkers of the day began to differentiate between strategy and the tactics used to achieve it, linking military action with political policy at the international level. Frederick the Great of Prussia (1712–86) became the next great grand strategist, developing from his central geographic position the concept of "interior lines" (secure routes and methods of command, control, and maneuver) on the battlefield. However, he used statesmanship to even better advantage to secure the foundation of the German empire.

Napoleon Bonaparte of France (1769–1821) applied existing strategic theories to perfection. Except for his 115 military maxims he did little writing, but he made many strategic contributions indirectly through subsequent writers who critically reviewed his campaigns. The two most important of these were Antoine Jomini (1779–1869) of France and Karl von Clausewitz (1780–1831), a Prussian. Jomini began the modern systematic study of the subject of war, particularly the maneuvering of troops to occupy territory. The nineteenth-century French military leaders and many American Civil War field commanders used Jomini's strategic concepts.

Clausewitz concerned himself with the basic nature of war. His book, *Vom Kriege* (*On War*), is generally acclaimed as the most influential writing on strategy ever published. Much of it can be applied successfully to modern times, though some modifications have to be made for present-day circumstances. Clausewitz showed that war has both social and political aspects. Probably his most famous statement is that "war is not merely a political act, but also a real political instrument, a continuation of policy carried out by other means." He continually asserted that military and political strategy must go hand in hand.

Clausewitz recognized the concept of "limited aims for limited warfare," with the purpose of wearing down an opponent. In other words, he saw beyond the battlefield toward the eventual enforcement of policy over an enemy. A later strategist, Hans Delbrück, a German, further clarified Clausewitz's meaning. He showed that Clausewitz had defined two methods of conducting war: annihilation of the enemy in decisive battle, and limited warfare, or a strategy of exhaustion. In the latter concept, the commander could move between battle and maneuver. The political object of war could be obtained by means other than all-out battle, such as by occupying territory, blockade, or destroying crops and commerce.

In the nineteenth century, strategic thinking was increasingly influenced by the Industrial Revolution and the changes in society it engendered. New technology, including new methods of propulsion, communication, and power projection, had a great impact on national and military strategy. In America there was an increasing emphasis on the importance of education in the development of a professional officer corps: the U.S. Military Academy was founded at West Point, New York, in 1802, and the first American naval academy had its beginnings as the Philadelphia Naval Asylum in Philadelphia, Pennsylvania, in 1838. It was moved to Annapolis, Maryland, in 1845 and renamed the U.S. Naval Academy. The Naval War College was established at Newport, Rhode Island, in 1884. American society shifted from being predominantly agrarian-based at the beginning of the century to industrially based at the end, spurred by the outcome of the Civil War in the 1860s, with attendant shifts in attitudes and philosophies. Philosophers such as Karl Marx (1818–83) rose to prominence in Europe. In 1867 he added a new dimension to strategic thought when he published the first volume of *Das Kapital*, a critique of the then ongoing world shift toward capitalism; the book would later become the basis of modern communism.

Schools of Strategy

Three classical **schools of strategic thought** developed between the late nineteenth and mid-twentieth centuries: maritime, continental, and aerospace. Each became the basis of the grand strategies of some of the major powers for much of the

twentieth century. All three of these theories still have their merits and continue to find favor with many strategic theorists today, although all have had some details of their original theses altered to reflect current circumstances.

The Maritime School

In the late nineteenth century, the great American naval strategist Alfred Thayer Mahan (1840–1914), at that time the second president of the Naval War College, developed a strategic theory that would revolutionize naval strategic thought. In 1890, after extensive studies of the strategies of Napoleon, Jomini, Clausewitz, and the English admiral Lord Nelson, he published a brilliant text on naval history and strategy, *The Influence of Sea Power upon History, 1660–1783*. This book, and subsequent writings by Mahan, had a profound influence on the theory of warfare and on naval policy and strategy in the United States and abroad from that time forward. It was quickly adopted by the Imperial Japanese Navy as a textbook, and led to Japan's confrontation with Russia in the Russo-Japanese War in 1904–5. It also received acclaim in Germany, Britain, and later China.

Acclaimed as America's greatest naval strategist, Alfred Thayer Mahan (1840–1914) published his famous text on naval history and strategy in 1890. It revolutionized naval thought and had a profound influence on the theory of warfare and on the development of naval policy and strategy in the United States and abroad.

Mahan advocated a large navy, overseas bases, and national greatness through sea power. He emphasized the significance of commerce in war, and of economic warfare through the application of sea power. He was convinced that a coalition (allied group) of nations in command of the seas could best acquire the trade, wealth, and resources of the world and be more likely to win future wars. He applied Frederick the Great's concept of interior lines of communication to naval strategy, arguing that central position in the world's seas was even more important than central continental position. He viewed concentration of naval forces and command of the sea approaches as fundamental to America's attainment of **insular safety** (safety resulting from our separation from likely aggressors by the oceans surrounding us), national greatness, and prosperity.

President Theodore Roosevelt and the U.S. Navy adopted Mahan's theory of naval strategy and the use of the Navy as an instrument of national power. When the United States acquired overseas possessions as the result of the Spanish-American War in 1898, our strategic position in the world was dramatically changed. America emerged as a world power, permanently altering the strategic balance of power among the nations of the world.

The geography of the Earth has not changed since Mahan's writing, though politics and weapons have. There is no question that the United States is a maritime nation and always will be. Mahan's theory of maritime strategy remains completely applicable to America and its allies. Insular safety is no longer a valid concept, however, with the advent of land- and sea-launched intercontinental ballistic missiles.

The Continental School

In 1919, some thirty years after Mahan's writings, British geographer Sir Halford J. Mackinder (1861–1947) published an alternative thesis that emphasized the strategic importance of geographic landmasses. In *Democratic Ideals and Reality* he hypothesized (suggested) that by controlling Asiatic Russia and most of Eastern Europe, an area he called the "Heartland," a central land power could eventually extend its control to the rest of the world.

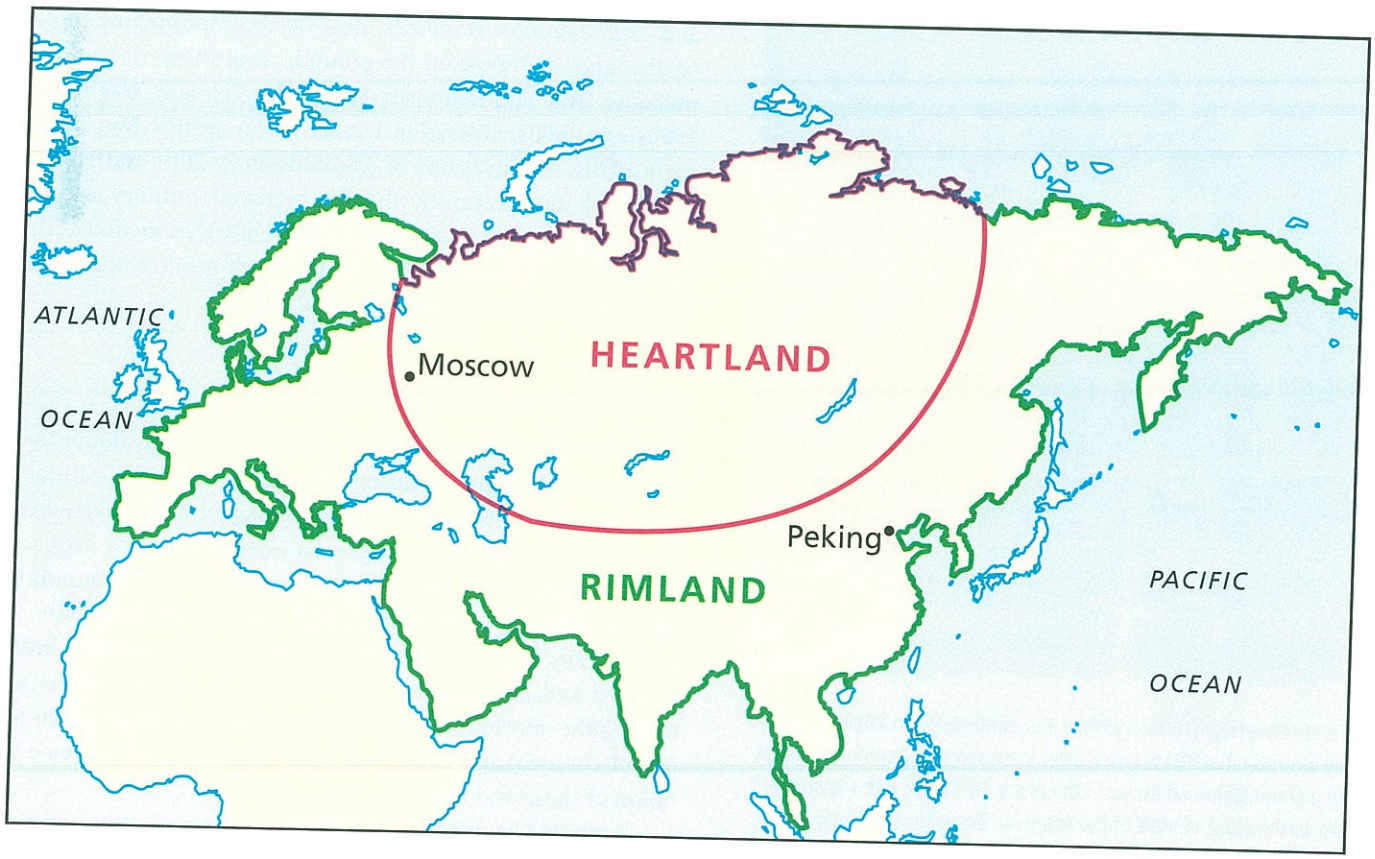
Mackinder believed that the nation in control of this strong, centralized land position could move powerful armies in any direction with little opposition. The first goal of such a nation would be to subjugate (conquer) the rest of Europe and Asia; this **geographic rimland** (peripheral lands) of Eurasia he named the "Inner" or "Marginal Crescent." The next step would be to conquer Africa, which, along with Eurasia, he called the "World Island." Once consolidated, he believed that the nation

in control of this World Island would control the bulk of the world's resources. Then it would be just a matter of time before the remainder of the world, called the "Outer" or "Insular Crescent," would fall under the domination of the central land power.

World War I and World War II in the European and Atlantic theaters can be viewed as battles for supremacy fought between the continental powers of central Europe, as per Mackinder's theories, and the maritime powers of Western Europe and the Americas, as per Mahan's. They were in many ways fought to prevent Mackinder's postulations from becoming reality. The proponents of Mahan's theories were ultimately victorious in both these conflicts and in the Pacific War of World War II. Nevertheless, Mackinder's theories foretold the nature of much of the conflict that would occur between the Soviet Union and the West during the Cold War years that followed the war. In the Cold War, the Soviets took over the role of the continental land power that sought to extend its domination of the Heartland to the World Island and beyond. However, it was ultimately blocked from gaining control of the Inner Crescent (the Middle East and Southeast Asia) by the dominant sea power, the United States, and by the Western European NATO nations.

Many contemporary strategists still support Mackinder's basic theories, although the continental school ideal of totally secure interior lines of communication (infrastructure such as communications networks, roads, bridges, and railroads) in the Heartland has been shattered by strategic bombers and intercontinental missiles. In addition, the development of an advanced system of roads and rail transportation sufficient to establish these interior lines has proven to be problematic and will probably never happen.

Sir Halford J. Mackinder (1861–1947) established the continental theory of strategy, in which the control of the Heartland consisting of Asiatic Russia and Eastern Europe would be key to controlling the rest of the world.



The Heartland and Rimland, as per Mackinder's continental school of strategy. *Journal of Liberty and International Affairs*

The Aerospace School

With the advent of technologically advanced aircraft and guided missiles after World War II, many proponents of modern air power declared both Mahan's and Mackinder's theories obsolete. One such critic who gained prominence was Army Air Corps strategist Maj. Alexander de Seversky (1894–1974). Born in Russia, he had been a pilot in the Imperial Russian Navy through the early part of World War I and was Russia's top naval air ace before being assigned as assistant naval attaché at the Russian embassy in Washington, D.C. When the Bolsheviks took over Russia, he joined the U.S. War Department as an aeronautical engineer and test pilot. With the war's end he started his own aircraft corporation, became a U.S. citizen in 1927, and obtained a commission as major in the Army Air Corps Reserve.

When World War II broke out in Europe, de Seversky became America's best-known philosopher, prophet, and advocate for air power, eventually even serving as an advisor to the chief of staff of the Army Air Corps. Benefiting from earlier work by Italian army air officer Giulio Douhet and the experiences of World War II, de Seversky authored *Victory through Air Power* in 1942 and, in 1950, *Air Power: Key to Survival*. Both books put forth the premise that complete **air superiority** (total and extended control of the airspace over a contested battle area or battlespace), as opposed to just local or temporary control, could impose total surrender on an enemy. He criticized overseas bases as untenable (defenseless), downgraded the importance of naval and land combat, and stated that "the manifest destiny of the United States is in the skies."

Alexander de Seversky (1894–1974) at the controls of an Imperial Russian Navy aircraft circa 1914. Later, after becoming an American citizen, obtaining a commission as major in the Army Air Corps, and serving as an advisor to the chief of staff of the Army Air Corps during World War II, he became America's best known proponent of air power and advocate for what became known as the Aerospace School of Strategy.

In de Seversky's view the main area of East-West confrontation would be across the Arctic Ocean, not the Atlantic or Pacific. He drew a circle centered on the United States, showing the five-thousand-mile strike radius of contemporary manned strategic bombers, and a similar circle centered on the Soviet Union. The southernmost parts of these circles represented U.S. and Soviet air dominance areas. The central area where the circles overlapped he called the "Area of Decision"; it encompassed the bulk of the northern Eurasian and North American continents, and the entire Arctic region. Here, he postulated, the struggle for mastery of the air would be decided, and with that decision, domination of the globe.

Most strategists today believe the aerospace theory is entirely too restrictive. People and nations are located on the Earth's surface, and so are its resources. Resolution of conflict and exploitation of resources must be accomplished by forces on the land, or "boots on the ground," regardless of the aerial outcome. This was demonstrated in the Vietnam War in the 1960s and 1970s, Operation Desert Storm against Iraq in the early 1990s, the invasions of Afghanistan in 2001 and Iraq in 2003, and most recently, the international military actions against ISIS/IL in Syria and the Middle East. Destruction of the surface by air attack alone will not by itself result in the defeat of an enemy in control of the ground beneath.

Grand Strategy and Preparedness

World War II and its aftermath proved beyond any doubt that modern war had grown closer to total war than ever. Military strategy now had to be considered—along with science, industry, diplomacy, and psychology—an integral part of a national grand strategy. War had become a contest of opposing political and economic ideas waged on all fronts in the international arena. A key factor in such a competition is **preparedness**, both military and nonmilitary. Preparedness is a matter of maintaining the appropriate strength or power base from which to launch the ideas and take the actions essential to the implementation of the grand strategy.

Among Clausewitz's teachings is the following, which anyone who would reduce American preparedness should seriously consider:

> Woe to the cabinet which, with a policy of half measures and a fettered military system, comes upon an adversary who . . . knows no other law than that of his intrinsic strength. Every deficiency in activity and effort then is a weight on the scales in favor of the enemy. If bloody slaughter is a horrible spectacle, then it should be a reason for treating war with more respect, but not for making the sword we bear blunter and blunter by degrees from feelings of humanity, until once again someone steps in with a sword that is sharp, and hews away the arms from our body.

Clausewitz's statement points out that a government cannot deter an adversary from waging war with half measures and inadequate military strength. Every sign of deficiency will be used to advantage by the opponent. The sentiments expressed by our first president, George Washington, are still as valid today as they were then: if we hope to avoid war, then the best strategy is to be fully prepared to fight one.

Evolution of U.S. Grand Strategy

U.S. grand strategy has evolved through several phases from the early days of our republic to the present day in response to the ever-changing dynamics of the world around us.

Western Hemispheric Defense and Isolationism

In the first major phase of U.S. grand strategy, referred to as the period of **western hemispheric defense** (1783–1898), entangling alliances were shunned. The United States tended toward **isolationism** (a national strategy of freedom from entangling alliances) while wisely recognizing the balance of power that existed in Europe, and the fact that the British Royal Navy's command of the seas ensured our national security. The Monroe Doctrine, for example, was allowed to stand almost unchallenged for a century after its announcement in 1823 because of the balance of power existing in Europe after Napoleon's defeat in 1815.

Limited Interventionism

The next major phase of U.S. grand strategy, **limited interventionism**, or the use of limited military force or other types of coercion to attain national foreign policy objectives, emerged with the U.S. victory in the Spanish-American War of 1898 and has lasted in one form or another up to the present day. The Spanish-American War, while revealing many shortcomings on the part of the American land forces, showcased a powerful and far-reaching American Navy. The war made the United States an imperial power with newly won possessions in the Caribbean (Puerto Rico) and the Pacific (the Philippines and Guam). America had now moved onto the world stage. The United States abandoned its long-standing isolationist policy and began to participate in world affairs. U.S. sea power, spurred by Mahan's writings, became our major military force, showing the flag, protecting our commerce, and extending our periphery of defense to our overseas territories. American military power, especially sea power, would play a major role in the victory of the United States and its allies in the two world wars that would follow in the twentieth century, as well as in the Cold War after that.

Containment, Massive Retaliation, and Mutual Assured Destruction

Following World War II, both the Soviet Union and China adopted political doctrines and ideologies greatly at odds with the values and interests of the West. Both these countries began worrisome endeavors to try to expand communism worldwide, with a major strategy being the support of numerous communist revolutions in developing countries.

As America rapidly demobilized its armed services in the postwar years, the Soviet Union engaged in building up a powerful and dangerous military force that soon acquired a nuclear component capable of threatening the United States. Despite huge losses suffered during the war, the USSR nevertheless pursued a ruthless political and military program that soon brought all of Eastern Europe under its control. In Asia, the Communist Chinese finally brought an end to their long civil war, driving the Nationalists to Taiwan and solidifying their status as a regional power. The stage was thus set for decades of confrontation that would become known as the Cold War.

The strategy formulated by the postwar Truman administration in 1946–47 to counter the expansionist communistic ideologies and actions of the USSR and China was called the **containment strategy**. It would end with the dissolution of the Soviet Union and the end of the Cold War in 1991. During the intervening years, the containment strategy was closely related to the strategy of limited interventionism, because the pursuit of containment often required military intervention to some degree, and military intervention in foreign states was often justified as required to achieve containment.

To contain the expansionist moves of China and especially the Soviet Union, the United States engaged in two major wars in Korea and Vietnam, and orchestrated or sponsored lesser military interventions throughout the 1970s and 1980s in numerous other countries including Grenada, Nicaragua, Angola, Somalia, and Afghanistan. Rather than direct involvement of U.S. military forces as in the first two conflicts, however, intervention and containment in the latter cases often involved the use of *surrogate* (substitute) indigenous (local native) military or paramilitary forces, extensive military and economic aid, and, on occasion, extensive media campaigns. Other initiatives

to contain the expansionist policies of the People's Republic of China during these years centered on keeping a strong American presence in the western Pacific through such measures as the maintenance of a robust U.S. Seventh Fleet; mutual defense treaties with Japan and with South Korea that allowed the stationing of American troops in both these countries; and the Taiwan Relations Act, which both allowed the United States to sell defensive arms to that country and strongly implied that the United States would come to Taiwan's assistance should China seek to conquer it by force.

For a time during the post–World War II years, America had little left with which to pursue its containment strategy to counter communist military aggression except its monopoly in nuclear weapons. It was during this time, therefore, that the United States sponsored the major mutual defense and collective security pacts known as the North Atlantic Treaty Organization (NATO) with the Western European democracies, and the Organization of American States (OAS) with many of the Central and South American countries. Both are still in effect today. The United States provided the nuclear umbrella integral to each of those strategic alliances. The Soviet Union, however, exploded its own version of the atomic bomb in 1949 and soon built up a nuclear arsenal comparable to that of the United States. In 1954 Secretary of State John Foster Dulles in the Eisenhower administration proclaimed the threat of **massive retaliation** by U.S. nuclear arms should the Soviets try to use their conventional or nuclear military forces to try to invade Western Europe or the Americas.

Over the next decade there followed a nuclear arms race between the United States and the USSR, featuring dramatic increases on both sides in the numbers of nuclear weapons and the means to deliver them. A doctrine that became known as **mutual assured destruction** (MAD) was adopted by both sides as a part of their national military strategies, wherein the destruction of each side by the other should a nuclear war erupt would be assured, thus deterring the use of such weapons by either. At the same time, however, it also prompted the nuclear arms race to continue unabated.

Overall these strategies were successful during the balance of the Cold War years and prevented another major war, even with confrontations as dramatic as the Cuban Missile Crisis in 1962. However, as noted, nuclear deterrence/massive retaliation failed to discourage the outbreak of limited wars along the eastern rim of Asia from Malaysia to Korea during and after the 1950s. The strategic reliance on a single weapon system proved to be inadequate for the challenge of the times. Other options had to be developed.

Flexible Response

Following the Cuban Missile Crisis, the Kennedy administration undertook a modification of the U.S. massive retaliation strategy to cope with *all* levels of aggression, in a new strategy called **flexible response**. This involved the development of an ability to apply controlled force decisively against any kind of aggression, at times and places of our choosing. The armed forces were directed to be ready to suppress, simultaneously, a general war, a major conventional war in Europe or Asia, and minor insurgencies or revolutionary wars worldwide. That ambitious undertaking soon ran into budgetary roadblocks. Flexible response was too expensive, and the American public became increasingly unwilling to pay the price to maintain such force capabilities. Further changes in our national strategy would have to be made.

The Nixon and Carter Doctrines

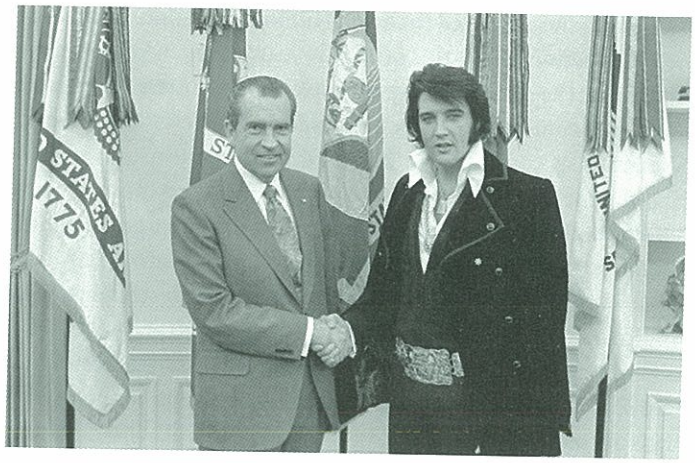
Notwithstanding its impractical aspects, flexible response was a valid strategy for the times. It was the manner of implementing it that needed revision. All of the aspects—credible deterrence, collective security, and appropriate response—had to be present. President Richard Nixon made good progress in refining the strategy to a viable doctrine.

There were three main principles in the resulting **Nixon Doctrine**, as announced by him in 1969:

- The United States would keep all of its treaty commitments.
- The United States would provide a shield if a nuclear power threatened the freedom of a nation allied with the United States or of a nation whose survival the United States considered vital to its security.
- In cases involving other types of aggression, the United States would furnish military and economic assistance when requested in accordance with its treaty commitments. But the United States would look to the nation directly threatened to assume the primary responsibility of providing the manpower for its own defense.

Probably the most far-reaching of these principles was the last, stating in essence that the United States would thereafter support allies facing military threats with economic and military aid rather than with ground troops. Although the doctrine did not apply to the then ongoing fighting in Vietnam, which would not conclude for another three and a half years, Nixon envisioned a world in which the United States would no longer be the primary defender of freedom, but would share that responsibility with its allies. He also expressed the hope that one day the United States, the USSR, Western Europe, China, and Japan would coexist peacefully and trade together to their mutual benefit.

The Nixon Doctrine guided U.S. foreign policy throughout most of the 1970s, until Soviet encroachment in the Middle East and the overthrow of the shah of Iran by revolutionary forces led by Ayatollah Ruhollah Khomeini in 1979 destabilized



President Richard Nixon (1913–94) greets rock star Elvis Presley in the Oval Office of the White House in 1970. President Nixon formulated the Nixon Doctrine that would govern U.S. foreign policy throughout most of the decade. *National Archives*

the region so much that its guidelines no longer served U.S. national interests. In 1980 President Jimmy Carter established a new principle, called the **Carter Doctrine**, ostensibly in response to the Soviet invasion of Afghanistan, declaring that henceforth the United States would resist with military force, including ground troops, any attempt by a foreign power to gain control of any country in the Persian Gulf region.

During these same years, in keeping with the Nixon Doctrine and in response to the drawdown of U.S. military forces following the close of the Vietnam War, the U.S. military strategy was adjusted according to the following principles, which have remained in effect with minor modification to the present day:

- A concept of **strategic nuclear *sufficiency*** rather than an attempt to maintain nuclear *superiority*
- A strong **conventional capability** (conventional weapons), assisted by increased participation and improved defense capabilities of allied nations
- Smaller U.S. **active military forces** (full-time active-duty military forces), with greater emphasis given to their readiness and modernization
- Emphasis on a strong **research and development program** to maintain our technological superiority
- Meeting the U.S. military needs with **all-volunteer active-duty forces** in all services and continued support of the reserves

Carter's successor, President Ronald Reagan, extended the Carter Doctrine in October 1981 with what is sometimes called the **Reagan Corollary to the Carter Doctrine**. President Reagan asserted that the United States would intervene to protect Saudi Arabia, whose security was then being threatened by the Iran-Iraq War. Thus, while the Carter Doctrine warned against any outside power attempting to gain control of friendly nations within the Persian Gulf region, the Reagan Corollary pledged to secure internal stability within the region. The strategic policy groundwork was thus laid for Operations Desert Shield and Desert Storm in the 1990s.

Post–Cold War

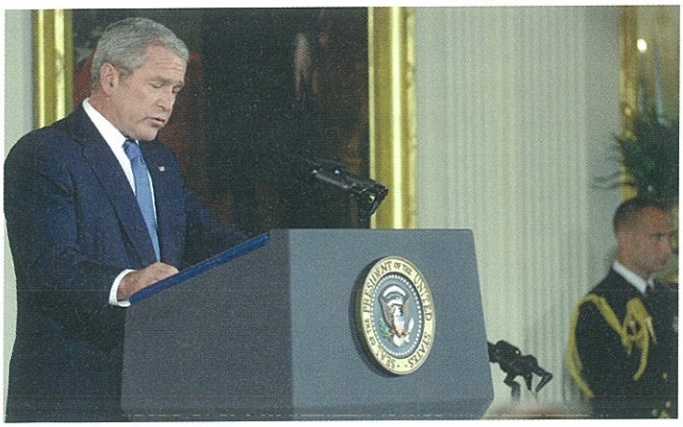
The fall of the Berlin Wall and subsequent collapse of the Soviet Union in 1991 provided the impetus for major changes in the national and grand strategies that had governed America's international relations for more than four decades. Almost overnight the threat of nuclear war with the USSR and China was eliminated. As a result, the United States and its allies were forced to adjust their strategic focus, in the context of an increasingly interdependent global economy and emerging revolutions in information technology and communications that eroded the concept of state (national) sovereignty in fundamental ways. The result was a rise in international organized crime, significant increases in international and domestic terrorism, massive migration and numbers of refugees, multiple outbreaks of ethnic and religious conflict, and a proliferation of failed states.

The post–Cold War drawdown of the American military in the 1990s was extensive. By the end of the decade, the manning level of the U.S. military services had been reduced by some 700,000 active-duty service members. The reduction in combat force structure was even more severe. The Army declined from 18 active divisions to 10, the Navy went from 566 ships to 354, and the Air Force went from 36 to 20 fighter wings, an overall reduction of 45 percent. The overall defense budget decreased by 40 percent.

The government architects of these reductions had assumed that the U.S. military would be far less engaged in a world that would be much less chaotic and violent than before. However, as events were to prove, the exact opposite effect took place in reality. The end of the Cold War was followed not by a scaling back of international tensions but by a rapid increase in conflict and in U.S. military commitments abroad. No longer driven mostly by superpower rivalry, U.S. grand strategy evolved in a more fragmented way, largely defined by old traditional regional ethnic, religious, and cultural conflicts that once again resurfaced. New challenges—economic, environmental, ideological, national, and regional—now confronted the United States in an international setting of greater complexity than ever before.

The Bush Doctrine

In response to the terrorist attacks on the United States on 11 September 2001, referred to ever since as the 9/11 attacks,



Following the terrorist attack of 11 September 2001, President George W. Bush formulated the Bush Doctrine, which asserted a right of preemptive attack against rogue states and terrorists who could be equipped with modern weapons of mass destruction.

President George W. Bush developed what has since been called the **Bush Doctrine**. Its main tenet was that the threat to the United States posed by rogue states and terrorists such as al Qaeda who could be equipped with modern **weapons of mass destruction** (chemical, biological, and nuclear weapons) was so severe by its nature that it justified unilateral **preemptive attacks** (attacks carried out to thwart a possible future enemy attack before it can occur) against them. Although controversial both then and now because it disregarded the issue of *imminence* (immediacy of the threat posed) that had always been necessary in the past to justify such attacks under customary international law, the new doctrine was nevertheless used in large part to justify the large-scale military interventions in Afghanistan in 2001 and Iraq in 2003.

Post 9/11

As in the Korean War and Vietnam War eras, the post-9/11 conflicts in Afghanistan and Iraq came to absorb much of the U.S. military effort and resources at the expense of other strategic concerns. American ground forces were fully committed to the military campaigns in these countries, leaving only a much reduced capacity for other contingencies such as the ongoing challenge of North Korea in the Korean Peninsula. Air and naval forces played much smaller roles. Over time, the overall readiness of the Army in particular for traditional prolonged conflict was severely degraded. It shed much of its armored, mechanized, and field artillery force structure designed for traditional warfare, and focused instead on combat training for counterterrorism and counterinsurgency operations.

In 2011 the U.S. Congress passed the Budget Control Act of 2011, which provided for a mandated $2.4 trillion reduction in federal spending over the next ten years. As part of this reduction, the act called for a $500 billion reduction in military defense spending over this same ten-year period, which became known in the U.S. military as *sequestration*. Even though its effect was somewhat lessened by legislation passed in the years afterward, it continued to have a dramatic effect on military manning levels and equipment procurement, so much so that senior leaders within DOD called it the current largest existing threat to national security. When the Trump administration came into power in January 2017, one of its highest priorities as annunciated by President Donald Trump was to end sequestration and rebuild the U.S. military back up to presequestration levels. It remains to be seen what direction this initiative will take in coming years.

Concurrent with these events, military special operations forces (SOFs) have continually expanded in both numbers and assignments in the years since 9/11. In 2001 there were 33,000 SOF personnel in the U.S. armed services. Today the estimated total exceeds 70,000. During the last several years they have deployed to more than 150 countries each year, and they have played a continual and expanding role as trainers and advisors in the coalition fight against ISIS/IL in Iraq and Syria, and in support of the continued U.S. presence in Afghanistan. It is probable that they will continue to play a major role in U.S. military operations and in strategic planning in the coming years.

In 2007 the Chief of Naval Operations and the Commandants of the Marine Corps and Coast Guard issued a joint document, *A Cooperative Strategy for 21st Century Seapower*, which set forth a comprehensive U.S. maritime strategy for the rest of the twenty-first century. The first document of its kind to be issued jointly by all three maritime services, it reaffirmed

Seabee personnel construct a six-room schoolhouse in Moroni, Comoros, in support of the humanitarian assistance element of U.S. maritime strategy as set forth by the chiefs of the maritime services in 2007.
Kenneth Fidler

One of the major issues confronting President Barack Obama as he took office in early 2009 was the U.S. strategy with respect to international terrorism. *Michael Ayotte*

the importance of the traditional elements of forward presence, deterrence, sea control, and power projection to U.S. naval strategy, and added to them two more critical elements: **maritime security** and **humanitarian assistance/disaster response** (HA/DR). The maritime security element emphasized the importance of international cooperation to maintain freedom of the seas, and the HA/DR element stressed the importance of participation in international and domestic relief efforts when natural disasters occur, such as Hurricane Katrina in the Gulf region of the United States in 2005, the devastating earthquake in Haiti in 2010, and the catastrophic tsunami in Japan in 2011.

In 2015 the sea services released an updated version of this document that emphasized operating forward and engaging partners across the globe, especially in the Indo-Asia-Pacific region. The strategy set forth by this as well as by other contemporary national security documents calls for increasing the Navy's forward presence, currently numbering about 100 ships at any given time, to 120 ships by 2020, including about 40 in the Middle East. The documents reaffirm the continued need to strengthen partnerships and alliances by stressing the importance of operating in NATO and other allied maritime groups and participating in international training exercises. If, as one high-ranking Navy official stated, it takes 1,000 naval warships operating worldwide to secure freedom of the seas around the globe, in the future we will provide our 280-odd (then-current inventory of Navy ships), but the remainder must come from our allies. As another important contemporary document called the *National Security Strategy* put it, "In today's interconnected world, there are no global problems that can be solved without the United States, and few that can be solved by the United States alone."

National Strategy Documents

Several important basic national strategic documents are key in formulating the ends, ways, and means of national grand strategy. They are periodically reviewed and amended as necessary to keep them current.

The ***National Security Strategy*** (NSS), signed by the President, addresses the tasks that, as a nation, are necessary to provide enduring security for the American people and shape the global environment. It provides a broad strategic context for employing military capabilities in concert with other instruments of national power. It establishes the *ends* (goals) of our national security strategy.

The ***National Defense Strategy*** (NDS), signed by the Secretary of Defense, outlines the Department of Defense (DOD) approach to implementing the President's National Security Strategy. The NDS supports the NSS by establishing a set of overarching defense objectives that guide DOD security activities and provide direction for the U.S. military strategy. The NDS objectives serve as links between military activities and those of other U.S. government departments and agencies in pursuit of national goals. This document thus provides the *ways* (methods) in the ends, ways, and means formulation.

The ***National Military Strategy*** (NMS), signed by the Chairman of the Joint Chiefs of Staff (CJCS), supports the aims of the NSS and implements the NDS. It describes how we will employ our military forces to protect and advance U.S. national interests and provides a vision for maintaining a force capable of meeting future challenges. It also provides a focus

President Donald Trump giving his inaugural address in January 2017. Among his stated goals for his presidency are to reverse the effects of the sequestration act of 2011 on the U.S. military, to rebuild it to become once again one of the world's most powerful military forces, and to hasten the defeat of ISIS/IL in the Middle East. *U.S. Marine Corps, Cristian L. Ricardo*

for military activities by defining a set of interrelated military objectives and joint operating concepts from which the commanders of the unified commands and the service chiefs identify desired capabilities, and against which the CJCS assesses risk. This provides the final piece of the ends, ways, and means formulation—the *means* (procedures).

The unified commands, the Joint Chiefs of Staff, and the military departments' service chiefs are discussed further in chapter 6.

Violent Extremism and Terrorism

Much thought on the direction that our national grand strategy should take now and in the future focuses on the threat currently posed worldwide by **violent extremism** and **terrorism**. In this regard, some strategists see the major world conflicts of the past one hundred years as four distinct world wars. World Wars I and II were open conflicts for world domination resolved by force of arms and national mobilization of resources by allied nations to achieve victory. World War III was the Cold War, ultimately resolved not so much by open conflict involving force of arms as by the triumph of one ideology (Western democracy) over another (Soviet-style communism). The ultimate victory was achieved by means of sustained political and economic pressure while using military power and intervention for strategic deterrence and regional conflict resolution.

World War IV is the global war against extremist violence and terrorism. This war is being waged against adversaries such as ISIS/IL (the Islamic State in Iraq and Syria, or alternatively, Iraq and the Levant), or as they are called in the Middle East, DAESH—an Arabic-language acronym for ISIS/IL—and al Qaeda, extremist Islamic militants and terrorists whose stated goal was for many years to establish a religious **caliphate** (ruling Islamic state) in Iraq and Syria. The caliphate was to have been governed by Islamic sharia law and used as a base from which to extend their control and religious philosophy over the entire remaining Middle Eastern region, and then from there ultimately the whole Western world, by means of a **jihad** (religious war) featuring unending **ideological warfare** (attacks against a society's system of ideals and governing principles) and random terrorist attacks against America, our allies, and our way of life.

Their radical followers, and other groups like them who may follow, have no allegiance to any country, and often little is known about who or where they are, what tactics they might use, and when and where they might strike. Outside of strongholds within the Middle East, there are few high-value fixed targets or concentrations of force to attack, either there or within their terrorist cells scattered throughout the world, so it is difficult to bring modern high-tech military forces, weapons, and tactics to bear against them.

While as of this writing a coalition of indigenous Middle Eastern military forces with American and other nations' support has been successful in recapturing a large part of the conquered DAESH territory in Iraq, the broader national strategy has to be to defeat them and other similar radical groups throughout the world by a kind of **moral warfare**. This involves a constant emphasis on the humanitarian principles upon which our nation was founded, while challenging at every opportunity the radical extremist assertions they use to justify their causes and gain credibility and support.

Current and Future Trends

In coming years the United States and our allies will need to continue to take leadership roles in issues of global concern that extremists can exploit to their advantage, such as inequitable wealth distribution, intolerance, and religious extremism. Information warfare capabilities need continued support and development in order to gain timely intelligence on radical extremist tactics, operations, intentions, and capabilities, and hopefully to thwart future attacks. First responders such as local, state, and regional police; the National Guard; and civil defense organizations need resources, continuous upgrading, and training to deal with any future successful overt or covert cyber or terrorist threats or attacks. Finally, the United States must continue to take a proactive leadership role in world events, both for the welfare of our citizens and for the benefit of humankind.

Critical Thinking

1. Sir Halford J. Mackinder wrote *Democratic Ideals and Reality*. How did Adolf Hitler use ideas from this book for his grand strategy in World War II?
2. Review the main themes in the writings of Capt. Alfred Thayer Mahan and General Karl von Clausewitz. Identify the ideas each had in common about global strategy.
3. Maj. Alexander de Seversky established the aerospace school of strategy in *Air Power: Key to Survival*. Review several major air campaigns of twentieth-century warfare, examine their outcomes, and show how each either supports or discredits de Seversky's theories.
4. If the United States and our allies are ever able to effectively neutralize the threats posed by extremist groups such as ISIS/IL and al Qaeda, what do you think will then be the major threats to our security? What should be our strategy to counter them?

Study Guide Questions

1. What term is used to designate the employment of national power and influence to attain national security objectives?
2. What governs U.S. grand strategy?
3. What are the four traditional core principles upon which U.S. grand strategy has always been based?
4. A. Who was the first great Western strategist?
   B. What did he postulate about the conduct of war?
5. What was Machiavelli's contribution to strategic thinking?
6. What did Karl von Clausewitz emphasize concerning strategy?
7. What were the three classic schools of global strategy?
8. What is meant by Clausewitz's statement concerning military preparedness ("Woe to the cabinet . . .")?
9. What are the main phases through which U.S. grand strategy has evolved from the early days of our republic to the present day?
10. What did the Soviet Union and China do in the days following World War II that led to the Cold War?
11. A. What was the strategy formulated by the Truman administration in the late 1940s to counter the expansionist communistic ideologies of the USSR and China?
    B. When did it end?
12. A. What threat was proclaimed by John Foster Dulles in 1954 as a deterrent to the use of nuclear weapons by the USSR?
    B. What potentially deadly competition between the United States and the USSR ensued?
    C. What doctrine was adopted by both sides in response?
13. What modification to the massive retaliation strategy was undertaken by the Kennedy administration following the Cuban Missile Crisis in 1962?
14. What were the three main principles of the Nixon Doctrine as announced by him in 1969?
15. What U.S. military strategy principles formulated after the Vietnam War have remained in effect to the present day?
16. What characterized the Bush Doctrine developed in the aftermath of the terrorist attacks on the United States in September 2001?
17. What two elements were added to the U.S. maritime strategy for the twenty-first century in 2007?
18. What did the updated version of the U.S. maritime strategy released in 2015 emphasize?
19. What differentiates "World War IV" against terrorism from the world wars that preceded it?
20. What directions should our national grand strategy take in future years?

New Vocabulary

grand strategy
military strategy
interior lines of communication
isolationism
massive retaliation
nuclear sufficiency
violent extremism
ideological warfare
containment strategy
preemptive attacks
national strategy
geographic rimland
air superiority
interventionism
flexible response
weapons of mass destruction
terrorism
moral warfare
mutual assured destruction (MAD)

4

U.S. Strategy and the Navy

The mission of the U.S. Navy is to be prepared to conduct prompt and sustained combat operations at sea in support of U.S. national interests. This basically means that maritime superiority for the United States must be ensured. The U.S. Navy must be able to defeat any potential threats to the continued free use of the high seas. In its simplest terms, defeating an enemy maritime threat means the destruction or **neutralization** (rendering ineffective) of hostile spacecraft, aircraft, surface ships, and submarines that threaten the seaborne forces of the United States and its allies. The Navy carries out this mission within the framework of our national strategy in coordination with the other U.S. armed services and in combined planning with our allies.

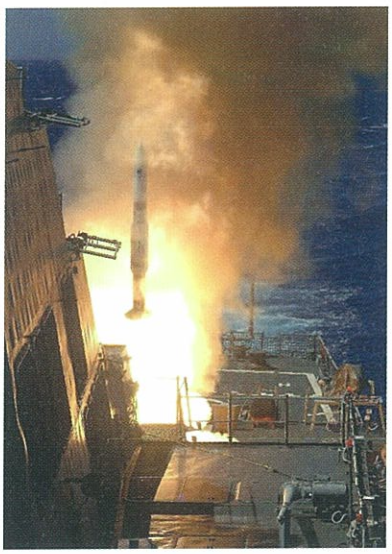
The Navy's two basic functions are sea control and power projection. These two functions are closely related. **Sea control** means mastery over the entire surface, subsurface, and air and near-Earth space above designated sea and littoral areas; in other words, over the **battlespace** within which naval operations are to be conducted. It also means preventing the approach of enemy forces within range of our forces or territory and defense against enemy ballistic and cruise missiles. It does not imply complete control of all the world's ocean areas, but only where and when needed. Sea control is necessary so the Navy may have secure operating areas for the **projection of power**, such as carrier air strikes, amphibious assaults, and cruise missile attacks. The ultimate means of power projection is through fleet ballistic missile submarines, a principal element of the nation's strategic offensive force.

Functional Roles of the Navy

The U.S. Navy is responsible for three functional roles within the national military strategy: strategic nuclear deterrence, deployment of overseas forces, and security of the sea lines of communication.

Strategic Nuclear Deterrence

Strategic weapons are intercontinental-range weapons of mass destruction, mainly nuclear bombs or ballistic missiles with nuclear warheads, designed to strike and destroy or neutralize the source of an enemy's military, economic, or political power, normally within its homeland. The effectiveness of the submarine-launched ballistic missile, combined with the near invulnerability of the ballistic missile submarine, constitutes the strongest and probably most survivable deterrent in our strategic nuclear forces against the use of any such weapons against us by any potential enemy. During much of the Cold War this system was generally regarded as the main stabilizing factor in the strategic nuclear balance between the United States and the Soviet Union.



U.S. national security is vital to the well-being of every American. Our military forces must be able to defeat aggressors if deterrence fails. New weapons technology, such as this Standard missile being launched from a Navy destroyer, helps defend our national forces against any potential enemy threat at sea. *Marcos Hernandez*

Overseas-Deployed Forces

The Navy maintains operationally ready naval forces overseas as part of other deployed American and allied forces. Well known in this capacity are the Sixth Fleet in the Mediterranean, the Fifth Fleet in the Indian Ocean, and the Seventh Fleet in the western Pacific. These naval forces are deployed where they can support forward-positioned U.S. and allied forces in peacetime and engage enemy forces should hostilities break out.

Security of the Sea Lines of Communication

The success of the forward military strategy depends upon the Navy's ability to keep the **sea lines of communication** (sealanes) open, both to support deployed U.S. and allied forces and to ensure a continued

UAVs such as the Predator shown here provide real-time infrared and color video to intelligence analysts and controllers both on ships at sea and on shore, and can be fitted with smart weapons for covert attacks.

supply of vital imported raw materials for our industry. The protection of friendly ships close to enemy shores where they are most vulnerable to enemy air, surface, and submarine attack places a demanding burden upon the U.S. Navy.

Tactics versus Strategy

Tactics is the art and science of fighting battles, or, according to Karl von Clausewitz, the "formation and conduct of single combats in themselves." Traditionally, tactics has always been distinguished from **strategy** in a military sense. Strategy is concerned with the large-scale planning that goes on in the prelude to battle. It relates to large movements and disposition of forces among the theaters of operations and the direction of the overall campaigns.

Strategy gives tactics its direction, although strategy is often limited by the tactical capabilities of the forces employed. Tactics depend on the strategic considerations involved with the planning and conduct of campaigns; successful tactics meet the strategic requirements of the broad plan.

Modern Tactical Innovations

The tactical considerations of the atomic age permeated all aspects of warfare during the Cold War, and have to a great extent since. The key to survival in nuclear warfare is dispersal, and that is dependent on mobility. The first atomic weapons were strategic nuclear and hydrogen bombs designed to neutralize industrial cities or huge concentrations of forces. With the dispersal capability of modern infantry divisions and the mobility of naval forces, however, it became necessary to develop lower-yield **tactical nuclear weapons** delivered by artillery and short- and intermediate-range missiles to fit the changing tactical picture within the battlespace. Just as ships are intended to be mobile and largely self-sufficient, the modern army division includes both air and ground transport to aid in dispersing its forces.

Though nuclear and hydrogen weapons of mass destruction are surely here to stay, several limited wars and numerous insurrections have been fought since 1945 without their being used. This does not mean that strategists and tacticians can eliminate these weapons from their planning. To do so would certainly be foolish if a potential adversary were known to possess them. But it is at least conceivable that humankind will take the necessary effort to prevent these and other weapons of mass destruction from being used in any future conflict.

Another technical innovation that was used for the first time to great tactical advantage in Operation Desert Storm in the Persian Gulf War in 1991, and in almost all conflicts involving U.S. military forces and intelligence agencies since, is the **smart weapon**, a class that includes laser-guided bombs, rockets, and programmable cruise missiles. These highly accurate precision weapons have greatly increased the probability of successful target destruction with just a single shot or attack, often from far greater ranges than were possible before. They are more "surgical" in nature and greatly reduce the possibility of unintended **collateral damage** to innocent civilians and private property.

In more recent years, increasing use has been made of various kinds of remotely controlled or autonomous **unmanned vehicles** (UVs) of all kinds to conduct all manner of tasks ranging from land surveillance and attack of enemy installations and personnel, to air and surface warfare at sea, to undersea mine countermeasures. A prototype of an autonomous unmanned carrier-based aircraft (UAV) that can take off from and land on aircraft carriers has already been developed and tested, and a completely autonomous surface warship is on the drawing boards. There are also autonomous smaller surface craft and underwater vehicles. More about them will be presented later in this textbook.

These and other innovations will undoubtedly continue to have far-reaching effects on all aspects of military and naval tactics in the future.

Naval Force Capabilities

The U.S. Navy must have certain capabilities if it is to be able to support our national strategy. The Navy's ballistic missile

submarine (SSBN) fleet has long been a vital part of our nation's strategic **nuclear triad**, along with the Air Force's land-based intercontinental ballistic missiles (ICBMs) and long-range strategic bombers. Since the 1960s this triad has supported our national strategy of nuclear deterrence against attack by weapons of mass destruction by any nation having this capability. All other forces in our Navy are called *general purpose* forces. In order to support other aspects of our national strategy, they must have the tactical capabilities summarized below.

Offensive Power

Naval forces must be capable of projecting power through such means as carrier and amphibious battle forces, and of destroying all hostile forces in the theater of operations by weapons such as guns and missiles. The Navy's offensive capabilities in the theater must be credible to allies for defense and to potential enemies for deterrence.

Defensive Strength

Deployed naval forces must be able to quickly react to and defend against any enemy attack within a given theater. Such attacks might range from localized actions initiated by terrorists to large-scale attacks by forces equipped with both **conventional weapons** such as guns and antiship missiles, and weapons of mass destruction. Naval defensive capabilities must include long-range detection systems such as airborne early warning, quick-reacting command and control systems, and effective defensive weapons systems including those designed for defense against ballistic and cruise missiles.

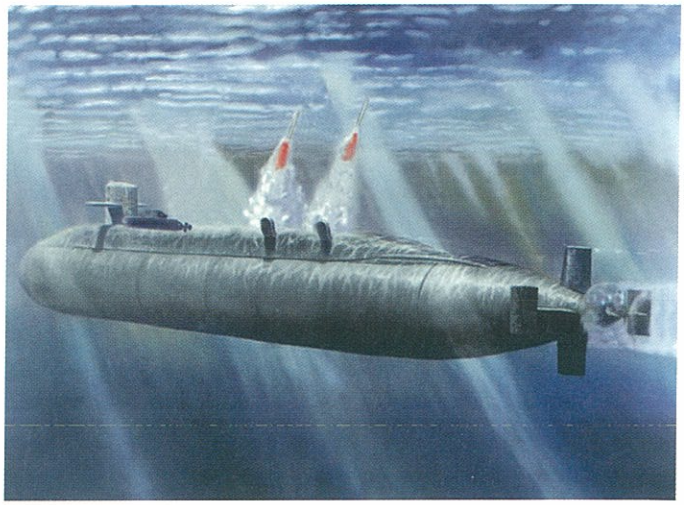
Logistical Independence

Logistics refers to the supply chain by which goods such as food, fuel, munitions, spare parts, and related information are conveyed from their point of origin to the point of consumption in order to meet the needs of the operating forces. Naval forces must be capable of sustaining themselves for extended periods, and when necessary be resupplied by underway replenishment at sea by mobile logistic supply forces. Overseas bases may be helpful in providing logistics support of deployed forces during peacetime, but they may become a liability in time of war.

Command and Control

The naval commander must be able to communicate with and monitor assigned forces through a system for command and control. This system also connects forward-deployed naval forces with one another and with the supporting shore establishment, forces of other services and nations, and government and nongovernment agencies.

Modern U.S. Navy and other military service command and control systems have seven subdivisions: command, control, communications, computers, intelligence, surveillance, and reconnaissance, or **C4ISR** for short. They include all information systems, equipment, software, and infrastructure that enable the commander to direct assigned forces. Such all-encompassing command and control networks will be central to most warfighting in the future, so much so that the term ***network-centric warfare*** has been applied to it.



The ability to project power ashore is one of the Navy's main missions. This artist's rendition shows two land-attack Tomahawk missiles being launched from the USS *Ohio*, a former nuclear ballistic missile submarine now converted to a guided missile submarine.

The Defense Information Services Agency (DISA) is currently developing a revolutionary new C4ISR worldwide Internet-based network to be fully implemented by 2020. Called the **Joint Information Environment** (JIE) system, it will revolutionize the way military operations are conducted by U.S. and allied forces. Based on cutting-edge information and communication technology, the network will use a common database instantly accessible from land, sea, and air to provide real-time access to all information required for the conduct of operations anywhere in the world. It will link together not only all U.S. operational forces and support activities involved in these operations but also any allied forces as well.

Tactical Nuclear Weapons Capability

The Navy must be able to employ tactical nuclear weapons if confronted with them. Only with equivalent weapons capability can the U.S. Navy expect to fight and win at sea.

Naval Warfare

Naval warfare is conflict in which at least one of the opponents is operating from the sea with surface ships, submarines, and/or sea-based aircraft. The three corresponding naval warfare

areas are surface, subsurface, and aerospace. The forces that are used in these warfare areas each have their own characteristics, strengths, and limitations. The art of naval warfare is to employ these forces in such a way as to exploit the strengths and minimize the weaknesses of each. This objective has led to the integrated use of all three types of forces in mutual support to gain advantage over an enemy. Moreover, naval forces now and in the future must be able to work together with those of other services and other nations in all tactical warfare areas in order to meet the multidimensional threat posed by our potential enemies.

The Navy is tasked with both sea control and power projection in all three warfare areas. Its tactical warfare tasks are classified as *fundamental* and *supporting* tasks. The **fundamental warfare tasks** are the following:

- **Air warfare (AW)**: The destruction of enemy air platforms and airborne weapons, whether launched from air, surface, subsurface, or land platforms. AW includes all the measures used to achieve air superiority.
- **Undersea warfare (USW)**: The destruction or neutralization of enemy submarines, mines, and other undersea forces.
- **Surface warfare (SUW)**: The destruction or neutralization of enemy surface combatants and merchant ships. Its aim is to deny the enemy effective use of its surface warships, support ships, and cargo-carrying vessels.
- **Strike warfare**: The destruction or neutralization of enemy targets ashore through the use of conventional or nuclear weapons. This includes any enemy strategic nuclear forces, shipyards, and any operating bases from which the enemy might launch an attack against U.S. or allied forces.
- **Amphibious warfare**: Attacks launched from the sea by naval forces and landing forces embarked in ships and craft designed to make a landing on a hostile shore. It includes close air support and shore bombardment in support of troops in contact with enemy forces.
- **Mine warfare**: The use of mines and mine countermeasures. It consists of the control or denial of sea or harbor areas through the laying of minefields, and the countering of enemy mine warfare through the destruction or neutralization of hostile minefields.
- **Information warfare (IW)**: Actions taken against an adversary's information or information technology (IT) systems while defending our own information and information systems.

The **supporting warfare tasks** are the following:

- **Special warfare**: Naval and other military operations that are unconventional in nature and often clandestine in character. **Special warfare** often accomplishes other fundamental warfare tasks, but does so in a unique manner. Examples of special warfare are underwater demolition, special mobile operations, coastal and river interdiction, beach and coastal reconnaissance, and certain tactical intelligence operations. In the Navy many of these tasks are carried out by SEAL teams, among the most highly trained and capable special warfare personnel in the U.S. armed services. More about special warfare will be presented in the Modern Naval Warfare unit, chapter 21.
- **Intelligence**: The assessment and management of information obtained via surveillance, reconnaissance, and other means to produce timely warning of the location, composition, capabilities, and tactics of opposed forces. National leaders and military commanders who correctly use interpreted intelligence are able to make decisions based on accurate knowledge of the enemy's forces and capabilities.
- **Ocean surveillance and reconnaissance**: The observation of ocean areas to detect, locate, and classify potential aerospace, surface, and subsurface targets, and the reporting of this information to users in a timely manner. A target may be any hostile, neutral, or friendly platform of interest. Ocean surveillance and reconnaissance provide the operational setting for the battlespace in which Navy commanders deploy forces to do battle.
- **Electronic warfare (EW)**: The electronic support for all warfare tasks. Its primary objective is to ensure effective use of the electromagnetic spectrum by friendly forces while determining, exploiting, reducing, or denying its use by an enemy.
- **Logistics**: The resupply of combat consumables to combatant forces in the theater of operations. A principal goal of naval logistics is to make the operating forces as independent as possible of overseas bases. This is accomplished mainly by sealift from mobile naval logistic ships operated by MSC or from the U.S. merchant marine. Logistics are often the major factor in determining the success or failure of an operation.

Naval Tactical Forces

There are two categories of major naval ships: **combatants** and **auxiliaries**. The combatant category includes vessels classified as warships, such as aircraft carriers, surface combatants, submarines, and amphibious warfare ships. Auxiliaries include primarily mobile logistic and support ships, such as oilers and repair ships, and smaller vessels such as tugs, salvage, and special mission ships.

Of this total group of ships, only the fleet ballistic missile submarines are part of the U.S. strategic forces. All other naval vessels are regarded as general purpose tactical forces.

Each type of ship has unique tactical capabilities and different primary and secondary missions in the conduct of naval warfare and the support of U.S. national military strategy. Navy

SEAL teams are probably the best-known special warfare personnel in the Navy. Their missions are rugged, and so must they be, as these SEAL trainees show.

planners and tacticians attempt to structure our naval forces in such a way that there is always a proper balance of ship types to accomplish the expected warfare tasks.

The grouping of units to achieve a proper balance for a specific war-fighting requirement is called **tactical force organization**. Navy units are operationally deployed in task organizations designed for specific jobs, as, for example, a USW task group, a carrier strike group, an amphibious task force, or an underway replenishment group.

Under normal conditions, about 30 percent of our active operating naval forces are deployed overseas in a fully operational status. Another 40 percent are operationally ready but assigned to fleets working out of U.S. ports. These are ready for immediate deployment to reinforce forward-deployed forces if required. The remaining 30 percent are in a reduced operating status undergoing planned maintenance or conducting basic training. In a time of increased tension, the deployed forces can be increased to 50 percent or more for limited periods. Under extreme conditions of general mobilization, up to 85 percent of the fleet could be deployed, as it was during most of World War II.

Current naval planning foresees far greater emphasis on *joint* and *combined operations* in the years to come. This means that in future conflicts our naval forces can expect to operate much more closely than ever before with elements of the Air Force, Army, Coast Guard, and reserve forces (**joint operations**), and with available allied forces from other nations (**combined operations**), to accomplish the desired objectives of sea control and force projection onto land. The exact composition of strike and support forces from all these sources will be tailored to meet the specific requirements of each mission. In contrast to past conflicts such as those in Vietnam, Iraq, and Afghanistan, in which joint and combined operations when conducted at all consisted mainly of segregated operations that involved interactions of different national and allied forces only at the perimeters of their assigned areas of operation, in the future such operations will be far more integrated, with joint national forces and combined allied forces fully intermixed throughout the battlespaces.

Critical Thinking

1. Research the factors that would contribute to a warship's survivability in the event of an attack by weapons of mass destruction at sea. Why would dispersal of forces be an important tactic at sea in this type of attack?
2. Given the demise of the Soviet Union following the Cold War, is it still important for the United States to maintain its strategic nuclear triad? Why?
3. Why is a comprehensive real-time Internet-based information network like the JIE being developed and implemented by the Defense Information Services Agency so important to commanders of today's military forces? Research the important features of the JIE.
4. Why is it of ongoing importance today that the U.S. Navy and the other U.S. military services maintain a defensive missile shield capable of intercepting incoming enemy ballistic missiles? Where are such shields deployed today?

Study Guide Questions

1. What is the mission of the Navy?
2. What are the Navy's two basic functions?
3. What are the functional roles of the U.S. Navy?
4. What are strategic weapons?
5. What is the difference between tactics and strategy?
6. What is the advantage of having naval forces forward-deployed in peacetime overseas?
7. What is the key to survival in atomic warfare?
8. What revolutionary new kind of tactical weapon was used for the first time in the Persian Gulf War in 1991, and in almost all conflicts involving U.S. military forces and intelligence agencies since?
9. What is our nation's strategic nuclear triad?
10. What are the essential tactical capabilities of our general purpose forces?
11. What are the seven subdivisions of modern U.S. Navy and other military service command and control systems?
12. What are the three naval warfare areas?
13. What are the fundamental tactical warfare tasks of the Navy?
14. What are the supporting tactical warfare tasks of the Navy?
15. How do Navy planners and tacticians attempt to structure Navy tactical forces?
16. A. What are joint operations?

    B. What are combined operations?

New Vocabulary

neutralize, neutralization
battlespace
strategic weapons
smart weapon
unmanned vehicle (UV)
strategy
nuclear triad
logistics
network-centric warfare
supporting warfare tasks
surveillance
electronic warfare
auxiliaries (ships)
joint operations
sea control
power projection
tactical nuclear weapons
collateral damage
sea lines of communication
tactics
conventional weapons
C4ISR
fundamental warfare tasks
special warfare
reconnaissance
combatants (ships)
tactical force organization
combined operations

5

National Security and Modern Conflict

National strategy combines all the capabilities of a nation to attain its national interests and objectives. One of the most important of these objectives is the maintenance of **national security**. While military power is the primary means by which national security is maintained, it is not the only means. All aspects of a nation's power must be considered in the total strategy.

Political policy is of primary importance in all national security strategy. It is through politics, both at home and abroad, that the minds and actions of people can be influenced. There are other important considerations as well. A nation's economy, including its natural resources, industrial capacity, and finances, is a very important element of national power and can be used to attain national objectives. The strength and will of its citizens are also important, including their numbers, location, morale, and education. Geographic position, natural defenses, terrain, and the food supply are all significant factors. Finally, a good scientific and technological base is important for both national security and commerce.

The Russian aircraft carrier *Admiral Kuznetsov*, described as a heavy aircraft–carrying cruiser intended to support and defend missile–carrying submarines, surface ships, and aircraft of the Russian navy. A sister ship was sold to China and commissioned by the Chinese Navy as the *Liaoning*. The ship lacks catapults and relies on the bow ramp to boost its aircraft into flight.

Threat Evaluation

National security factors are meaningful only when viewed in context with external and internal threats. The most obvious threat to any nation is military. But national security can be harmed just as badly by political, economic, and psychological warfare as by force of arms. A good example of this is the effect of instability in the Middle East on the supply and price of oil in the United States and Europe. The military threat is merely easier to identify, and perhaps the easiest to counter if a nation has the will to keep sufficient forces in readiness.

There are three basic considerations in evaluating possible external threats to a nation's national security:

- Capabilities—what *can* a potential adversary do?
- Intentions—what *will* the adversary do?
- Vulnerabilities—what are the adversary's weaknesses?

Capabilities means the ability of a state to satisfy its objectives or to stop others from threatening it—in peace as well as in war. They are the sum total of national power: political, military, economic, social, scientific, technological, psychological, moral, and geographic. Capabilities are useful only when combined with the means of applying that power effectively.

Intentions concern a state's will to execute certain plans. Intentions are subjective and often easily concealed. They are shaped by interests, objectives, policies, principles, and commitments, many of which may be unknown to outsiders. Determining the intentions of a potential adversary is extremely difficult. They are usually the hardest to assess because they are subjective and often easily concealed. An adversary's probable course of action, however, must always be considered in determining one's own best strategy. A good rule of thumb is: the best indication of intentions is not what people say, but rather what they do.

Vulnerabilities are the weaknesses of a nation, which, if attacked by any action or means, will reduce the war potential, combat effectiveness, or national will of that nation. Nations' vulnerabilities differ; they may include the ease of interdiction of key transportation routes, the vulnerability of major

industrial centers, dependence on overseas imports of raw materials or fuels, weak or unpopular governments, and so forth. The list is extensive.

The **intelligence process** is used to gain the information necessary to make estimates of the situation or threat that might face a nation. Data concerning capabilities, intentions, and vulnerabilities must flow in a never-ending stream to intelligence specialists, who must process, analyze, and evaluate this information. They arrive at **intelligence estimates** that are provided to the decision-making leaders, consisting of evaluated, integrated, and interpreted information required for the development of national security objectives, policies, and plans.

The purpose of intelligence estimates is to forecast intentions. Forecasting intentions, however, as stated above is a difficult and dangerous business because no one can positively say what actually is in the minds of potential enemy leaders. Wide background knowledge, wisdom, experience, and judgment are necessary, and even then the intelligence specialist must recognize that the best intelligence evaluators are subject to error because they are human. Threat evaluation is a difficult and vital process, but one on which every government and nation depends for survival.

The strategic planner must assess the **degree of risk** associated with various possible courses of action that could be taken to achieve national objectives. This means, simply, the probability of success of a course of action versus the stakes. The degree of risk is almost entirely a matter of judgment. Defeat and failure can result from miscalculations such as overrating one's own capabilities or underrating those of the opposition. Sometimes unavoidable **calculated risks** (actions having some degree of risk associated with them) must be taken in order to make best use of the available resources, be they economic, military, or other. To do this intelligently, the planner must be well informed and alert to any possible negative effects on the overall grand strategy.

Principles of War

If all measures short of war fail and war comes, there are certain principles that have evolved over the centuries that govern war-fighting strategy and tactics. They have been used by all successful military commanders, both famous and infamous, since biblical times, including Hannibal, Julius Caesar, Napoleon, Lord Nelson, Grant, Eisenhower, Nimitz, and Schwarzkopf, to name just a few. Taken together, these are called the **principles of war**. They are as follows:

- *Define the objective.* Every military operation should be directed toward a clearly defined, decisive, and attainable objective. Whether the objective is destroying an enemy's armed forces or merely disrupting the ability to use forces effectively, the most significant preparation a commander can make is to express clearly the objective of the operation to subordinate commanders.
- *Mass forces.* Use strength against weakness. A force, even one smaller than its adversary, can achieve decisive results when it concentrates or focuses its assets on defeating an enemy's critical vulnerability.
- *Maneuver.* Place an enemy in a position of disadvantage through the use of speed and agility to gain an advantage in time and space relative to the enemy's vulnerabilities.
- *Take the offensive.* Seize, retain, and exploit the initiative. Offensive action allows the commander to set the terms and select the place of confrontation, exploit vulnerabilities, and seize opportunities from unexpected developments.
- *Economize force.* Employ all combat power available in the most effective way possible; minimize combat power spent on secondary targets. A successfully coordinated strike at an enemy's critical vulnerability can have far more significance than an attempt to attack all vulnerabilities at once.
- *Achieve unity of command.* Ensure coordinated effort for every objective under one responsible commander. Whether the responsibility involves a single independent unit or a complete battle force, **unity of command** is achieved by assigning a single commander at every level of command.
- *Maintain simplicity.* Avoid unnecessary complexity in preparing, planning, and conducting military operations. The implementing orders for some of the most influential naval battles ever fought have been little more than a paragraph. Broad guidance, rather than detailed and involved instructions, promotes flexibility and simplicity. Simple plans and clear direction promote understanding and minimize confusion. For example, the operation order for Operation Desert Storm summarized the allied objectives in a single sentence: "Attack Iraqi political-military leadership and command and control; sever Iraqi supply lines; destroy chemical, biological, and nuclear capability; destroy Republican Guard forces in the Kuwaiti theater; liberate Kuwait."
- *Achieve surprise.* Strike an enemy at a time or place or in a manner for which the enemy is unprepared. It is not essential that an enemy be taken completely unaware, only that the enemy becomes aware too late to react effectively. Concealing capabilities and intentions by using covert techniques and tactics provides the opportunity to achieve surprise.
- *Maintain security.* Never permit an enemy to acquire unexpected advantage. Alert watchstanders, scouting forces, and the use of electronic emission control all reduce vulnerability to hostile acts, influence, or surprise.

Interestingly, many of the foregoing principles are also applicable to activities other than warfare, such as various board games like chess and sports like football and soccer. Most successful players and head coaches in these games and sports are well aware of these principles at either the conscious or intuitive level, and employ them to good effect to win their contests.

Modern Forms of Armed Combat

In modern times there are three main forms that large-scale armed conflict might take: general war, limited war, and various kinds and degrees of irregular warfare. Each of these is discussed in the following sections.

General War

A definition of traditional **general war** is armed conflict between major powers in which the total resources of the belligerents are employed, and the national survival of a major belligerent is in jeopardy. At one time, victory in such a war was considered to be worth any cost. Speaking before the House of Commons in 1940 in the darkest days of World War II, Winston Churchill bravely said, "You ask what is our aim? I can answer in one word: victory—victory at all costs; victory in spite of all terror, victory however long and hard the road may be, for without victory, there is no survival."

Speaking of the Korean War in 1951, Gen. Douglas MacArthur stated, "There is no substitute for victory." This is a succinct and easily understood statement, but it might not be as valid today as it was then.

Victory in the context of general war, involving the unrestricted use of today's weapons of mass destruction, might be very hollow indeed. A global struggle with wide use of nuclear, chemical, and biological weapons would endanger life everywhere on our planet. A true victory in such an event would be hard to imagine for either side, or, for that matter, for any of the survivors on Earth.

Probably no sane leader would ever deliberately start a general war, unless one of two preconditions existed: threat of national destruction or assurance of victory. If a leader had positive evidence that his or her country was about to be destroyed by a nuclear attack, for example, that leader might think there was nothing to lose by launching one first. Or if a country made a spectacular technological breakthrough that would make retaliation unlikely, the leader might consider that the potential gains would far outweigh the risk. But because the long-term effects of a general war involving large-scale use of weapons of mass destruction are so unknown and potentially devastating, deliberate initiation of such a war seems unlikely as long as the potential victim maintains a credible military deterrent.

The United States has such dominant military power that it is difficult to imagine how an opponent could envision overcoming it. However, proliferation of nuclear weapons or other weapons of mass destruction among unprincipled countries or terrorists could lead to general war through accident, miscalculation, or misunderstanding in the future.

Irrational acts can never be discounted. The danger is not so much the possible mental breakdown of a leader as that leader's consideration of totally illogical, unwarranted, or unrealistic approaches to a problem. When considering this possibility, one must be aware of cultural differences between peoples. For instance, most Americans place a high value on human life. This is not necessarily the case in other cultures or countries. As recent history has shown, no matter what the cost to themselves or to others around them, there will probably always be individuals, groups, and even nations willing to sacrifice innocent lives for political or economic gains, or to advance extremist ideologies.

Limited War

Limited war falls between the extremes of general war and the so-called cold war. The previous section discussed the totality of general war; *cold war*, in which all measures short of armed combat are used to attain national objectives, is the other extreme. Limited war is defined as armed encounters, other than incidents, in which one or more major powers or their proxies voluntarily restrict their actions in order to prevent escalation to general war. A **proxy war** is a form of limited war in which a major power avoids direct military involvement in a conflict with another by having satellite states engage the other major power or its allies in its stead.

These limitations or restrictions are seldom effected by formal agreements. They usually result from "understandings" that are conveyed by means other than direct diplomatic contacts. The understandings might be made known through a speech by the head of state, through official releases to the media, or perhaps by an exchange of notes through diplomatic "back channels" in third countries. Interpretation of these understandings or "rules" that limit operations may be rather broad, but clearly the intent is to prevent escalation to general warfare.

Wars may be limited in a number of ways, such as by limiting objectives, arms, targets, forces, or geographic areas in which operations may be conducted. Nations usually avoid limiting their objectives, so restraints most often involve means, not ends. For example, the U.S. national security objective in Korea—the containment of communism—was successfully attained, but the secondary goal of unifying Korea was abandoned. The object in limited war is to select goals that avoid the appearance of directly endangering the enemy power's vital interests.

In any war, arms limitations, particularly limitations of nuclear weapons, are controversial. Most civilized people agree that strategic nuclear bombardment of population centers

should be avoided, but what about the use of smaller tactical nuclear weapons designed specifically for battlefield use or the destruction of enemy missile silos? Argument against their use is centered on the probability that once introduced for any purpose, both the size and extent of their use could rapidly escalate. An opposite contention is that tactical nuclear weapons actually *should* be used in limited-war situations in the overall best interest of humanity and civilization. The argument here is that if they are used once or twice on the right targets at the right time, further aggression can be stopped and future limited wars can be deterred from ever starting. Each argument poses a strategic dilemma.

The use of chemical and biological agents poses the same kind of problems for strategists dealing with limited war.

Careful target selection is also an important factor in limiting the scope and intensity of war. All manner of limitations and understandings can be imposed. The Vietnam War was a classic example of target limitation imposed by political leaders. At one time, U.S. Navy and Air Force aircraft were allowed few targets other than enemy troops, armored vehicles, and logistics in transit. Many important facilities essential to the North Vietnamese war effort, such as bridges, ports, railyards, and industrial areas, were exempted. Haiphong Harbor was restricted from both aerial attack and minelaying until the very end, enabling massive quantities of war equipment to be delivered without hazard. Political, not military, prohibitions prevailed in the effort to limit the war. According to many analysts, America lost the Vietnam War largely because of these limitations. Would it have been won if these constraints had been removed, or would such actions have escalated the war, perhaps involving other nuclear powers? No one will ever know.

Limitations imposed for years by our political leadership on the air campaign against ISIS/IL (DAESH) in the Middle East are a more recent example.

Limitations as to type, number, roles, and origins of military forces can also affect a war. Defensive, support, and advisory troops are less provocative than major combat elements. Proxy forces avoid major power confrontations. Forces from alliances or the United Nations are often less objectionable than those from individual states. Use of naval and air power is less risky than an invasion by ground forces, which immediately implies more than a temporary presence. All of these factors figured into the limited wars fought in Korea and Vietnam. Soviet troops never actually participated in either war. The Chinese insisted their forces in Korea were all volunteers, despite the obvious fiction of that claim. The fact that UN forces fought in Korea against the Chinese "volunteers" tended to reduce the impact of the cold fact that the United States was in reality at war with China.

Geographic limitations are inherent in limited war. The area of conflict is mostly restricted to a relatively small region or a single country. Additionally, there often are **safe havens** that are left alone because of political constraints. In the Korean War, for instance, Chinese staging areas across the Yalu River were constantly under observation by U.S. reconnaissance planes but were completely immune from any UN attack. During the Vietnam War, the Communists had a safe haven in Cambodia for years in the Parrot's Beak, a portion of land projecting deep into South Vietnam near Saigon. Allied forces were prohibited from advancing toward Baghdad in the 1991 Gulf War, and al Qaeda and the surviving Afghan Taliban found sanctuary for years in the mountainous terrain along the Pakistan-Afghanistan border following the U.S. invasion of Afghanistan in 2001. Regular coalition forces were never authorized to directly attack pirate havens within Somalia during antipiracy operations in the adjoining Indian Ocean region throughout the 2000s.

Irregular Warfare

Irregular warfare is a relatively new form of warfare that developed following World War II and has continually expanded in scope since, to the point where today it is the main type of armed conflict worldwide. For a while it was referred to as **unconventional warfare**, and after the mid-1990s, **asymmetric warfare**, because it usually involves opposing forces greatly unequal in conventional military resources, wherein the lesser opponent seeks to overcome this disadvantage by the use of unconventional weapons and tactics such as violent extremism and terrorism to exploit the vulnerabilities of the stronger. Nowadays the *asymmetric* term has gone out of vogue, because in a broader sense all warfare seeks asymmetric concentrations of force against an enemy's weaknesses. The term ***special warfare*** is now almost universally used to describe all types of irregular warfare.

Although broadly speaking irregular or special warfare is a form of revolutionary warfare, it is not a historical form of such warfare, because the less powerful adversaries, who can be either state (native) or nonstate actors, or both, typically attack nonmilitary targets in order to influence or control the local population, as opposed to direct attacks upon the military forces of an established government. Some perpetrators, however, such as ISIS/IL in recent years, may possess a range of sophisticated weapons, effective command and control systems, and support networks that are typically characteristic of a more traditional military force. They may employ a full range of military and other capabilities in order to erode their opponent's power, influence, and will. More often, though, irregular warfare threats typically involve insurgency, violent extremism, terrorism, disinformation campaigns, propaganda, and organized criminal activity such as drug trafficking and kidnapping. Both sophisticated and less sophisticated irregular warfare perpetrators will usually have the advantages derived

from knowledge of the local area and the ability to blend in with the local population. Irregular forces such as partisan and resistance fighters are often used to fight against conventional military forces of the target state.

From the standpoint of its perpetrators, irregular warfare is total war. Their philosophy, as expressed by the infamous Chinese revolutionist and later dictator Mao Tse-tung, is brutal: "Any and all means are justified to attain desired ends, without regard for stupid scruples about benevolence, righteousness, and morality."

Such irregular warfare is hard for established governments to combat because it is difficult to employ conventional military force against it. Special warfare tactics and forces such as those discussed later in chapter 21 must be used against it, along with the *moral warfare* referred to in chapter 3. When legitimate governments are faced with this threat, it is vital that militant causes such as the following be eliminated: corruption and crime; unequal treatment and opportunity before the law; discrimination against minorities of any category; economic troubles and unemployment; and a breakdown in traditions because of lax educational, spiritual, and moral standards. Even when rebels or extremists know their initial position is weak, they can be encouraged by future possibilities and can become determined to pursue their course.

Osama bin Laden propaganda poster recovered by Navy SEALs in an abandoned al Qaeda classroom in Afghanistan during the early days of Operation Enduring Freedom. The kinds of irregular warfare orchestrated by bin Laden were the hallmark of the early 2000s.

Irregular Warfare in the Modern Era

In the early 2000s a relatively new and more sinister form of irregular warfare burst onto the world stage—violent extremism and terrorism, waged most notably by the Osama bin Laden–led al Qaeda organization. Its hallmark was, of course, the 11 September 2001 attack on New York and Washington, D.C., by bin Laden's al Qaeda plane hijackers.

In more recent years, taking advantage of a civil war and UN sanctions against the regime of Syrian president Bashar al-Assad in that country, and the power vacuum in Iraq following the withdrawal of U.S. forces in 2011, the extremist terrorist group that is called ISIS/IL in the West, and DAESH in the Middle East, mounted an extensive military and terror campaign in the region to establish a religious Islamic caliphate there. By 2015 they had captured a large part of eastern Syria and northern Iraq. Meanwhile, they proclaimed a worldwide jihad, and using this as a pretext perpetrated or inspired dozens of terrorist attacks around the globe, including the Boston Marathon bombings in April 2013; an incident at Ottawa, Canada, in October 2014 in which a gunman stormed the Canadian Parliament building and shot and killed a guard; a music hall attack in Paris in November 2015 that killed 137 and injured 368; shootings at a welfare center in San Bernardino, California, in December 2015 that killed 14 and injured 21; bombings at the Brussels airport and a subway station in Belgium that killed 35 and injured 300 in March 2016; a night-club shooting in Orlando, Florida, that killed 49 and wounded 53 others in June of that year; and many other incidents.

In response to the ISIS/IL radical Islamic jihadist campaign, an extensive military effort to recapture the lost territories and defeat DAESH was mounted beginning in late 2015 by a diverse U.S.-led coalition composed of many of the threatened Arab states in the area. It was backed up by air forces and ground troop special forces "advisors" supplied by Russia, the United States, and several European countries. As the action against DAESH progressed, however, these advisors often became more actively engaged, out of either necessity or choice. It remains to be seen what the eventual outcome will be, both in the Middle East and also worldwide as it relates to the many ISIS/IL/DAESH and related al Qaeda–inspired terrorist attacks that have taken place since the terrorists' rise to prominence.

The USS *New York* (LPD 21), christened in 2008, was built in part with scrap steel from the ruins of the World Trade Center buildings attacked by terrorists on 11 September 2001. The *New York* is the fifth of the newest *San Antonio*–class LPDs, designed for missions that include special operations against terrorists.

Critical Thinking

1. Many of the classic principles of war are routinely though perhaps unconsciously used in many games and sports to achieve victory. Choose a game or sport and describe how each principle of war is applied to it by winning participants.
2. With the rise of terrorism worldwide, has the threat of nuclear war in fact increased or decreased in the modern world? Explain the rationale for your answer.

Study Guide Questions

1. What main factors affect a nation's national strategy?
2. A. What are the three basic considerations in evaluating an external threat?
   B. Which is the most difficult to assess?
3. A. What are intelligence estimates intended to do?
   B. Why are they so important?
4. What are the nine principles of war?
5. What is general war?
6. How are "understandings" concerning limitations in a limited war conveyed to the nations affected?
7. What are the two schools of thought concerning the introduction of tactical nuclear weapons to the battlefield?
8. How may selective use of military force limit wars or reduce the danger of major power confrontations?
9. Why are naval and air operations less risky than ground force invasion?
10. What is the goal of modern irregular/special warfare?
11. What was Mao Tse-tung's concept of irregular warfare?
12. What are the forms that irregular warfare threats can take?
13. What must an established government do in order to combat an irregular warfare threat?
14. What new forms of irregular warfare became widespread in the new millennium?

New Vocabulary

national security
intelligence process
degree of risk
principles of war
general war
proxy war
irregular warfare
asymmetric warfare
vulnerabilities
intelligence estimates
calculated risk
unity of command
limited war
safe haven
unconventional warfare
special warfare

Unit 2

Naval Operations and Support Functions

Broadly speaking, the term *naval operations* refers to the day-to-day conduct of all actions involving units of the U.S. fleet in the oceans of the world. It can also refer to the activities of the department on board a ship that is concerned with the planning and accomplishment of these actions. *Naval communications* is the transmission and reception of military instructions and information by sound, electronics, or visual means. It is the means by which naval operations are executed. *Naval intelligence* gives government and military leaders the information about potential or actual enemies needed to make good decisions. It is often an integral part of naval operations and is transmitted through naval communications. *Naval logistics* provides the means of support for naval operations, while *naval research and development* ensures that the Navy operates with the latest technology. All five areas are interrelated insofar as the daily operations of naval units are concerned. The chapters that follow describe these areas in sufficient detail to give some understanding of the activities that take place in each.

6

Naval Operations

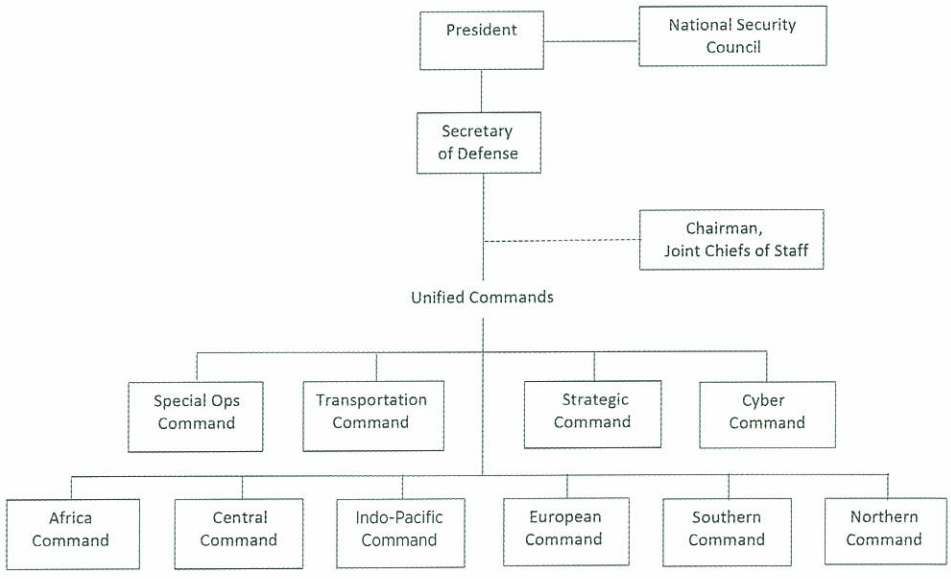
The employment and movements of various types of naval ships and other naval forces in carrying out the Navy's mission are collectively called **naval operations**. These operations can range from missions carried out by individual combat units, ships, or aircraft to large-scale evolutions done by an entire fleet.

In his 2002 blueprint for the U.S. Navy of the twenty-first century, *Sea Power 21*, Chief of Naval Operations Adm. Vernon Clark stated that henceforth there would be three basic concepts underlying all future naval operations: Sea Strike, Sea Shield, and Sea Basing. **Sea Strike** is the ability to project offensive power from the sea worldwide, whenever and wherever required. **Sea Shield** concerns naval operations related to homeland defense and defense of U.S. and allied sea and land forces and territory abroad. **Sea Basing** concerns the maintenance of deployed fast-response forces sufficient to carry out the Navy's mission worldwide, and their sustainment from the sea. These three basic concepts have since been refined by additional strategy documents released by Navy leaders, but they remain central to all U.S. naval operations conducted today, tied together and managed by means of an enhanced computer-based command and control system that incorporates the latest Internet and information systems technology to provide real-time coordination of all aspects of naval operations.

Command and Control Organization

By law, national command authority for U.S. naval forces, as with all U.S. military forces, starts with the President and extends through the Secretary of Defense, with advice from the Chairman of the **Joint Chiefs of Staff** (JCS), to various *unified* and *specified commanders* (see the diagram). A unified or specified command is a military command with a broad, continuing mission under a single commander, normally either an admiral or a four-star general. The **unified commands** (sometimes called *unified combatant commands*) are composed of combatant forces from at least two military services, with responsibility either for all military operations carried out within a particular geographic **area of responsibility** (AOR) called a *theater*; or broad functional responsibilities such as special operations; nuclear, cyber, and other types of strategic warfare; and transportation. There are currently ten unified commands, as indicated in the command structure diagram. Six are geographical commands and the other four are functional commands. Most unified commanders have traditional service affiliations that align with the service branches within their commands, but any unified command can be led by a flag officer from any one of the services.

A **specified command** would be composed of forces from only one service and have only functional responsibilities, such



U.S. national defense command structure.

as for special operations or strategic warfare. There have been no specified commands assigned since the dissolution of the Strategic Air Command in 1992. This organization, called the operational **chain of command** (hierarchy of authority), provides unity of command and control of all U.S. military forces in both peacetime and war.

The *National Security Council* (NCS) is a body of advisors consisting of several cabinet members and other select presidential staff members that advises and assists the President on national security and foreign policy. It is not in the direct national defense chain of command, although it does serve as the President's principal arm for coordinating these policies among the various federal agencies. More on the composition and function of the NSC is presented in chapter 8 of unit 2 of this section on naval intelligence.

The *Joint Chiefs of Staff (JCS)* is a body of senior uniformed leaders in DOD who advise the President, Secretary of Defense, the Homeland Security Council, and the National Security Council on military matters. The JCS consists of the Chairman, the Vice Chairman, the Chief of Staff of the Army, the Chief of Naval Operations, the Chief of Staff of the Air Force, the Commandant of the Marine Corps, and the Chief of the National Guard Bureau. The Chairman of the JCS (CJCS) is a four-star admiral or general from any of the services. He or she is appointed at the pleasure of the President with confirmation by the Senate for one four-year term (with a possible wartime exception) and is by law the highest-ranking officer in the U.S. military. The Chairman and Vice Chairman must be from different services. Directives from the President or the Secretary of Defense to the unified commanders, and other communications between them, are normally transmitted through the CJCS, and he or she advises the President and Secretary of Defense on potential courses of action. However, neither the Chairman nor any of the other members of the JCS exercises operational command over any combatant forces assigned to the unified commands.

The President and Secretary of Defense exercise authority over the armed forces through two distinct branches of the chain of command. One branch, for operational direction of missions and forces assigned to the combatant commands, runs from the President through the Secretary of Defense to the unified combatant commanders, with advice from the CJCS, as shown on the command structure diagram. The other branch, for all other administrative purposes, runs from the President through the Secretary of Defense to the secretaries of the military departments (the Secretary of the Army, Secretary of the Navy, and the Secretary of the Air Force).

The service secretaries exercise complete authority through their respective service chiefs over all of their forces not assigned to the unified commanders. The secretaries are responsible for organizing, training, and equipping their service's forces, and as directed by the Secretary of Defense, assigning operating forces to the various unified commands through their service chiefs. The service chiefs, including the Navy's Chief of Naval Operations, perform their duties under the authority, direction, and control of the secretaries of the respective military departments to whom they are directly responsible. Once their forces are assigned to the unified commands, neither the secretaries of the various military departments nor their service chiefs exercise any *operational control* over them, but they retain *administrative responsibility* for them wherever they may go. As an example, a crewmember on board a ship deployed within a unified command is responsible through his or her commanding officer to the unified commander for the accomplishment of the ship's mission, but administrative matters such as maintenance of that crewmember's master service record and future duty assignments remain an administrative responsibility of the Department of the Navy.

Within the geographic unified commands, the Navy's operating forces are divided by region into a number of operating fleets: eastern and northern Pacific, Third; eastern Atlantic, Fourth; Persian Gulf, Red Sea, Arabian Sea, and Indian Ocean, Fifth; Mediterranean Sea, Sixth; and western Pacific, Seventh. The Navy's Fleet Cyber Command, a part of the unified combatant U.S. Cyber Command, is presently designated the Tenth Fleet, although almost all of its personnel and equipment are based ashore. All other provisional numbered fleet designations between 1 and 12 are currently inactive. When they are deployed within a unified command, naval operating forces are then assigned to one of these numbered fleets. The fleets are in turn subdivided into task forces, groups, units, and elements,

The guided-missile destroyer USS *Halsey* (DDG 97), the aircraft carrier USS *Abraham Lincoln* (CVN 72), the French navy aircraft carrier *Charles De Gaulle* (R 91), the French navy destroyers *Forbin* (D 620) and *Tourville* (D 610), and the Military Sealift Command fast combat support ship USNS *Rainier* (T-AOE 7) under way in formation in the Arabian Sea, part of the U.S. Fifth Fleet area of responsibility. Such multinational combined forces are the rule rather than the exception in today's worldwide naval operations.

which can be combined when appropriate with assigned forces from other services and, on occasion, other nations.

The unified commanders typically organize their assigned forces for specific tasks by forming **joint task forces** (JTFs—task forces composed of forces from two or more services). The joint task force commanders organize their forces into operational and support components as the mission or operation demands. An example might be an amphibious ready group (ARG) composed of a Marine expeditionary unit assigned to an amphibious assault ship (LHA or LHD) as part of a Marine air-ground task force (MAGTF), with accompanying Marine air squadrons and escort and MSC replenishment ships, supported perhaps by assigned Army infantry units and Air Force aircraft squadrons. A JTF is normally disbanded after its purpose is completed, although some have long-standing permanent missions that keep them operational indefinitely.

In multinational operations, a JTF may also include components from other nations. In such cases, the combined force is called a *combined joint task force* (*CJTF*).

As in the example above, an organizational commander may establish various **support relationships** between subordinate commanders when one unit or organization can aid, protect, complement, or sustain another force. A commander normally establishes a support relationship by directing one force (the "supporting force") to provide support to another (the "supported force").

To assist with their command responsibilities, organizational commanders at various levels are normally assigned a **staff** (group of assistants) appropriate to their level of command. The staff assists the commander in carrying out his or her duties by providing specialized expertise and allowing a division of labor. The staff is not part of the chain of command and thus has no authority of its own, although the commander may delegate authority to a staff officer if he or she so chooses. In such cases, the staff officer exercises that authority "by direction" of the commander.

Combat Support Agencies

Though not in the direct chain of command of the military's operational forces, there are several designated **combat support agencies** (CSAs) within DOD that provide direct support to combat operations. Four of these are intelligence agencies that have dual roles within both DOD and the broader national intelligence community, and the remainder work solely in support of the unified commands as directed by the Secretary of Defense.

The four intelligence combat support agencies are the Defense Intelligence Agency (DIA), the National Security Agency (NSA), the National Geospatial-Intelligence Agency (NGA), and the National Reconnaissance Office (NRO). Their missions as they relate to naval intelligence are discussed in chapter 8. The others are the Defense Logistics Agency (DLA), discussed in chapter 9 in conjunction with naval logistics; the Defense Information Systems Agency (DISA), providing information technology and communications support throughout the military chain of command; the Defense Threat Reduction Agency (DTRA), which is concerned with weapons of mass destruction and protection from improvised explosive devices (IEDs); and the Defense Contract Management Agency (DCMA) and Defense Health Agency (DHA), both of which have responsibilities in line with their titles.

Strike Warfare

A **strike** is a form of power projection meant to damage, seize, or destroy a targeted objective. If conducted against land or sea targets by naval air, surface, or submarine forces using conventional nonnuclear weapons such as guns and cruise missiles, such operations are called **strike warfare** (STW). It does not include the use of torpedoes fired by submarines or ships, or mine warfare. Types of naval forces used in strike warfare are carriers, cruisers, destroyers, and submarines. These ships may operate independently or together, most often as part of a JTF. If they operate together, they are called a **strike group**. Naval strike forces carry out national military policy in peace and in war. Their presence near a trouble spot may serve as a stabilizing influence.

Today's naval strike forces are built primarily around the carrier, just as in World War II. These carrier forces are called **carrier strike groups** (CSGs). There are also some strike forces built around cruisers and destroyers.

The missions of carrier strike forces (CSFs) are still basically the same today; all involve sea control. These are:

- Power projection ashore against a wide range of strategic, operational, and tactical targets defended by sophisticated air defense systems
- Gaining and maintaining sea control, including coastal regions, bounded seas, chokepoints, and the open ocean
- Anti-access/area denial (A2/AD)
- Protection of commercial and military shipping
- Protection of Marine amphibious forces while en route to, and upon arrival in, amphibious objective areas (AOAs)
- Humanitarian assistance/disaster relief (HA/DR)
- Surveillance, intelligence gathering, and reconnaissance to achieve and maintain a comprehensive operational picture of the littoral environment, including surface, undersea, air, and relevant land areas of interest
- Establishing air superiority or air supremacy over a designated area by seizing and maintaining control of designated airspace

- Theater ballistic missile defense (TBMD) of littoral areas and selected theater-wide areas against attack
- Operations in support of the peacetime presence mission, including supporting U.S. diplomacy through cooperative engagement with designated allied forces, normal peacetime operations, and shows of force

While many of these missions involve support of amphibious assault forces, the primary mission of the CSGs remains to win command of the seas. To do this they can make strikes, sweeps, and raids. As mentioned above, a *strike* is a form of power projection meant to damage, seize, or destroy an objective. A series of strikes against several enemy targets in a general area is termed a **sweep**. A **raid** is a sudden destructive attack against a limited target, area, or facility, with no intention of holding the targeted objective.

The carrier strike group normally has one carrier along with at least one guided-missile cruiser and several destroyers, one or two attack submarines, and combat logistics force ships. Unlike World War II formations, with concentric circles of protective escort ships surrounding the carriers, today's CSG formations are spread over large expanses of sea, often with the ships out of sight of one another. Dispersion makes it more difficult for an enemy to determine the defense plan or to target multiple ships in a single attack.

Protecting the CSG from surprise air attack are airborne early-warning aircraft and combat air patrol (CAP) fighters. Other airplanes may do tactical scouting and reconnaissance. Still others may attack the enemy to damage, destroy, or demoralize enemy forces. **Surface action groups** (more fully described below) may be formed from the surface warships of the CSG and detached for particular tasks, such as destruction of isolated enemy units, interception and engagement of incoming threats, shore bombardment, or scouting missions.

Mobility, one of the greatest assets of naval strike forces, and a constant state of readiness enable these forces to make surprise attacks from any point on navigable waters. A modern naval strike may take place anywhere from the open ocean to great distances inland, depending on the weapons used. A naval strike force can be available immediately for prompt and decisive action whenever the need arises.

Naval Aviation Organization

Navy and Marine Corps air forces are assigned to **functional air wings**, administrative and training commands that each support several squadrons of one type of aircraft, such as helicopter, fighter/attack, airborne early warning (AEW), patrol, and unmanned aerial vehicles (UAVs). These functional air wings and their squadrons are based at a number of Navy and Marine Corps air stations (NAS and MCAS) and naval air facilities (NAF), mostly within the coastal regions of the United States.

A squadron may contain anywhere from two to as many as several dozen aircraft, and from several dozen to several hundred personnel, depending on the kind of aircraft, mission, and duty assignment. Each squadron has a commanding officer and an administrative organization consisting of several officers and senior petty officers. All pilots are normally commissioned officers.

Squadron designations such as the VFA-103 Jolly Rogers indicate the squadron's type and mission, and its nickname. The first letter indicates the type, and the additional letters

An F/A-18C from the Blue Diamonds of Strike Fighter Squadron (VFA) 146 prepares to land on the flight deck of the aircraft carrier USS *Nimitz* (CVN 68). Note the three arresting gear wires stretched across the deck, with the fourth wrapped around the tensioner at the bottom of the picture "not on deck" (not available) for some reason.

A pair of V-22 Ospreys, a common part of Marine air groups on board carriers, LHAs, and LHDs. With the engines positioned as shown here, the aircraft can take off and land vertically. Once airborne, the engines rotate 90° forward, converting the Osprey into high-speed turboprop aircraft. *Mike Jones*

A Navy P-8 Poseidon USW patrol plane.

signify the mission. The numbers following identify a particular squadron of that type and are not systematically assigned. In the example given, the V indicates a fixed-wing aircraft, the F a fighter, and the A attack, with the 103 and Jolly Rogers being the unique squadron number and nickname. The various types of aircraft used in the Navy and assigned to various types of Navy and Marine air squadrons were discussed in *Naval Science 1*.

Various Navy and Marine aircraft squadrons are assigned to deploy from their functional wings to aircraft carriers or amphibious assault ships such as LHAs and LHDs, to form the **carrier air wings** or **Marine air groups** of those ships. Normally most carrier air wings are comprised only of naval aircraft squadrons, but on occasion they may also include Marine air squadrons, referred to as a Marine air group component of the air wing when this occurs. Aircraft assigned to amphibious ships are exclusively Marine Corps assets. On occasion some Marine squadrons may also be deployed to advance overseas bases or expeditionary airfields near operations being supported.

Navy patrol aircraft squadrons (VPs) such as those flying the P-8 Poseidon are assigned to patrol and reconnaissance wings (PRWs) operating out of naval air stations located in the United States, or they deploy to others located abroad in allied countries.

Each carrier air wing or Marine air group staff is home-based at one of the Navy or Marine air stations that support the functional air wings, close to the home ports of the ships they support, although some of their squadrons may be based at different locations. Each has its own two-letter tail code that identifies its aircraft, such as AJ for Carrier Air Wing 8 (CVW-8) based at Oceania Naval Air Station in Virginia. When aircraft carriers or LHAs and LHDs deploy, their aircraft are usually flown on board after the ships depart their home ports, but in some cases they may be hoisted on board before the ship departs. When the ships return from deployment, their aircraft typically fly off and return to their home air stations a day or two prior to the ship entering port.

This view of the nuclear-powered carrier USS *John Stennis* (CVN 74) shows many of the aircraft of its air wing while on a deployment. The remaining aircraft are below deck in the hangar bay.

In the past, aircraft carrier air wings were permanently associated with and identified by the carriers on which they normally deployed, but today any carrier air wing might deploy with any carrier. There are at present eleven active Navy aircraft carriers, and nine numbered carrier air wings that support them. At any given time there are about a half-dozen aircraft carriers deployed with their assigned air wings around the globe, with the remaining carriers and air wings undergoing maintenance, upkeep, and training at their respective home ports and naval air stations or functional wings.

A typical carrier air wing today consists of several fighter/attack and helicopter sea combat and maritime strike squadrons, plus AEW, electronic attack (EA), logistics support planes, and UAVs, totaling altogether seventy to eighty aircraft. Depending on their assigned missions, Marine air groups on amphibious assault ships can comprise about twenty fighter

Almost every color of jersey is represented here in this photo of flight deck crewmembers readying an EA-18 Growler aircraft for a mission on board the aircraft carrier USS *Nimitz* (CVN 68). *David Claypool*

Two F-35B Lightning II aircraft land on the flight deck on the amphibious assault ship USS *America* (LHA 6). The F-35B short takeoff/vertical landing (STOVL) variant is the world's first supersonic STOVL stealth aircraft and is slated to replace the AV-8B Harrier as the main fixed-wing aircraft flown by the U.S. Marine Corps. *Kyle Goldberg*

aircraft (Harriers or F-35Bs) or a mix of fighters, Osprey tiltrotor aircraft, heavy-lift and light attack helicopters, and UAVs, totaling altogether some thirty aircraft.

While deployed on board a ship, Navy air wing and Marine air group personnel work closely with the ship's air department personnel on all matters affecting aircraft operations and safety. All personnel who work on the flight deck wear various colored jerseys to indicate their duties:

- yellow—aircraft handlers and directors, catapult and arresting gear officers
- green—catapult and arresting gear maintenance personnel, air wing maintenance personnel, troubleshooters, enlisted helicopter landing signalmen
- blue—assistant plane handlers, elevator operators, tractor drivers
- purple—aviation fuel personnel
- red—ordnance handlers, explosive ordnance disposal personnel, crash and salvage crewmen
- brown—plane captains, air wing leading petty officers (LPOs)
- white—safety observers, air wing landing signal officers (LSOs)

Air Warfare

All air warfare may be roughly broken down into three main classifications: air to surface, air to air, and surface to air.

Air-to-surface warfare includes all measures used by aircraft to attack surface targets on land and sea, including guns, missiles, bombs, and other types of air-dropped ordnance. Although carried out primarily by attack aircraft, in recent years fighters, patrol aircraft, UAVs, and especially helicopters have been increasingly used in this role. Major subcategories of air-to-surface warfare are **undersea warfare** (USW) and **surface warfare** (SUW).

Air-to-air warfare is carried out by aircraft against other aircraft. The primary type of plane involved in this type of warfare has been the fighter, but attack planes and sometimes helicopters also get involved on occasion, as do surveillance and AEW aircraft that detect incoming hostile aircraft. Although in modern times missiles have largely replaced guns as the main air-to-air combat weapon, it may still be necessary to get in close and engage enemy aircraft one-on-one with guns in the classic dogfight. Some specialized tactical aircraft require a crew of two—one to fly the airplane and the other to operate the complex fire control and weapons systems of today's sophisticated aircraft.

Surface-to-air warfare, called simply **air warfare** (AW) in the fleet, includes all measures designed to counter attack by hostile aircraft or guided missiles. Active AW uses aircraft, antiaircraft guns, missiles, and **electronic countermeasures** to jam enemy radars, confuse guidance systems, and present false targets. Passive AW uses such tactics as cover, concealment, and dispersion.

Fleet AW tactics are designed to provide **defense in depth** to the carrier or other high-value ships in a strike group. AW operations occur in three phases as potential attacking aircraft approach. The first phase involves searching for, finding, evaluating, and reporting a possible enemy attack threat with long-range search radar and AEW aircraft while it is still hundreds

of miles away. If the inbound aircraft are evaluated as hostile, this is followed by the second phase, consisting of initial AW defense measures begun while the enemy aircraft are still far distant from the force. These may include electronic deception, fighter aircraft intercepts, and the use of long-range surface-to-air Standard SM-3 missiles with ranges of two hundred to three hundred miles. The third phase begins if the enemy aircraft penetrate the outer defenses and come within weapon launch range of the main body of ships. Now the full aggregate air defense power of the strike group is brought to bear to defeat the threat. Combat air patrol fighters continue to engage the enemy forces, and guided-missile destroyers and cruisers are positioned on the threat axis between the main body and the incoming threat. They launch intermediate-range missiles such as the Standard SM-2 and ESSM Sea Sparrow as soon as the attackers or any antiship missiles they might launch come within range. These are followed by short-range missiles such as the SeaRAM launched against targets five to ten miles out.

Any surviving enemy aircraft or antiship missiles that manage to get within two miles from the force are automatically taken under fire by the Gatling guns or point defense RAM missiles of the Phalanx close-in weapons systems on board both the escort and the main body ships. (All these weapons are described in more detail in chapters 17 and 18.) All ships within the force engage in evasive maneuvering to make it more difficult for attacking planes and missiles to hit them.

Defense in depth against an air attack demands careful coordination between widely dispersed ships and aircraft in the strike group. The attackers can climb to very high altitudes or they can come in just above the waves. No matter what their altitude, their speed is likely to be supersonic. And they can fire missiles that can home in on target ships from many miles away, which means that defenders must be able to react and compute defensive fire-control solutions very quickly.

An antiair warfare commander (AWC), usually the commanding officer of one of the strike group Aegis cruisers, is in charge of a team that directs air defense for the entire battle force. Using computerized tactical data links in the Aegis cruiser's combat information center (CIC), the AWC and his or her subordinates guide with direct communications and electronics the surveillance, detection, identification, intercept, and engagement of all enemy aircraft and other enemy threats within the operational area of the strike group. **Aegis**, which was described in *Naval Science 1*, is an integrated naval weapons control system that uses powerful computer and radar technology to track and destroy enemy targets. An Aegis ship is specially designed for command and control of the inner air battle. Aegis cruisers and destroyers are able to effectively combat the most serious threat to surface ships, the low-altitude antiship missile. This virtually automatic system is regarded as the best defensive and offensive system for task groups ever developed.

Over the next several years, modern information and communication technology such as the Navy's Integrated Fire Control system now being developed will make the Aegis system even more effective. It will make tactical information instantaneously available to all operational units engaged in all types of warfare within a battlespace via electronic data links. These links will make possible unprecedented coordination among all surface and air units of a strike force. For example, targets in an offensive strike against enemy surface forces might be identified by long-range "hunter" patrol aircraft such as the E-2 Hawkeye or P-8A Poseidon. Designated targets might then be attacked by missiles such as the newly operational antiship version of the Standard SM-6 missile surface-launched from CSG ships, or the JSOW (Joint Standoff Weapon) air-launched at a safe standoff distance by "killer" aircraft such as the F/A-18 Super Hornet or F-35 Lightning. While en route, these missiles will be continuously monitored and provided with updated guidance by the "hunter" aircraft or other units in close proximity to the targets.

Surface Warfare

Surface warfare at sea has been conducted ever since two enemies first confronted one another in boats. Like CSGs, surface attack forces are primarily intended to establish command of vital sea areas so that friendly forces may operate there and enemy forces cannot. Operations of this type are called **anti-access/area denial** operations in modern terminology.

Until the advent of naval aviation and submarine warfare in the early part of the twentieth century, virtually all naval warfare was conducted between opposing surface forces. Many major naval battles were fought between opposing battle fleets, such as the Greeks and Persians at the Battle of Salamis in 480 BC, the defeat of the Spanish Armada by Britain in 1588, and the Battle of Jutland fought in World War I between the English and the Germans. Combat also took place between individual ships, like many of the famous actions in the American Revolution and other major conflicts thereafter.

In World War II numerous surface actions were fought to establish control of vital shore areas, straits and other navigational chokepoints, and sea routes over which war supplies traveled. In the Korean and Vietnam Wars, surface actions involved mainly support of forces ashore and transportation of war matériel, and denial of these capabilities to enemy forces.

Surface forces were used to convoy U.S. and allied oil tankers through the Strait of Hormuz and the Persian Gulf during the Iran-Iraq War, to enforce trade sanctions and launch cruise missiles in strike warfare operations against Iraq in the 1990s and early 2000s, Kosovo in 1999, against al Qaida in Afghanistan in the late 1990s and 2000s, and more recently against Syria in spring 2017. For a number of years U.S. surface

The Aegis cruiser USS *Lake Erie* (CG 70), front, steams in company with the USS *Decatur* (DD 936), an *Arleigh Burke*–class guided-missile destroyer, and the Coast Guard Cutter *Bertholf*, as a joint surface action group transiting the Gulf of Alaska as part of Operation Northern Edge, Alaska's largest annual military exercise. *U.S. Coast Guard, Charly Hengen*

The converted nuclear-powered guided-missile submarine USS *Ohio* (SSGN 726). Formerly the lead ship of the *Ohio*-class SSBNs with the designation SSBN 726, the *Ohio* along with three sister ships was refitted as a guided-missile submarine and relaunched in its new role in 2005.

warships along with those of other nations have protected shipping against piracy in the waters off the Horn of Africa and in other places around the world where this has become an ongoing problem.

Surface Action Groups

When traditional surface action occurs, it is often a series of rapid engagements, often overlapping. Surface warfare ships such as cruisers and destroyers, often part of a CSG, can be moved in and out of battle for attack, pursuit, or mopping-up operations. However they may be deployed, surface warships in a battle formation are usually close enough to each other that some mutual support is possible. Such ships are often referred to as a *surface action group* (SAG).

Long-range surface-to-surface cruise missiles such as the Tomahawk add greatly to the capabilities of a SAG. These missiles allow naval surface forces to attack land targets from positions far offshore, formerly a capability reserved for carrier air forces and ballistic missile submarines.

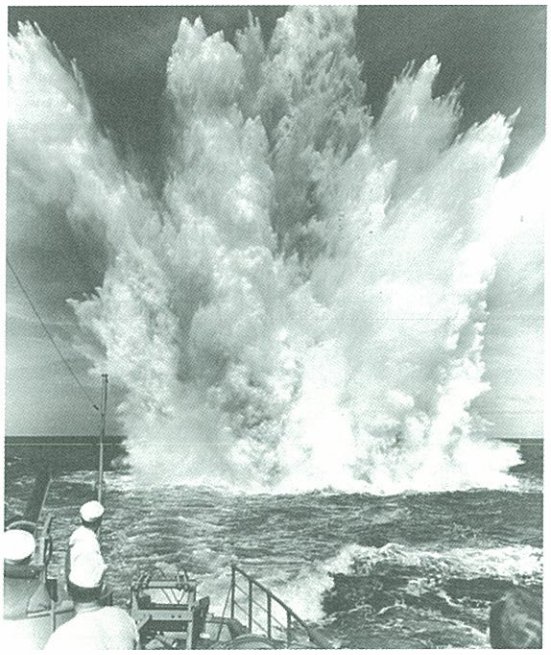
Surface ships used in surface warfare today include guided-missile cruisers; destroyers; and a wide variety of patrol, littoral combat, and mine warfare craft. They have many capabilities and missions, ranging from peacekeeping in the troubled areas of the world to global antipiracy operations and drug traffic interdiction in the waters of the Caribbean and the Straits of Florida to, on occasion, strike warfare.

Submarine Warfare

Historically, the mission of a submarine has been to seek out and destroy enemy surface ships, both naval and merchant. Since the advent of the nuclear attack submarine in the 1950s, the submarine's basic mission has changed. While it still seeks to destroy surface ships, its primary objective is now to sink enemy submarines. The development of the nuclear-powered ballistic missile submarine introduced yet another mission: to attack strategic enemy land targets such as missile sites, heavy industry, and rail and other transportation networks with ballistic missiles. Modern attack submarines can also launch cruise missiles to attack land targets, and they were used in this role in both Operations Desert Storm and Iraqi Freedom, as well as in Operation Enduring Freedom in Afghanistan.

Some fourteen fleet ballistic missile submarines in today's fleet each carry twenty-four Trident four-thousand-mile-range sea-launched ballistic missiles (SLBMs) stowed in vertical launch tubes. They operate on 120-day rotational cycles. During their submerged patrols they operate completely independently. They are permitted to receive messages but not to respond. They are manned by 2 complete crews—Blue and Gold—each with about 155 officers and enlisted crewmembers. In a typical cycle, a crew will take its ship on a 2-month patrol, return home for a month's leave, have a month of refresher training ashore, and then be ready to start another deployment. While one crew is ashore, the other is on patrol with the boat.

Between 2002 and 2007 four former *Ohio*-class fleet ballistic missile submarines were converted to guided-missile submarines (SSGNs), both to comply with the Start II nuclear arms reduction treaty signed with the Soviets in 1992 and also to use their capabilities as launch platforms for large numbers of cruise missiles. These SSGNs can carry up to 154 land-attack Tomahawk cruise missiles, which can be launched from 22 missile launch tubes. They can also accommodate up to sixty **special operations force** (SOF) personnel, such as Navy SEAL teams. Two former missile tubes on each submarine were converted to lockout chambers that allow clandestine egress and retrieval of SOF swimmers. Together, the four SSGNs represent



A depth charge explodes behind a patrol vessel along the U.S. Atlantic Coast during World War II. Until the U-boat menace was brought under control, the Allies suffered heavy shipping losses in the Battle of the Atlantic.

more than half of the total cruise missile launch capability of the U.S. submarine force.

Undersea Warfare

Until 1917 there was no adequate means of finding a submerged submarine. During World War I, however, three major developments established antisubmarine warfare (ASW), now referred to as **undersea warfare** (USW).

The first of these was the **convoy system**. This method of grouping ships together for mutual protection with destroyers as escort ships proved to be very effective. Proposed by Adm. William Sims, the convoy system enabled more than 2 million American troops to cross the Atlantic to Europe during the war without a single loss of life due to submarine action.

Second was the introduction of the directional **hydrophone** (underwater microphone). This was the beginning of effective underwater sound detection equipment. These hydrophones could be lowered from two or three destroyers or submarine chasers at the same time. Using a mathematical process called **triangulation** (systematically decreasing the size of a geometric shape formed by three or more lines of position), the submarine's location could thus be pinpointed by the sounds of its engines and propellers.

Finally, the **depth charge** gave the destroyer a weapon that could destroy a submarine underwater once it was located.

An aviation ordnanceman loads disposable radio sonobuoys into a P-3 Orion patrol aircraft. The sonobuoys can be dropped on the water around a suspected submerged submarine, allowing an operator on the aircraft to track its movements. *John Collins*

Essentially a large canister of high explosives, the depth charge could be rigged to detonate at a preset depth and then released over the determined position of the submarine.

American scientists improved on the hydrophone system during World War II, calling it the sound navigation and ranging system (**sonar**), or underwater sound ranging system. By bouncing sound pulses off the hull of a submarine and measuring the time lapse until the return of their reflections, sonar operators could determine the range and bearing of the submarine almost exactly. The science of underwater sound has continued to advance since. Using sonar ranges and bearings to contacts, computers can quickly figure their courses and speeds, and if desired, program weapons to attack them, taking into account such variables as water temperature, salinity, and pressure.

Since World War II significant advances in USW have been made. The helicopter has become a major USW platform. The highly maneuverable nuclear-powered attack submarine (SSN) has become the most effective USW vessel. The SSN can use sophisticated sensing devices to find and attack enemy

submarines with homing torpedoes and a variety of long-range missiles (including subsurface-to-subsurface types).

Modern cruisers, destroyers, littoral combat ships, and USW aircraft, both shore based and ship based, carry a variety of sensors to locate and attack submerged submarines. These include:

- *Radio sonobuoys*, small buoyant tubes dropped from aircraft that contain a hydrophone and radio transmitter to help locate submarines by transmission of its noises to the aircraft
- *Magnetic anomaly detection* (MAD) gear, usually in aircraft that detects variations in the Earth's magnetic lines of force created by a submarine
- *Dipping sonar*, a device lowered into the sea from a hovering helicopter to echo-range a submarine
- *Infrared detection*, a method involving electronic detection of heat emitted from submarines
- *Towed arrays* of a long line of sensors that can be streamed behind warships to detect low-level sound emitted from submarines at long range

Once detected, the submarine can be attacked with depth charges, antisubmarine missiles, and homing torpedoes.

Amphibious Warfare

Amphibious warfare, like surface warfare in general, goes back all the way to the ancient Greeks and their assault on Troy. Amphibious assaults and withdrawals have played key roles throughout history, including in the American Revolution and the Civil War. Undoubtedly the most famous amphibious operation of World War I was the ill-fated Allied invasion of the Gallipoli Peninsula in the Turkish Strait. There, logistics and communications were inadequate, heavy mining caused major ship losses, and strongly entrenched Turkish forces could not be driven from their fortifications. The lessons learned from the disastrous Gallipoli campaign assisted in the development of modern amphibious warfare doctrine.

In World War II amphibious operations were developed into a highly refined military science. Dozens upon dozens of landings took place in the Pacific against strongly held Japanese islands. Lessons were learned from mistakes made in the early assaults, and eventually a smoothly functioning Navy–Marine Corps team operation developed. In the European theater, landings were even larger in scale, involving hundreds of thousands of troops in the invasions of North Africa, Sicily, Italy, and France. The invasion of Normandy in France brought ashore l million men, 183,000 vehicles, and 650,000 tons of supplies from 3,000 vessels in the first 28 days of the assault!

Amphibious warfare uses nearly all types of ships, aircraft, weapons, and landing forces to carry out a coordinated military attack against a hostile shore from the sea. The Navy's amphibious warfare capabilities provide four strategic benefits for a nation dependent on its ability to exploit its command of the seas to project influence and power.

Marines practice a fast rope-out egress from a hovering V-22 Osprey aircraft. Such aircraft provide the Marine Corps with a quick-strike capability far inland during an amphibious operation. *Lana Waters*

Freedom of action. Amphibious forces can use the maritime domain as a base from which to conduct operations. They can loiter indefinitely in international waters and land ashore at the time and place of their choosing.

Deterrence. While a standoff strike is sometimes an adequate response, other situations require the rapid insertion of sustainable combat forces—"boots on the ground"—to underscore the nation's commitment to an ally or to protect our national security interests.

Assured access. Amphibious forces contribute unique and essential capabilities toward the nation's ability to take advantage of the freedom of the high seas. They can enter a region without regard to access constraints and impediments, and

sustain sea-based operations almost indefinitely without need for in-theater host government support.

Uncertainty for adversaries. A credible forcible-entry capability compels potential adversaries to invest in a broad range of systems and spread their defenses over larger areas of concern.

Once an amphibious operation is undertaken, there are four main objectives:

- To capture territory from which a land campaign can be launched and supported (it may be to outflank and surprise, or to gain a base for forward movement of forces)
- To capture a land area from which air operations can be launched and supported
- To prevent enemy use of selected territory or facilities
- To destroy enemy facilities, interrupt their communications, and cause them to spread their forces to try to respond to amphibious raids

The amphibious operation is highly useful because of its mobility and flexibility. In other words, it has the ability to concentrate forces and to strike with great strength at selected points. It exploits the element of surprise. At the right time, it can strike when and where the enemy is least prepared. The mere threat of an amphibious assault may be sufficient to cause the enemy to disperse his forces and make expensive and wasteful efforts to defend a long coastline. The amphibious striking forces of the United States normally consist primarily of Navy and Marine Corps forces but may include personnel and equipment from every service.

The basic amphibious warfare unit in the U.S. Navy is the **Marine air-ground task force** (MAGTF). The MAGTF includes all the Marine combat and support units necessary for an amphibious operation and can be scaled in size from a few hundred troops to more than 50,000. For some operations it may also include Army troops and support personnel from both the Army and Air Force. The Marine component of a MAGTF normally comprises a command unit that exercises command and control of the operation; a ground combat element formed primarily of infantry units; an aviation combat unit including fixed-wing, helicopters, tiltrotor, and UAV squadrons; and a combat logistics element including heavy motorized transport, ground supply, and advanced medical units.

For amphibious operations the MAGTF is embarked upon Navy amphibious ships such as LHAs and LHDs (amphibious assault ships), LPDs (amphibious transport dock), and LSDs (dock landing ships). These ships are collectively called an **amphibious task force** (ATF), and the MAGTF they transport is referred to as the **landing force**. The combination is called an **amphibious ready group** (ARG). Ships of the ATF are capable of embarking and supporting other forces as well when the mission requires, including U.S. Army, special operations forces, or other joint and combined forces. Upon arrival and debarkation at an **amphibious objective area** (AOA), the landing force is initially supplied by a number of prepositioning ships preloaded with military matériel and located in strategic locations in the major operating theaters (see chapters 2 and 9). The ARG is supported as necessary in transit and in the AOA by carrier strike groups and other air, surface, and undersea warfare forces as required. Altogether, such a force is referred to as an **expeditionary strike group** (ESG).

Ships of the *Kearsarge* amphibious ready group under way in close formation while supporting maritime security operations in the Red Sea, in the U.S. Fifth Fleet area of responsibility. *Scott Pittman*

Besides amphibious ships, other ships that may support amphibious operations include destroyers, cruisers, and submarines that can provide gunfire and cruise missile surface fire support and also air defense if the need should arise. In an opposed amphibious assault, naval surface fire support can mean the difference between success and failure. But in order for it to be effective, naval gunfire and cruise missile support for amphibious operations must be carefully planned in advance and executed with precision and timeliness. Naval surface fire is vitally important both before the assault, to neutralize beach defenses, and after the troops have landed, to support them before adequate field artillery can be brought ashore and put into action.

In addition to amphibious landings themselves, naval surface fire support can also be used in other support operations including mine warfare activities; air-sea rescue missions; demolition operations; and feints, raids, and flak suppression during air strikes against land targets. It can be used in interdiction of coastal roads, railroads, airfields, and troop assembly areas.

Information Warfare

The gathering, transmission, storage, processing, and accessing of information has always been of concern to war fighters and is critical to success in modern warfare. **Information warfare**

(IW), sometimes called **information operations** (IO), is any action taken to negatively affect the information, information systems, or C4ISR capabilities of an enemy; to safeguard our own information resources; or to exploit that information militarily. It includes such things as electronic warfare, psychological warfare operations, military deception, computer network defense, and operations security. A subset of IW is **cyber warfare**, which pertains to large-scale electronic hacking attacks on government or military computer systems, communications networks, and infrastructure such as power grids. Cyber warfare is discussed in more detail in the Modern Naval Warfare unit, chapter 20.

The last of five Navy Mobile User Objective System (MUOS) satellites launches on board an Atlas V rocket from Cape Canaveral, Florida. This is a new Navy communications satellite system that extends UHF cell phone capabilities to all U.S. and allied users worldwide. *United Launch Alliance*

Space Warfare

The use of space-based communications, intelligence, and navigation systems has become increasingly important to the Navy. Naval aviators were among the first selected for astronaut training, and they served as crewmembers on many of the early space exploration missions as well as in the space shuttle program. Navy navigation satellites provided global all-weather positioning information to both military and civilian users from the mid-1960s until the advent of the Global Positioning System (GPS) in the late 1990s, and communications satellites have been a mainstay of the Navy communications system for many years.

Space satellite systems play a key role in linking widely dispersed forward-deployed naval forces with each other, the supporting shore establishment, the forces of other services and other nations, and government and nongovernment agencies. They have become indispensable tools in the command and control of naval forces.

Today's naval forces are among DOD's largest users of space systems, relying on space support for most ship-to-shore communications, precision navigation, and weather forecasting, and much of their C4ISR capabilities. All branches of the U.S. military rely upon Navy satellites for ultra-high-frequency (UHF) narrowband communications.

Space systems provide a unique capability to collect and disseminate large volumes of information. They can provide sustained, covert surveillance of the battlespace to allow timely indications and warning of hostile actions. They can detect, classify, and identify high-interest targets and can help in assessing battle damage. They can provide highly accurate positional data to aid navigation, weapons direction, mapping and charting, and search and rescue. Finally, they can tie together naval, joint, and multinational forces across large areas of the globe by means of high-capacity, secure communications.

Because of their extended line of sight, space systems have unique characteristics that make them especially valuable to naval forces. They can provide global coverage of almost any area of interest. Depending on their orbits, satellites can provide either periodic short-duration coverage of specific points on the Earth's surface or continuous, long-dwell coverage of larger areas. Communications satellites are now the primary means of providing immediate worldwide connectivity to all military forces on land, sea, and air, regardless of the location, weather, or type of operation.

The development of increasingly versatile satellite systems is continuing and will undoubtedly result in the addition of many more capabilities in the future, including large-area electronic surveillance and warfare coordination, and completely passive detection and tracking of enemy ships, aircraft, and missiles. These capabilities will have a great effect on future naval operations.

Critical Thinking

1. Find pictures taken by satellites on the Internet. How high were the satellites when they took the pictures and what were the smallest things they could see on the Earth?
2. Locate a schematic picture of a sonobuoy. Draw it and identify its major parts. Describe how it works and identify two major types.

Study Guide Questions

1. As set forth in *Sea Power 21*, what are the three concepts that will underlay all naval operations in the twenty-first century?
2. What is the operational national chain of command for all U.S. military forces, including the Navy?
3. A. What are the composition and responsibilities of the unified commands?
   B. How many are there?
4. A. What is the Joint Chiefs of Staff?
   B. Who are its members?
   C. What is its relationship with the national chain of command authority?
5. What are the two branches of the chain of command of the U.S. armed forces?
6. What are the roles of the various combat support agencies that support the Department of Defense?
7. A. What is a striking force built around an aircraft carrier called?
   B. What are its missions pertaining to power projection and sea control?
8. A. What is the CAP?
   B. What is its purpose?
9. A. What are the aircraft that deploy on board an aircraft carrier called?
   B. What types of aircraft are they?
   C. What types of aircraft deploy on board amphibious assault ships?
10. What do the various colored jerseys worn by flight deck personnel on ships having an air wing or air group signify?
11. What are the three main classifications of air warfare?
12. What are the three phases of fleet air warfare tactics?
13. What is Aegis designed to do?
14. What is a SAG, and what kinds of ships might constitute it?
15. A. Historically, what has been the mission of the submarine?
    B. With the coming of the nuclear-powered attack submarine (SSN), what became its primary attack mission? What can modern attack submarines also do?
    C. What additional mission was introduced by the development of the nuclear-powered ballistic missile submarine?
16. What are the capabilities of the four converted *Ohio*-class guided-missile submarines?
17. What three major developments established undersea warfare during World War I?
18. A. What is the primary electronic detection device used in USW operations?
    B. What are some variations of it that can be used by aircraft?
    C. What are two other kinds of modern submarine detection devices that can be used by aircraft?
19. What are the four strategic benefits provided by the Navy's amphibious warfare capabilities?
20. What are the four possible objectives of amphibious operations?
21. A. What is the basic Marine amphibious warfare unit?
    B. What is its normal composition?
    C. What is an amphibious ready group (ARG)?
22. Besides amphibious ships, what other types of ships may support amphibious operations?
23. What is information warfare?
24. What are the warfare capabilities of today's space satellite systems?

New Vocabulary

naval operations
specified command
combined JTF
carrier strike group
raid
air wing
air station
undersea warfare
air-to-air warfare
surface-to-air warfare
Aegis (warfare system)
defense in depth
undersea warfare
hydrophone
depth charge
sonobuoy
towed array
AOA
information operations
unified command
joint task force (JTF)
strike
sweep
surface action group (SAG)
air group
air-to-surface warfare
surface warfare
dogfight
electronic countermeasures
A2/AD operations
special operations force
convoy system
triangulation
sonar
magnetic anomaly detection
MAGTF
information warfare
cyber warfare

7

Naval Communications

To communicate means transmitting a message so the receiver understands it accurately. The tools of communication are written and spoken words. In order to communicate well, ideas must be put in the form of words that accurately convey them. This is especially important when the messages are commands or orders.

Naval communications is the transmission and reception of military instructions and information by sound, electronics, or visual means. The Navy operates worldwide, so it needs a global communications network. A commander must be able to communicate orders reliably, securely, and quickly to and from ships, shore stations, and aircraft.

Satellite communications dishes at Wahiawa, Hawaii, for the satellite-based MUOS that links together all U.S. and allied forces worldwide.
John Ciccarelli

Communications makes it possible for a commander to evaluate a situation and determine appropriate courses of action for his or her units from a central command post. Without the ability to communicate, there could be no coordinated action among ships, aircraft, and ground forces.

Naval communications must be reliable, secure, and rapid in both peace and war. Of the three, reliability is the most important; it must never be sacrificed for security or speed. If a choice must be made between security and speed, the originator must decide which of the two is more important.

Naval Telecommunications

Naval telecommunications includes all of the electronic communications effort within the Department of the Navy. The main function of naval telecommunications is to meet the command and control needs of the operating forces. Its secondary function is to allow administration of the naval establishment. Telecommunications includes transmission, routing, reproducing, distributing, recordkeeping, and encrypting and decrypting naval messages.

Telecommunications and Command

The naval telecommunications system includes all communications facilities on shore as well as on ships at sea and aircraft in the air. The largest of the shore facilities are called *naval computer and telecommunications area master stations* (NCTAMSs). There are six of these throughout the world, including facilities at London, England; Naples, Italy; and Hawaii. They have a full range of telecommunications equipment to give support to all U.S. naval communications in a specific large geographic area. Subordinate to them are eight *naval computer and telecommunications stations* (NCTSs) at various other locations worldwide. Together they bring superior C4I capability via secure and reliable classified and unclassified voice, messaging, video, and data telecommunications to U.S. Navy, joint, interagency, and coalition forces operating worldwide. Fleet commanders control all tactical communications of ships and aircraft under their command.

For the operating forces, telecommunications is the voice of command in tactical situations. It is the way ships and aircraft talk to one another. The communications organization on board ship is under the direct control of the commanding officer. The size of shipboard communications organizations depends on the size and type of the ship. A large ship, such as an aircraft carrier or amphibious command ship, has a separate communications department headed by a communications officer. In other ships, such as destroyers or auxiliaries, the communications division is part of the operations department, and the communications officer is their division officer. Shipboard communications facilities have ample communications equipment for their needs, plus additional standby capabilities in the event of emergency.

Electrical/Electronic Communications

We usually refer to electrical communications as electronics, which has to do with the conduction of electrical energy or impulses by electrons in a conductor (wire), the dissemination

of radio waves in or above our atmosphere, or the artificial generation of sound pulses in water.

Radio is one of the Navy's main forms of communication. Radio circuits are potentially the least secure of all communications, however, so with the exception of a few short-range nonsecure voice radio circuits, most present-day Navy and other military service radio voice and data transmissions are **encrypted**; that is, sent in some form of coded format called a *cipher*. Most military radio circuits are now encrypted electronically, so **decryption** by unauthorized means is considered nearly impossible.

A Navy MUOS satellite.

Radiotelephone (R/T)

The **radiotelephone** (voice radio telephone) is one of the most basic military communication devices. Because it is easy, direct, and convenient, it is used routinely for tactical communications among surface ships, ground forces, and aircraft. There is almost no delay in transmission, and acknowledgments can be returned immediately. Most tactical R/T equipment has *line-of-sight* capability only; that is, the radio waves go in straight lines and do not follow the curvature of the Earth. Over-the-horizon (OTH) R/T communication can be done using specialized low-frequency radio or communications satellite links.

Most R/T transmissions are sent in **plain language** (as spoken), so there must be strict **circuit discipline**; that is, prescribed frequencies, language, formats, and procedures must be used. Radiotelephones operate in *half-duplex mode*, meaning that an operator must push a button to talk, then release it to listen, as opposed to a landline or cell phone that allows these to occur simultaneously. Broadcast unencrypted plain language R/T is considered the least secure means of electronic communications because anyone within range can hear the message. Therefore, almost all military R/T in use today is automatically encrypted by devices that convert the analog voice signal into digital format, then encode it using digital ciphering algorithms. Such R/T circuits are called *secure voice* circuits. Only properly equipped receivers can decipher such transmissions.

Those using R/T voice radio communications must pronounce words properly and have a thorough knowledge of the **phonetic alphabet**, wherein each letter has a corresponding "code word" and pronunciation guide (see the inset). Numbers also have a standard pronunciation guide. There are different phonetic alphabets for all the major languages, but the standard for the U.S. armed services, most of our allies, and many civilian applications is the English language NATO phonetic alphabet used by all NATO nations, including the United States. Because the phonetic alphabet is used routinely in the Navy and other services and will often be used during the NJROTC course of study, all cadets should learn it.

Satellite Communications

Most long-distance voice and data communication in the Navy and the other services today is done via satellite. The Navy is very active in space satellite communications research and development. Essentially, satellite communications are an application of long-distance radio relay wherein ships, ground stations, or aircraft can communicate with each other via satellite relay stations high above the Earth. There are several different groups, or **constellations**, of military communications satellites presently in orbit, and more are planned for the future. The services also make use of commercial communications satellites to provide extra capability when needed. These links enable instant secure communications with military units worldwide and allow for live reception of televised sporting events and personal video cam and e-mail service wherever a service member may be deployed.

The Navy is the operator of the newest-generation military communications satellite system called MUOS (Mobile Users Objective System). It consists of a system of five geosynchronous satellites that together with their supporting ground stations provide worldwide narrowband UHF communications capabilities for all U.S. and allied military services on land, sea, and in the air. MUOS enables cell phone–like voice, data, and multimedia including video communications formerly limited to line-of-sight to all users worldwide.

Tactical Data Links

The Navy, other armed services, and allied nations within NATO transmit tactical data among surveillance and weapons control system computers on ships, ground stations, and aircraft via transmission of digital data over secure radio networks called **tactical data links** (TDLs). Data transmitted over these links either directly or via communication satellites can enable geographically dispersed forces to receive a complete tactical picture of everything happening in a designated battlespace for hundreds of miles. Other links transmit tactical data between aircraft, or between air controllers on land or on board ship and the tactical aircraft they are directing.

As was noted in chapter 6, the Navy is currently developing and implementing a new Integrated Fire Control data-link system that will allow full integration of all air and surface

units within a battlespace to enable cooperative engagement of surface and airborne enemy targets and threats. The system will allow in-flight guidance of missiles such as the surface-launched SM-6 and air-launched Navy Joint Standoff missile by platforms other than the firing ship or aircraft, such as the E-2 Hawkeye or F-35C Lightning. It will make possible such things as launching long-range surface-to-air defensive missiles against incoming air threats well before they can be acquired by the launching ship's own radars, and launching air-to-surface weapons against distant surface targets by "killer" aircraft a safe distance away, while patrolling "hunter" aircraft guide them to their targets throughout their flight.

C4ISR Telecommunications Networks

The U.S. Navy has long been at the forefront in the development and use of integrated telecommunications networks. As far back as the mid-1990s this gave rise to the term *network-centric warfare*, wherein all phases of warfare would be conducted and coordinated by means of state-of-the-art information and communications technology. The first such comprehensive system developed and partially implemented in the U.S. Navy over the time span from the mid-1990s to the mid-2000s was called *ForceNet*. Over the next several years it gave way to an upgraded system concept called the *Global Information Grid* (GIG). As was mentioned in chapter 4 of the Sea Power and National Security unit, the Defense Information Services Agency is currently developing the next-generation C4ISR worldwide Internet-based network, with 2020 being the current target date for full implementation. Called the **Joint Information Environment** (JIE) system, the network will use a common database instantly accessible via satellite-based telecommunications links from land, sea, and air platforms to provide real-time access to all information required for the conduct of operations anywhere in the world. It will emphasize interoperability among all U.S. armed services and those of our allies. It will therefore link together not only all U.S. operational forces and support activities worldwide but also any JIE-capable allied forces as well.

Visual Communications

Visual communications may be done over short distances, weather conditions permitting. Visual means are often as reliable and convenient as radio, and can be more secure. Radio waves go out *omnidirectionally* (in all directions) for a considerable distance, whereas visual signals can be received only by observers relatively close by, and in the case of flashing light, only those in the line of sight. Visual signals include flashing light (signal light), flaghoist, and semaphore.

Visual communication is versatile, reliable, silent, and economical. With the use of standardized international codebooks

Signalmen raise signal flags from a stowage box during a flaghoist drill on board the amphibious transport dock ship USS *Cleveland* (LPD 7). Note the signal light near the rail nearby. *Eli Medelin*

it can be used to exchange information with merchant ships or foreign mariners who cannot easily communicate in English. Further, it has the advantage of using simple equipment that does not often break down. Visual signaling is efficient and economical because it shares the communications load with radio while not using the electronic frequency spectrum.

The **signal bridge** on naval ships is where most visual signaling is done, by Navy enlisted signalmen. The signal bridge is a separate platform deck on the superstructure, usually aft of the ship's bridge. The signal bridge has a metal stowage box containing all the signal flags arranged for easy access for hoisting by signal halyards to an overhead yardarm on the mast, as well as several signal lights for flashing light signals. On merchant ships such signaling is done by mates or seamen on watch as members of the ship's deck department, from one of the open decks on the superstructure. Visual signaling can perform all the functions of radio except for long-distance communications. In addition to hoisting signal flags and transmitting messages by flashing light, Navy signalmen identify other shipping and challenge unidentified vessels and sometimes aircraft by flashing light.

The following sections elaborate on the three main methods of visual signaling.

Flashing Light

Signaling by flashing light can be done by day or night, either by using a hooded signal light pointed at an addressee or by yardarm blinkers that allow it to be seen omnidirectionally. The message is sent by means of **international Morse code**, in which the characters (letters, numbers, and punctuation marks) are represented by various combinations of "dots" and

A signalman mans his light on the signal bridge of an aircraft carrier.
Joseph Hendricks

"dashes" of light formed by opening and closing shutters across the face of the signal light (a dash is three times as long as a dot). The transmitting signalman sends one word at a time with a slight pause between the letters. The receiving signalman flashes a dash after each word is received, meaning that it has been received and he or she is ready for another. A proficient signalman can transmit up to about fourteen words per minute using flashing light.

Flashing light signaling at night can also be done with infrared lights or filters that make the signal invisible unless it is viewed through a special optical receiver. Infrared light signaling is called **Nancy**. It is a very secure method of communication and can be used effectively over distances up to about seven and one-half miles.

At one time Morse code was widely used for telegraphy and in amateur radio, but today it is mostly used for communication at sea by flashing light, and to identify certain lighted buoys and radio marine and air navigation aids that flash or transmit Morse letters. Many NJROTC cadets may want to learn international Morse code well enough to send and receive their names or short messages (see the inset).

Flaghoist

Flaghoist signaling is a rapid and accurate system of sending standardized tactical signals or international code during daylight. A flaghoist signal system can send maneuver instructions more uniformly than any other system. Signals comprised of various signal flags are hoisted by the originating ship and duplicated by those receiving them, thus ensuring that the message is received accurately. Once the originating ship sees the signal properly replicated on the receiving ship or ships, the signal is ready for execution, by its being rapidly hauled down

Letter	Phonetic Alphabet	Pronunciation Guide	International Morse Code
A	ALFA	AL FA	·—
B	BRAVO	BRAH VOH	—···
C	CHARLIE	CHAR LEE	—·—·
D	DELTA	DELL TAH	—··
E	ECHO	ECK OH	·
F	FOXTROT	FOKS TROT	··—·
G	GOLF	GOLF	——·
H	HOTEL	HOH TELL	····
I	INDIA	IN DEE AH	··
J	JULIETT	JEW LEE ETT	·———
K	KILO	KEY LOH	—·—
L	LIMA	LEE MAH	·—··
M	MIKE	MIKE	——
N	NOVEMBER	NO VEM BER	—·
O	OSCAR	OSS CAH	———
P	PAPA	PAH PAH	·——·
Q	QUEBEC	KAY BECK	——·—
R	ROMEO	ROW ME OH	·—·
S	SIERRA	SEE AIR RAH	···
T	TANGO	TANG GO	—
U	UNIFORM	YOU NEE FORM	··—
V	VICTOR	VIK TAH	···—
W	WHISKEY	WISS KEY	·——
X	XRAY	ECKS RAY	—··—
Y	YANKEE	YANG KEY	—·——
Z	ZULU	ZOO LOO	——··

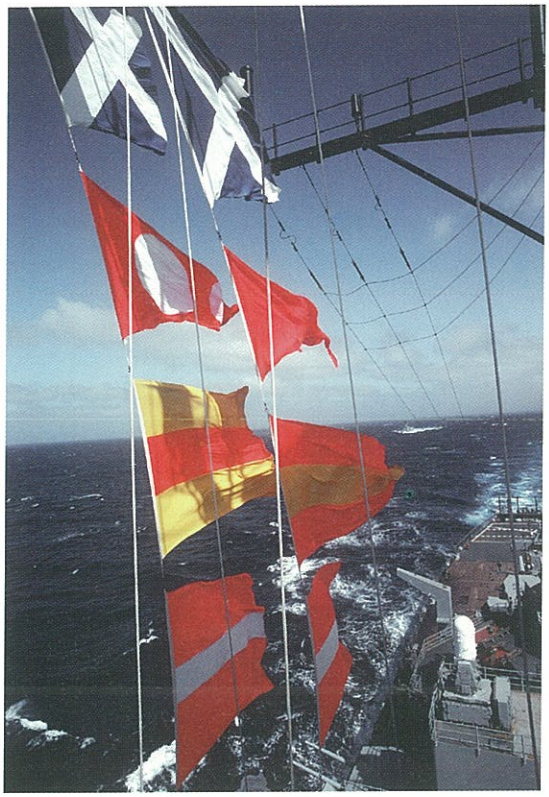
Number	Pronunciation Guide	International Morse Code
1	WUN	·————
2	TOO	··———
3	THUH-REE	···——
4	FO-WER	····—
5	FI-YIV	·····
6	SIX	—····
7	SEVEN	——···
8	ATE	———··
9	NINER	————·
0	ZERO	—————

Name	Morse	Semaphore	Symbol
Colon	------	OS	:
Comma	------	MIM	,
Hyphen or dash	------	DU	-
Parenthesis/left	-.--.	KN	(
Parenthesis/right	-.--.-	KK	)
Period	·-·-·-	AAA	.
Question mark	··--··	IMI	?
Slant sign	-··-·	XE	/

The phonetic alphabet and international Morse code.

on the originating ship. The receiving ship or ships follow suit. Meanings of signals that may be sent by flaghoist are contained in classified signal books held by ships in the U.S. and allied navies and in international codebooks carried by all naval and merchant vessels on the high seas.

There is a signal flag for each letter of the alphabet, one for each numeral from zero to nine, and others with special uses (see illustration next page). A total of sixty-eight flags and pennants can be used to send thousands of signals. NJROTC cadets may want to learn the flags for each letter of the alphabet and the numbers because these are often seen and used in maritime settings worldwide. Decks of signal cards are available to use in learning the signal flags and pennants.



Flaghoists are read from the top down, outboard to inboard. Flaghoist signals used for tactical communications and maneuvering are based on the standardized *Allied Naval Signal Book*.

Flag	Name	Flag	Name	Flag	Name	Flag	Name
	Alfa		Juliett		Sierra		Two
	Bravo		Kilo		Tango		Three
	Charlie		Lima		Uniform		Four
	Delta		Mike		Victor		Five
	Echo		November		Whiskey		Six
	Foxtrot		Oscar		Xray		Seven
	Golf		Papa		Yankee		Eight
	Hotel		Quebec		Zulu		Nine
	India		Romeo		One		Zero

Basic Navy alphabetic and numeric signal flags (pennants not shown).

Semaphore

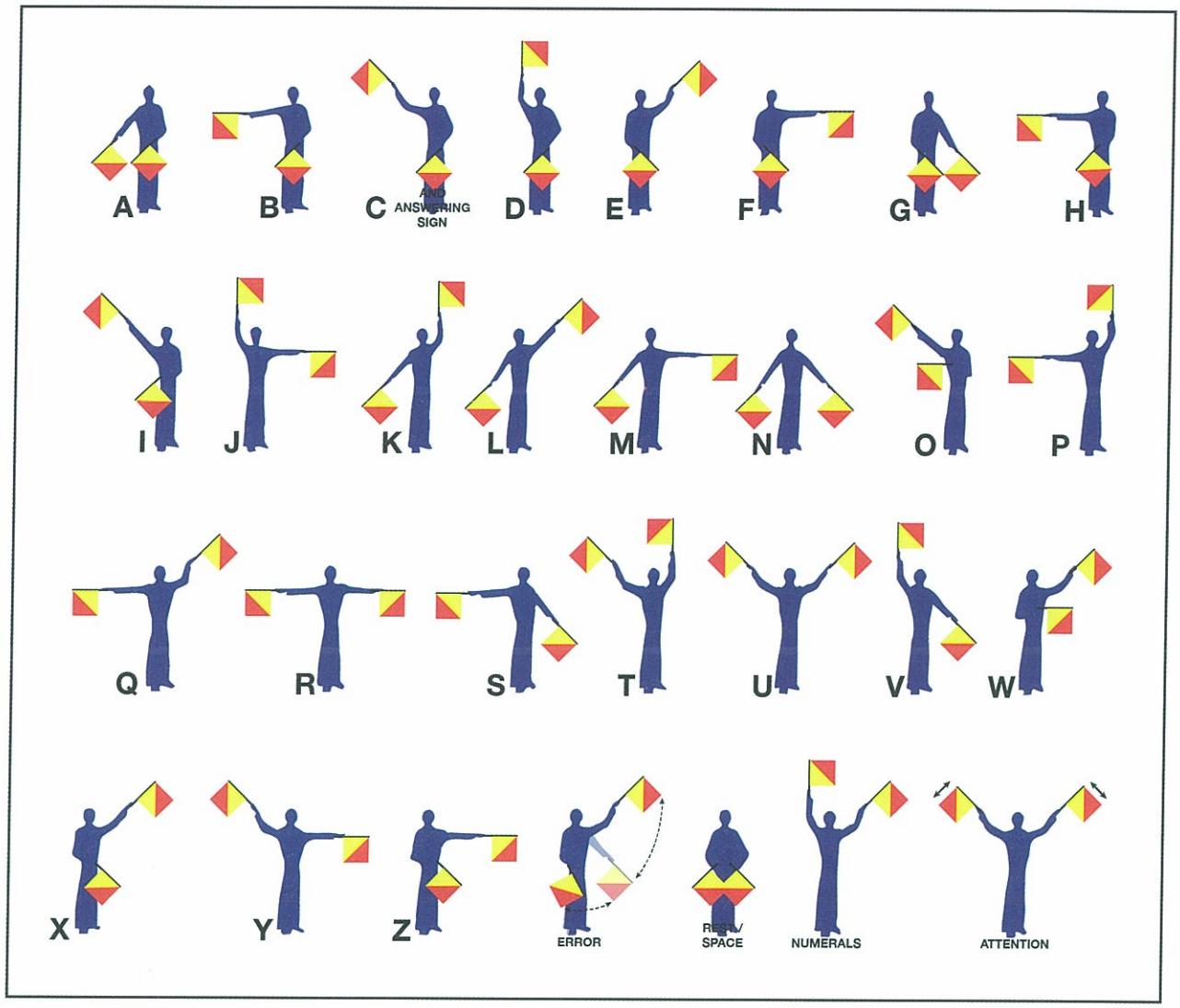
Semaphore uses signals transmitted by various arm positions of the signalman for short-distance communications between naval ships. It is faster and more secure than flashing light. In order to increase the range and visibility of movements, the signalman usually holds two hand flags attached to short staffs. By convention they are colored yellow and red at sea, and white and blue on land. At night, semaphore can be done using lighted wands. Signalmen on board Navy ships in close steaming formations or alongside for underway transfer and replenishment operations commonly use semaphore to communicate.

Semaphore is considered better than other visual means for long messages. Speed and security are the major advantages of semaphore. Its major limitation is its short range of only a few hundred yards.

A signalman sends semaphore signals by moving his or her arms to various positions representing each letter of the alphabet and several auxiliary signs (see the illustration opposite). Only thirty positions need to be learned. Numerals are sent by first signaling the auxiliary "numerals" sign, then the signals for the letters A through I as appropriate, corresponding to the numbers 1 through 9. To return to the alphabet, the signal for the letter J is sent. Each word sent is separated by the use of the auxiliary "front" rest/space position, and receipted by the receiver with the letter C position. Standard punctuation signs like periods, commas, and semicolons can also be transmitted using various letter combinations. A proficient signalman can transmit up to fifteen words per minute using semaphore.

A signalman uses semaphore flags to send a message to a nearby ship. *Greg Messier*

As a point of interest, trained civilian lifeguards manning isolated lifeguard towers along lengthy public beaches such as those at Ocean City, Maryland, and Bethany Beach, Delaware, traditionally use semaphore signals as an effective way to communicate with each other.



Semaphore alphabet and special signals.

Sound and Pyrotechnic Signaling

Sound communications include whistles, sirens, bells, and underwater acoustics. The first three are used by ships for sending a variety of warning signals. These include navigational signals prescribed by the rules of the road such as fog and maneuvering signals; air raid, breakdown, and collision warnings; and wartime communications between ships in convoy.

A waterborne sound communications method called **Gertrude** uses an underwater acoustic system associated with submarine or destroyer sonar equipment. It can communicate either by continuous wave (CW) soundwaves or voice. It enables communication between surface vessels and submerged submarines, but it is limited in range, often hard to understand because of distortion and background noise, and not very secure.

Pyrotechnics are used for emergency signals. They are mainly of the "fireworks" variety: pistol flares; colored shell bursts, including parachute flares; aircraft parachute flares; Roman candles; and a number of colored float- and smoke-type flares. The color of the flare determines the meaning of the signal.

Distress signals indicating that a ship or person needs help are covered by the nautical rules of the road, discussed in chapter 10 of the Naval Skills section of this textbook. All ships at sea are required to maintain a listening watch on radio distress frequencies at all times. It is a fundamental law of the sea that any vessel that sees or hears a distress signal must render assistance if at all possible.

Critical Thinking

1. Research satellite communications and describe how this communications system facilitates worldwide television, voice, and Internet communications.
2. Do you think cell phone technology is good for transmitting important information on the battlefield? Support your answer.
3. Using colored sketches, indicate how your name would be spelled using signal flags and semaphore.
4. Research and summarize the sequence of large-scale comprehensive C4ISR telecommunications systems developed for use in the U.S. Navy since the mid-1990s, listing the main features and capabilities of each.

Study Guide Questions

1. A. What is communication?
   B. What is "naval communications"?
2. Why are effective communications in the Navy so important?
3. What three qualities must naval communications have?
4. What are the main and secondary functions of naval telecommunications?
5. What are the largest of the Navy's communications facilities called?
6. Which officer is in charge of a ship's communications organization?
7. A. What is a radiotelephone?
   B. What alphabet is used for voice communications by radio?
8. What are communications satellites?
9. A. How is tactical data sent between ships and aircraft in today's Navy?
   B. What enhancement is the Navy currently developing and implementing that will allow full integration of all air and surface units within a battlespace to enable cooperative engagement of surface and airborne enemy targets and threats?
10. What is the name of the next-generation C4ISR network currently being implemented by the Defense Information Services Agency?
11. How would your first name be sent in Morse code?
12. What are the main Navy visual communications methods?
13. What is the principal use of flaghoist?
14. A. What are three ways of communicating by flashing light?
    B. What is the advantage of the Nancy system?
15. A. What is semaphore?
    B. How can it be used at night?
16. A. What sound communications are used by ships, and under what conditions are they used?
    B. What is the Gertrude system?

New Vocabulary

telecommunications
decryption
circuit discipline
constellation (of satellites)
omnidirectional
flaghoist
pyrotechnics
encryption
radiotelephone
phonetic alphabet
tactical data links
signal bridge
semaphore

8

Naval Intelligence

Intelligence, or information about an actual or potential enemy, can give government and military leaders the knowledge they need to make good decisions. Intelligence can reduce the possibility of surprise, evaluate enemy strength, and predict an enemy area of operation. It can mean the difference between peace and war. In the event of war, it can be the difference between victory and defeat.

Naval intelligence, like military intelligence in general, operates in the broader context of national intelligence and the U.S intelligence community. This chapter, therefore, will describe the basic principles that apply to the gathering, processing, and safeguarding of national intelligence; the makeup of the U.S. intelligence community; the naval intelligence and DOD support organizations; and some of the more serious breaches of security that have affected the Navy and the country in general in recent times.

General Definitions

In political and military contexts, **intelligence** is knowledge upon which a political or military decision or course of action may be based. Intelligence information covers many subjects: geography, transportation, telecommunications, political and economic conditions, armed forces, technical developments, and biographical data on leaders. All these different areas fit together like parts of a puzzle. It is necessary to consider each part in relation to the others.

The *Encyclopaedia Britannica* defines political and military intelligence as "that information acquired on a national scale, usually about a rival, but sometimes about an ally or a neutral country." There is an important difference between information and intelligence. *Raw information* is the material collected from all sources about a given subject or country. This information becomes *intelligence* after it is gathered together and analyzed in order to be useful to a political or military leader in making decisions.

Intelligence is often considered to be a mysterious and dangerous activity undertaken by glamorous spies. The classic story of Mata Hari, the beautiful German spy of World War I, and the fictional adventures of James Bond, Agent 007 of the British Secret Service, have given intelligence gathering a "cloak-and-dagger" image. To be sure, intelligence collection has its moments of intrigue, mystery, and danger, but most such work is like work in any other military staff job. The main difference is that governments do not disclose how their intelligence organizations work. The practice has been to protect intelligence activity by strict security regulations.

Espionage is the attempt to obtain information about a foreign government *covertly* (in secret) through the use of spies and other undercover operations. **Counterintelligence**, or *security*, is the protection of a nation's secrets against espionage or other intelligence-gathering activities. Its goal is to prevent foreign countries from getting vital diplomatic, economic, and industrial information as well as military information of intelligence value. Counterintelligence is thus a continuing need in peace and war.

The Intelligence Cycle

The **intelligence cycle** is the process by which information is acquired, gathered, transmitted, evaluated, analyzed, and made available as finished intelligence for policy makers and military commanders to use in decision making and action. There are five steps in the intelligence cycle:

- *Planning and direction.* This involves the management of the entire intelligence effort from identification of the need for data to the final delivery of an intelligence product to a consumer.
- *Collection.* This involves the gathering of raw information from which finished intelligence will be produced. There are many sources of this information. **Open sources** include such things as radio and TV broadcasts, newspapers, periodicals, and books. **Covert sources** are secret agents, spies, and, on occasion, defectors who are willing to provide valuable information obtainable in no other way. **Technical collection**, such as by the use of surveillance electronics, airborne drones, and satellite

photography, has also come to play an indispensable role in modern intelligence collection.

- *Processing.* This step involves the conversion of the vast amount of information coming into the system from all sources to a form more suitable for producing finished intelligence, such as through decryption and language translations. Information that does not go directly to analysts is sorted and made available for rapid computer retrieval. Processing also refers to data reduction and interpretation of information gathered on film and sound recordings through the use of highly refined photographic and electronic analysis processes.
- *Analysis and production.* This refers to the conversion of basic information into finished intelligence. It includes the assembly, evaluation, and analysis of all available data, and the preparation of a variety of **intelligence products**. Intelligence data is frequently incomplete and at times can be confusing. Various analysts who are subject-matter specialists in various areas weigh the information in terms of reliability, validity, and relevance. They integrate the various pieces of data into a meaningful whole, put the information into context, and produce finished intelligence that includes assessments of events or developments and judgments about the implications of the information to the end user.
- *Dissemination.* The last step in the cycle, which logically feeds into the first, is dissemination, the distribution of the finished intelligence to the consumers whose needs initiated the process. Typically, dissemination is accomplished by means of various distribution lists, each made up on a "need to know" basis. Intelligence may be disseminated by oral briefings, messages, written reports, published studies, and photographs and other media. The continuous flow of accurate, timely naval intelligence is essential to planning successful naval operations. Good intelligence, properly used by commanders, has saved thousands of lives and won many battles.

Types of Intelligence

There are six basic national and military intelligence sources, or collection disciplines:

- signals intelligence
- imagery intelligence
- measurement and signature intelligence
- human-source intelligence
- open-source intelligence
- geospatial intelligence

Signals intelligence (**SIGINT**) is derived from intercepts of communications, electronics, and foreign instrumentation.

Imagery intelligence (**IMINT**) includes representations of objects reproduced electronically or by optical means on film, electronic display devices, or other media. The imagery can be derived from visual photography, radar sensors, and electro-optics, obtained either from satellites or aerial reconnaissance.

Measurement and signature intelligence (**MASINT**) is technically derived intelligence data other than imagery and SIGINT. The data results in intelligence that locates, identifies, or describes distinctive characteristics of targets. It employs a broad group of disciplines including nuclear, optical, radio frequency, acoustics, seismic, and materials sciences.

Human intelligence (**HUMINT**) is derived from human sources. To the public, HUMINT is synonymous with espionage and clandestine activities. Most HUMINT, however, is gathered by overt collectors such as diplomats and military attachés. It is the oldest method for collecting information, and until the technical revolution of the mid-to-late twentieth century, it was the primary source of intelligence.

Open-source intelligence (**OSINT**) is publicly available information appearing in print or electronic form including radio, television, newspapers, journals, the Internet, commercial databases, videos, graphics, and drawings.

Geospatial intelligence (**GEOINT**) is the analysis and visual representation of security-related activities on the Earth. It is produced through an integration of imagery, imagery intelligence, and geospatial information.

Intelligence may also be described by the area to which it pertains:

Naval intelligence is concerned mainly with collecting information of interest to the Navy. It includes information about foreign (both friendly and unfriendly) ships, weapon systems, naval strategies and tactics, harbor and port facilities, and any other data that might help the Navy carry out its mission. Intelligence collected at sea or during battles is tactical in nature. By using such intelligence a commander can try to decide what the intentions of the enemy are and modify the battle plan accordingly.

During the 1960s and 1970s, special secret high-speed jet aircraft such as the U-2 and SR-71 Blackbird were developed that could fly above the ceiling of most defensive weapons and photograph wide bands of the surface with special high-resolution cameras. When these "spy planes" returned from their missions, air intelligence officers could examine the resulting film and learn a great deal about such things as enemy fortifications, bombing damage to enemy facilities, and troop dispositions. This type of intelligence, then called **air intelligence**, was extensively used during the Vietnam War and in many of the other conflicts involving U.S. forces since then.

During these same years the Navy used "standoff" reconnaissance aircraft such as the EA-3, RA-3, and EP-3 to gather intelligence by flying near the enemy's borders and coastlines.

Spy planes like the SR-71 Blackbird were used extensively during the Cold War era to gather intelligence. The SR-71 could fly at altitudes above 80,000 feet at speeds in excess of Mach 3, above and beyond the effective limits of most contemporary antiair missile systems. *NASA*

Supersonic aircraft such as the RF-8, RF-4, and RA-5C were used over land areas to gather photo intelligence and **bomb damage assessment** (BDA) immediately following air strikes on enemy targets.

Beginning in the 1980s and 1990s, continuing advances in photographic and space technology made possible the use of Earth satellites to obtain much of the kind of imagery intelligence previously available only from reconnaissance aircraft and spy planes. Today's spy satellites can spot objects as small as a grapefruit from their orbits. Some are "steerable," meaning that their orbits can be changed at will to observe any area on Earth of particular interest to our intelligence agencies. Some are equipped with infrared detectors that can "see" and instantly report such things as the heat of a missile launch, bomb blast, or a ship, or even a submarine operating at shallow depths at sea.

Much use is now being made of remote-controlled **unmanned aerial vehicles** (UAVs)—drone aircraft—for reconnaissance and intelligence-gathering purposes, and as launch platforms for missile attacks on enemy personnel and other high-value targets. They range from model-sized traditional airplanes and helicopter-like platforms capable of hovering above their targets to large drone aircraft, and can be launched and controlled by soldiers and Marines in the field, by ships, or from impromptu airstrips or airfields near areas of operations. Once launched, many of the larger AUVs can be controlled from remote locations many thousands of miles away by means of communications satellite relays.

The U.S. Intelligence Community

The U.S. **intelligence community** consists of all the primary agencies that produce intelligence in the United States. The modern community began to take shape with the passage of the National Security Act of 1947, which, in addition to reorganizing the U.S. armed services, created the National Security Council (NSC) and the Central Intelligence Agency (CIA). Most of the U.S. intelligence community as we know it today was established by an executive order of President Ronald Reagan in 1981.

As a result of analysis of failures and shortcomings of the intelligence community that contributed to the terrorist attacks of 11 September 2001, relationships within the community were greatly modified by the Intelligence Reform and Terrorism Prevention Act of 2004. One of the major provisions of that act was the establishment of a Director of National Intelligence (DNI) who would henceforth oversee, set priorities, and manage the budget of the entire national intelligence community. The DNI is also the intelligence advisor to the NSC. The NSC sets domestic, foreign, and military policy related to national security. It is chaired by the President, and its regular attendees include the Vice President; Secretaries of State, Defense, and Treasury; and the DNI. The Chairman of the Joint Chiefs of Staff is its military advisor, and other heads of departments and senior officials are invited to attend when appropriate.

Including the Office of the Director of National Intelligence, there are currently seventeen federal agencies that are part of the U.S. intelligence community. All are coordinated by the DNI. In addition to the CIA, the member agencies include the Federal Bureau of Investigation (FBI), the Department of Homeland Security (DHS), and eight DOD agencies such as the National Security Agency (NSA), the Defense Intelligence Agency (DIA), and the individual military service intelligence agencies. Intelligence bureaus and offices within the State Department, Department of Energy, Treasury Department,

The Global Hawk UAV is a large Air Force endurance drone able to cruise at 400 mph for 35 hours; it can scan an area the size of the state of Illinois in just 24 hours. *Air Force*

service and DOD to the host country's government and to its armed forces.

Military personnel assigned to attaché posts around the world have diplomatic passports and status. The senior armed forces attaché officer on a diplomatic post is called the **defense attaché**; other, more junior officers serve as **naval attaché**, **Army attaché**, and **air** (Air Force) **attaché**. The defense attaché may be of any service and the Coast Guard, and is responsible for the supervision and coordination of all other attachés assigned. Officers from the Navy, Marine Corps, and Coast Guard are all eligible to receive assignments as naval attachés. Not all diplomatic posts have attachés from all of the military services, and in some cases the same attaché may serve several diplomatic posts in different countries within a geographic region.

As part of their duties, military attachés collect pertinent military and political information of all kinds related to their service and report it to DIA and to their parent services. This is done legally and overtly, not as espionage.

More about military attachés and their duties is presented in chapter 13 in connection with international law.

Military Service Organizations

Each military service within DOD, plus the U.S. Marine Corps, has its own independent intelligence organization that concentrates on tactical intelligence unique to its specialized needs. All four of these report to DIA as well as to their individual services. The Navy's organization, called the Office of Naval Intelligence (ONI), is described in more detail below. Because the military service organizations do not have sufficient assets to produce all the tactical intelligence needed for all possible operations, however, military commanders will often look to the broader U.S. intelligence community to provide additional expertise whenever required.

Naval Intelligence

The Director of ONI is responsible for carrying out the intelligence mission of the Navy. When capitalized, the term *Naval Intelligence* refers to the ONI organization. When referring to the information gathered and processed, the term *naval intelligence* is not capitalized.

Located primarily in the National Maritime Intelligence Center (NMIC) in Suitland, Maryland, ONI is the national production center for global maritime intelligence. It has four operations centers that focus on conventional and irregular maritime warfare capabilities, new technologies, platforms, weapons, and C4ISR and cyber capabilities. Established in 1882, ONI is the nation's longest-serving intelligence agency. It is the center of the Navy's expertise for all maritime surface, subsurface, and air-related intelligence issues, as well as a core element of the Navy's information warfare community. ONI employs more than three thousand military, civilian, mobilized reservists and contractor personnel worldwide, including analysts, scientists, engineers, specialists, and technicians. It also has the support of more than eight hundred inactive Navy Reservists providing an equivalent of ninety-plus man-years of production during weekend drill and active duty periods.

In addition to ONI, NMIC also hosts the Coast Guard's Intelligence Coordination Center (ICC) and the National Maritime Intelligence-Integration Office (NMIO). NMIO was established in 2009 as a result of a recommendation of the 9/11 Commission that analyzed how the intelligence community might be more effectively organized following the 9/11 attacks in 2001. Its mission is to coordinate at the national level all maritime intelligence produced by all agencies of the intelligence community, as well as by state and local governments, academia, and the private sector, to better anticipate and counter future threats emanating from the maritime domain before they materialize.

The Naval Criminal Investigative Service is the primary criminal investigative and counterintelligence agency of the Department of the Navy. It investigates alleged criminal activities involving the Navy and Marine Corps serious enough to be felony offenses punishable under military law. Typical investigations involve arson, black-marketing, espionage, sabotage, narcotics violations, and loss or unauthorized revealing of classified information. NCIS also engages in investigations related to counterintelligence, counterterrorism, and cyber warfare. It is headed by a civilian, and well over half its staff of some 2,500 personnel are civilian special agents, who together with their uniformed counterparts serve on board shore stations, aircraft carriers, and other large Navy ships, as well as in some 40 countries worldwide. The Army and Air Force each have their own investigative services as well.

Foreign Intelligence Organizations

The general organization of intelligence agencies in most foreign countries is very similar to that of the United States. There is usually a central directing organization in the home capital that deals with national security and political, economic, industrial, and military intelligence, and other similar subordinate organizations. Since the main job of the security organization is to safeguard the country's intelligence system and operating methods, details about these organizations in foreign countries are often scarce. As with the United States, the intelligence organizations are represented abroad by attachés at embassies and other diplomatic posts. Military intelligence is managed by the service intelligence chiefs.

While these aspects of intelligence are similar in most countries, security methods are often considerably different. In the democracies, security measures are limited by laws that

apply to all citizens. In authoritarian countries such as Cuba, China, North Korea, and Iran, however, various kinds of **secret police organizations** (political policy enforcers who operate covertly) such as the old Soviet KGB are responsible for internal security. Secret police agents are placed in all levels of government, the military, and society in order to get information about their own citizens and to try to stifle any opposition to the government. They may swoop down on unsuspecting government officials or citizens and spirit them away for execution or questioning and torture in prisons from which few ever return.

External intelligence and counterintelligence in such countries are handled by highly secretive agencies that are bound by few if any laws and typically report only to the national leadership. Activities known to fall within the scope of these agencies include sabotage, political and military assassination, and sponsorship of terrorists, spy groups, intelligence groups, and propaganda and agitation groups.

Espionage

Almost all nations have espionage organizations. Many of their operations are carried out by secret agents called **spies**. They are usually well-trained specialists in either political or military affairs, the two main categories of espionage. They must have a great deal of self-discipline, courage, patience, and ability to discover and accurately report important information. Those who become spies usually do so either for love of country or, on the other extreme, hatred of their own or a target foreign country or its form of government; or need for money. In addition, fear is sometimes used as a motivator: either fear for the spy's own safety or, more commonly, fear that family or relatives will suffer if the individual does not perform satisfactorily.

There is no question about the effectiveness of foreign espionage around the world. Spy rings have been uncovered in the highest levels of government and in the military services of most Western nations, including the United States. Information about the latest computer systems, nuclear weapons, submarine quieting systems, and missiles has been stolen by both foreign and domestic spies in America and Western Europe. Radio bugs (listening devices) have been found in our embassies in many foreign capitals throughout the world. More recently, clandestine monitoring of cell phone and other communication networks and hacking of computer systems have become mainstays of espionage operations worldwide at all levels of government, commerce, and industry, and, on occasion, the military services.

In peacetime diplomats and military attachés from all countries are expected to observe and report on everything of note that goes on in the places they are stationed. Not only is it important that their home nations thus be kept abreast of important happenings in other countries, but also this information helps to maintain good diplomatic relationships between the home and host countries.

So long as these diplomats conduct themselves in an overt manner and do not attempt to bribe officials, steal documents, or sneak photos of forbidden areas, the host country welcomes them and gives them special privileges. If they are caught violating this trust, however, the host country may demand that they be *recalled* (sent home). Overt collection activities are considered legitimate duties of diplomats, so they are not considered to be spies under international law.

Espionage, however, does not involve just a few spies and diplomats trying to gather military information. Rather, it is a mass effort carried out in all fields by thousands of people. Many of these are one-time informants. The intelligence organizations gather up bits and pieces of information from all over the globe and slowly piece together a story. A single fact dropped unintentionally may prove to be the missing piece of an important puzzle.

The Navy has much valuable information, so it can be expected that attempts will always be made to get this information from naval personnel. New electronic equipment, training exercises, readiness, amount and types of supplies and ammunition on board, sailing dates, and operational schedules are common topics of conversation among sailors, especially when off-duty, and are the kinds of information that spies like to gather. People in uniform must always be alert to this kind of attempted espionage.

Counterintelligence and Security

Espionage is combated by *counterintelligence*, which pertains to the identification and neutralization of the threat posed by foreign intelligence services, and the manipulation of those services for the manipulator's benefit. The main jobs of counterintelligence personnel are to prevent espionage and treacherous acts, and to seek out and arrest spies.

The CNO controls all policies relating to the security of classified matter in the Navy. The CNO issues instructions and manuals on both personnel and information security, all of which are periodically reviewed and revised as conditions warrant.

But security rules by themselves do not guarantee protection. If classified material is acquired or viewed by unauthorized persons it is said to have been *compromised* (lost its secrecy). Many precautions must be taken to reduce the possibility of compromise or loss. Classified material might be compromised or lost by the following means:

- capture or salvage
- theft, espionage, observation, or photography
- interception of communications
- electronic tracking devices

Navy poster reminding personnel of the potential security threat posed by social media and the Internet, and the associated do's and don'ts.

- cryptanalysis (breaking of codes), bugging, or hacking
- carelessness

The United States is a primary intelligence target for many countries and terrorist organizations, including even some traditional allies who have attempted to acquire government, military, and industrial secrets. Continual advances in technology, along with increased emphasis on the maintenance of individual rights to privacy in recent years, and various local, state, and federal freedom of information acts, while furthering individual freedoms, have made it increasingly difficult for the United States to implement successful counterintelligence measures.

Security Classifications

In the United States, official material that must be protected in the interest of national security may be **classified** (given a security classification) in one of three ways or *levels*, in descending order of importance: **top secret**, **secret**, and **confidential**. These classifications indicate the degree of protection to be given the material, equipment, or information, depending on the degree of damage that unauthorized disclosure would cause to national defense or foreign relations of the United States. Once given a security classification, the material is referred to as *classified matter.*

The appropriate classification is determined by the originator of the material based on its content. *Top secret* is used for material that could result in great damage to the nation if revealed. *Secret* is for material that could cause serious damage. *Confidential* is for material that could be harmful to national security. There are also certain qualifications called **handling caveats** that can be applied to classified documents at any level, which restrict a document to or from specific viewers. Examples of such caveats are "For Official Use Only," "Officers Eyes Only," and "NOFORN" (distribution prohibited to non-U.S. citizens regardless of clearances held).

Some highly classified publications have very limited distribution within the government and the military services. These are called **registered publications**. Each one is assigned an account number and is delivered either by courier or from special registered publications vaults. At regular intervals, each of these publications must be accounted for by the organization's registered publications custodian and a report of any discrepancies must be made to higher authorities. Material that usually falls into this category includes code and cipher books, communications books, tactical publications, and intelligence manuals.

In the Navy, each ship, large aircraft, and naval shore facility has an **emergency destruction bill** detailing who is to be responsible for rendering classified materials safe from imminent capture or compromise by an enemy, and how and in what order this is to be done. On board ship, if there is no time for burning or shredding them, classified documents and

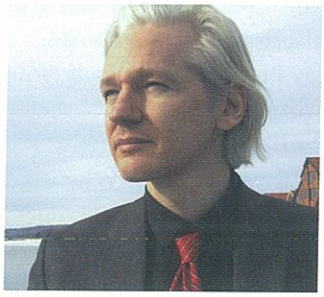
publications may be placed in weighted bags with holes and dropped into deep water. Coding devices, secure cell phone and radiotelephone SIM cards, and other similar kinds of classified equipment may be smashed and the parts scattered in deep water, or melted by chemical bombs that are ignited by electric batteries. Similar equivalent measures may be taken on board aircraft and shore facilities.

Security Clearance

Before anyone is allowed to receive, see, or use classified information, he or she must have a **security clearance** consistent with the classification level of the material. This is a document indicating that the person's background has been properly investigated by the government and stating for which classification level the person is *cleared* (granted authorization to view).

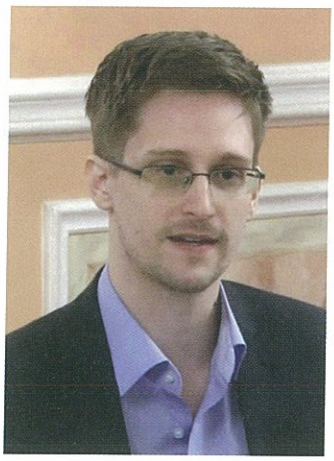
In order to be granted security clearances for access to classified material, applicants must be of unquestionable loyalty, integrity, trustworthiness, and character, with no criminal convictions or illegal substance-abuse activity on their record (all young people considering careers that require access to classified material, such as in the federal government or military services, should be especially aware of the latter requirement). Their personal conduct and associations must cast no doubt upon their ability to safeguard classified information. The handling of classified material is a matter requiring the utmost trust and confidence because the welfare of the nation could be at stake.

The existence, nature, content, or whereabouts of classified material must not be divulged to anyone other than those who are authorized to use it in their official duties. No person is automatically entitled access to classified matter solely because of rank, office, position, or a certificate of clearance. The latter only establishes *eligibility* (satisfaction of necessary preconditions) for access. To whom information can be disclosed is determined not only by the classification of the material and the security clearance of the person but also, above all, by whether the person has a **need to know** the information to do a job. Currently there are about 4.5 million people who hold some level of security clearances in the United States, both military and civilian.



Julian Assange. *Espen Moe*

Bradley Manning, now known as Chelsea Manning. *Army photo*



Edward Snowden. *WikiLeaks*

Notorious Security Breaches

There have been many highly publicized incidents of serious **security breaches** (losses or compromise of classified materials or information) in the Navy and other military and government agencies over the years. One of the worst of these in the Vietnam War era and for years afterward was perpetrated from 1967 to 1985 by a spy ring led by a former Navy warrant officer named John Walker. It involved the compromise of secret ballistic missile submarine communications systems and other highly classified technology. Counterintelligence experts later concluded that the Soviet navy's rapid advancements in submarine quietness technology in the 1980s were directly related to the disclosures of Walker and the other members of his group. Walker was given three life sentences and died in prison in 2014.

Another serious case that surfaced in 2001 was that of former FBI agent Robert Hanssen. He was charged in that year with selling U.S. secrets to the Soviet Union and subsequently the Russian Federation for more than $1.4 million in cash and diamonds over a twenty-two-year period from 1979 to 2001. Among other things, he passed to the Soviets more than six thousand pages of classified government documents and disclosed the identities of dozens of American double agents in Soviet-controlled countries, some of who were without doubt killed as a result. His activities were described by the Department of Justice as possibly the worst intelligence disaster in U.S. history. Hanssen is currently serving fifteen consecutive life sentences in federal prison without the possibility of parole.

Beginning in 2006 there were a number of unauthorized releases on the Internet of various classified documents and videos related to the wars in Afghanistan and Iraq by a notorious Internet organization called WikiLeaks, an international nonprofit news organization that publishes classified material obtained from anonymous sources. It was founded in 2006 by an Australian political activist and computer security analyst named Julian Assange. Much of the more sensitive material published on the WikiLeaks website in the early 2010s concerned the Iraq

War and was stolen from military files by Army private Bradley Manning, then an Army intelligence specialist serving in Iraq. Altogether Manning is said to have compromised some 750,000 classified files, battle logs, diplomatic cables, and other documents. Now known as Chelsea Manning after initiating a gender transformation process while in confinement in 2013, she received a thirty-five-year sentence in federal prison for her illegal activities; her sentence was commuted by President Barack Obama in January 2017. Assange escaped prosecution by fleeing to Europe and finally seeking asylum in the Ecuadorian embassy in London in 2012, where he is still fighting extradition to Sweden and the United States as of this writing.

Another more recent major security breach in the United States began in 2013 when an NSA contract analyst named Edward Snowden covertly copied and began selectively releasing some 1.7 million top secret NSA documents on various classified government surveillance programs authorized by the 2001 Patriot Act. Shortly after he began his releases to various news media, Snowden fled to Hong Kong, China, and eventually to Moscow in Russia, where he was granted asylum and remains today. His actions were denounced as one of the largest security breaches in U.S. history by then–Director of National Intelligence James Clapper. Others, however, have praised him for shedding light on certain previously classified highly controversial NSA domestic surveillance activities authorized by the Patriot Act, especially the recording and storage for potential analysis of **metadata** (statistical information related to communications, but not content) on millions of cell phone calls of American citizens.

Snowden also revealed that the United States had conducted cell phone and text message surveillance on several allied nations and some thirty-five world leaders, most notably German chancellor Angela Merkel. Snowden himself remains very controversial, and his disclosures have fueled ongoing debates in the United States over mass surveillance, government secrecy, and the proper balance between national security and information privacy. Top officials in the various U.S. intelligence agencies assert that Snowden's disclosures have had a very damaging impact ever since on the ability of the United States to monitor and track terrorist activities both at home and abroad.

Lessons Learned

Why would any loyal American, let alone uniformed military personnel, engage in activities so harmful to our country and its citizens? The answers are many, but in the final analysis they break down into the same kinds of flaws that have plagued humanity since the beginning of time: lust for power and sexual gratification, greed for money and other material benefits, and the inability to withstand blackmail or other kinds of personal threats. Since these human frailties will always be with us, it follows that every military service person should be continually aware of the damage that a security breach can do to our military services and our nation, and take all precautions possible to safeguard any classified material or knowledge that may be entrusted to him or her.

Although information sharing, intelligence gathering, and coordination among the agencies of the U.S. intelligence community and state and major city intelligence organizations have greatly improved in recent years after the consolidations in the early 2000s, much still remains to be done to increase the speed of dissemination of pertinent information to all with a need to know. Many attempted terrorist and cyber warfare attacks have been and continue to be thwarted, but too many others have been successful. Serious efforts must continue to make our national counterintelligence efforts even more timely and effective in the future.

Critical Thinking

1. John Walker was a Navy warrant officer who spied for the Soviet government. Research his crimes and list the things he sold to the Soviets and the impact this had on our national security.
2. During World War II the German military used a code machine called Enigma. Research this machine and describe how the Allies broke the Enigma code.
3. Devise a "secret code" using the juxtaposition of letters and numbers. Describe how you would maintain the security of this code. Send a friend a message using your code. How hard do you think it would be to "break" your code?
4. Research the current and potential future efforts in the federal government to reform the current security classification and clearance processes in the United States in reaction to the more serious breaches of national security and violence done after access to secure facilities and materials by persons having valid security clearances in recent years.

Study Guide Questions

1. What are military intelligence and political intelligence?
2. What is the difference between information and intelligence?
3. What are the five steps in the intelligence process?
4. What are the six basic national intelligence sources?
5. What kind of information is naval intelligence primarily interested in collecting?
6. What two new kinds of technology are now being used for reconnaissance and intelligence-gathering purposes?
7. What is the U.S. intelligence community?
8. What are the major federal agencies that are part of the U.S. intelligence community?
9. What new department was created in 2002 to coordinate national strategy against domestic terrorism?
10. What are the four military service intelligence organizations under the Defense Intelligence Agency (DIA)?
11. A. What is a military attaché?
    B. Besides providing military expertise to their embassies, what other duties do attachés have?
12. What is the organization responsible for carrying out the intelligence mission of the Navy?
13. What does the Naval Criminal Investigative Service (NCIS) do?
14. How do intelligence-gathering and security measures differ in authoritarian countries as opposed to the democracies?
15. A. What are the two main categories of espionage?
    B. Who carries out espionage operations?
    C. What is their motivation?
16. What is counterintelligence?
17. What is the unauthorized acquisition or viewing of classified material by unauthorized persons called?
18. What are some of the ways in which classified material might be compromised?
19. A. What are the three levels of security classification in the United States?
    B. To what degree would national security be damaged by the compromise of each?
20. A. What is a security clearance?
    B. What qualifications are necessary in order for a person to be granted a security clearance?
21. What security breach happened between the late 1960s and mid-1980s that compromised America's lead in submarine quietness technology?
22. What major security breach was perpetrated beginning in 2013 by ex-NSA security analyst Edward Snowden?

New Vocabulary

intelligence
counterintelligence
open sources
dissemination
air intelligence
unmanned aerial vehicles (UAVs)
geospatial intelligence
compromise
diplomatic immunity
registered publications
security breaches
espionage
intelligence cycle
covert sources
naval intelligence
bomb damage assessment
intelligence community
attaché
spies
handling caveats
security clearance
metadata

9

Naval Logistics

World War I and World War II approached in scope what has since been defined as *total war*, a conflict in which the entire resources of the participant countries are called upon for victory. Such emphasis on logistics made these wars unique in the history of the world. Modern logistics may be said to have begun in World War I, when the United States was required to support a large American expeditionary force in Europe.

With the exception of antisubmarine warfare along the Atlantic seaboard, World War II was mostly fought thousands of miles from the United States, and logistics became the key to victory. In fact, it took twelve tons of food and equipment to supply each soldier sent overseas, and another ton every month to keep him going.

Today, just as it has since World War II, military planning must consider logistics along with strategy and tactics. *Strategy*, as was discussed earlier in this book, is concerned with the general plan for the employment of the fighting forces. *Tactics* involves the specific maneuvers and techniques of fighting—the operational execution of the strategic plan. **Logistics** at the national level refers to the total process by which the resources of a nation, both material and human, are mobilized and directed toward achieving military goals. Thus, while strategy provides the scheme for the conduct of military operations, logistics provides the means.

A C-2A Greyhound launches from the flight deck of the USS *John C. Stennis* (CVN 74) for a logistics mission during Operation Iraqi Freedom.
Josue Escobosa

Logistics as it applies to the support of naval ships and the shore establishment is referred to as **naval logistics**. The following sections offer a brief look at some of the areas of concern in modern naval logistics.

Logistics Planning

Should total war come, the whole national economy would have to be mobilized efficiently. The U.S. national economy is complex. The experience of the last century has indicated that logistics problems of the future probably cannot be solved by plans made hurriedly under stress of war.

Believing that any future war would require total effort and place great strain on our economy, Congress incorporated the lessons of World War II into the national security organization. The National Security Act of 1947 recognized clearly that responsibility for national security is a matter of concern for the entire nation and is not confined to the military forces alone. This act provided for a comprehensive U.S. security program integrating policies, procedures, and functions of all elements of the government related to national security.

The Secretary of Defense advises the President concerning the coordination of military, industrial, and civilian mobilization. This includes manpower, effective use of natural and industrial resources for military needs, and the organization of the national economy for war. Similar to the principles of war discussed in chapter 5 that apply to all types of combat, there are certain **principles of logistics** that come into play in logistics planning at all levels. These are:

- *Responsiveness*—providing the right support at the right time, at the right place
- *Simplicity*—avoiding unnecessary complexity in preparing, planning, and conducting logistic operations
- *Flexibility*—adapting logistic support to changing conditions

- *Economy*—employing logistic support assets effectively
- *Attainability*—acquiring the minimum essential logistics support to begin combat operations
- *Sustainability*—providing logistics support for the duration of the operation
- *Survivability*—ensuring that the logistic infrastructure survives in spite of degradation and battle damage

Within the Department of the Navy, logistics planning is the responsibility of the operational commander, who must ensure that his or her logistics experts coordinate all operational and logistical plans.

When given a mission, the commander's planning staff analyzes the situation, developing and proposing several possible alternative courses of action. The commander then selects from these the one he or she judges most likely to succeed. In many cases, logistic limitations and plans will become the deciding factor.

Navy construction battalion rapid response vehicles provide support for an overland logistics mission near Ramadi during Operation Iraqi Freedom. *Michael Lavender*

Functional Areas of Logistics

All logistics plans take into account six **functional areas**:

- *Supply*—design, procurement, contracting, receipt, storage, inventory control, and issuance of end items (ships, planes, tanks, etc.), spare parts, and consumables
- *Maintenance*—actions necessary to preserve, repair, and ensure continued operation and effectiveness of equipment, both afloat and ashore
- *Transportation*—the movement of units, personnel, equipment, and supplies from the point of origin to the final destination
- *Engineering*—the construction, damage repair, combat engineering, and maintenance of facilities
- *Health services*—the provision of medical and dental supplies, blood and blood products, and facilities and services in both combat and noncombat environments
- *Other services*—the provision of administrative and personnel support to operational forces, including recordkeeping, disbursing, food services, and legal services

The products of these six functional areas, when properly taken into account in the commander's operational planning, provide effective logistic support to the operating forces.

Elements of Logistics

Within each of the functional areas described above, there are four elements of logistics that come into play.

Acquisition

This element pertains to procurement of *commodities*, such as food, petroleum, oils, and lubricants (POL), and repair parts; *facilities*, such as buildings and piers; *ordnance*, such as missiles, ammunition, and mines; and major weapons and *end items*, such as ships, aircraft, and electronic systems. For the Navy the principal acquisition organizations are the various systems commands, the Defense Logistics Agency (DLA), the General Services Administration (GSA), and the Naval Facilities Engineering Command (NAVFACENGCOM).

Distribution

This element concerns the methods used to get logistics support to the operating forces, taking into account what is being moved, its origin and destination, the lift assets available, and the urgency assigned. A single unified combatant command, the U.S. Transportation Command (USTRANSCOM), is in overall charge of strategic transportation for all U.S. armed services. For deployed forces, as was discussed in chapter 2, some 90 percent or more of all all their heavy-lift logistics requirements would be delivered via sealift by civilian-crewed Navy and chartered merchant ships under the purview of the Military Sealift Command (MSC). High-priority cargo, mail, and passengers are transported by strategic airlift provided by the Air Force's Air Mobility Command, and ground transport is the responsibility of the Army's Surface Deployment and Distribution Command. All three of these are component operational commands under USTRANSCOM. Once in theater, further transportation is provided by MSC combat logistic force ships and by boats, vehicles, and aircraft of the other two component service commands.

Sustainment

This element pertains to the provision of adequate logistic support to permit continuous operations without interruption

for as long as required. Forward-deployed naval forces carry with them sufficient initial stocks to support operations, but these must be replenished as they are consumed. Establishing and maintaining a reliable flow of **war matériel** (military supplies, ordnance, and related equipment), resources, and support services to operating forces is accomplished through the operation and management of supply systems, naval maintenance assets, and bases. In the Navy this element is a primary responsibility of the Naval Supply Systems Command, and for the Marine Corps, the Marine Corps Logistic Command.

A Seahawk helicopter conducts vertical replenishment operations from an oiler. *Jessica Bidwell*

Disposition

This element concerns the handling, storage, **retrograde** (war matériel subsequently removed from a theater of operations), and disposal of matériel and resources. A major aspect of disposition is the avoidance of any damage to the environment, especially by oil pollution or other hazardous materials. The Navy oil spill response team is one of the largest in existence and has deployed to every major U.S. marine oil spill in the last three decades, along with personnel of the Coast Guard, the primary government service responsible for oil-pollution response in U.S. waters. The process of disposition begins with the first piece of equipment or major item that must be removed from the operating theater for repair, replacement, or as excess for further distribution, and ends when the last forces depart, which are often the naval forces assigned to most operations.

The foregoing principles, functional areas, and elements of logistics are the building blocks upon which all effective logistics planning is done. All of these must be taken into account in order for any naval operation of any size to be successful.

Logistics in Modern Warfare

Each of the U.S. geographic combatant commands and the major subcommands within them have formalized contingency plans for what their forces would do and how they would be supported logistically in the event of hostilities within their areas of responsibility. In recognition of the long surface transportation time required to reach various locations in the western Pacific and Indian Ocean regions, large stocks of war supplies and ammunition have been preloaded on board cargo ships predeployed at key locations in these theaters.

These *prepositioning ships* consist of some twenty-five U.S. government–owned or chartered U.S.-flag cargo and auxiliary ships, plus two helicopter repair ships activated from the Maritime Administration's Ready Reserve Force, all operated by the Military Sealift Command (MSC). They are organized into two **Maritime Prepositioning Force** (MPF) squadrons, each comprising six to eight ships loaded with gear to support a Marine air-ground task force (MAGTF), and an additional eleven ships dedicated to the support of each military service. Each MPF squadron carries sufficient equipment and supplies to sustain more than 16,000 Marine Expeditionary Brigade and Navy personnel for up to 30 days. Though there is some risk of capture of these ships and their supplies by potential enemies should hostilities break out, the necessity of timely resupply of U.S. and allied forces already in theater overrides this concern. Such prepositioned stocks would, it is hoped, be sufficient to sustain military operations until further resupply could be accomplished, most likely by seaborne transport from the United States.

The methods and timing of resupply in any future general war are of growing concern to U.S. planners today because fuel and ammunition and other key consumables would be rapidly expended in the first days of conflict. In addition, the continued availability of cargo ships and tankers for wartime needs is questionable given the steady decline of the U.S. merchant marine in recent years. Almost certainly, one major consequence of the shortage of available merchant ships in any large-scale future war would be a severe reduction of civil air transportation, since most large U.S. airliners would be needed to carry military supplies and personnel. Continuous analysis and planning are required to ensure adequate logistic support of all U.S. and allied armed forces in any future war scenario.

Maritime prepositioning ship USNS *1st Lt. Baldomero Lopez*, part of Maritime Prepositioning Ship Squadron Two, which operates out of Diego Garcia in the Indian Ocean. *Katie Dunnigan*

Critical Thinking

1. List the advantages and disadvantages of prepositioning war matériel in various locations throughout the world. Based on your list, are such stocks a good or bad idea?
2. There are logistics billets on the staffs of most major commands both afloat and ashore. Should these billets be filled by individuals whose entire careers are spent in logistics, or by individuals who have more generalized backgrounds in operations and other warfare specialties? Give the rationale for your choice.

Study Guide Questions

1. When did modern logistics begin?
2. What is the relationship between strategy, tactics, and logistics?
3. What will probably have to be done from the logistics standpoint if the United States becomes involved in total war?
4. What are the seven principles of logistics that must be reflected in logistics planning at all levels?
5. What are the six functional areas of logistics?
6. What are the four elements of logistics that come into play in each functional area?
7. A. What are Maritime Prepositioned Force ships?
   B. What are the prepositioned stocks of war matériel they carry intended to do?

New Vocabulary

logistics
commodities
end items
prepositioned stocks
war matériel
retrograde
MPF squadrons

10

Naval Research and Development

The scientific and military strength of the United States is highly dependent upon a successful and comprehensive research program. Research and development (R&D) in DOD and its military branches is a major effort in terms of personnel, money, and materials.

All military services conduct various R&D programs in their areas of responsibility. In recent years, increasing numbers of these programs have been conducted jointly by the services, as, for example, the next-generation F-35 joint strike fighter program and the new global Joint Information Environment C4ISR system. The U.S. Coast Guard is also an active participant in the DOD R&D program.

Navy R&D Management

Under the Secretary of Defense, the Secretary of the Navy has policy control over the Navy R&D organization. Ultimate responsibility rests with that person. The Assistant Secretary of the Navy for Research, Development, and Acquisition is responsible for management and control of R&D matters. The top advisor to these two civilian leaders is the Chief of Naval Research. He or she is in charge of the basic research program of the Navy, coordinating all Navy efforts with the systems commands.

The organizations that ultimately develop and procure the equipment and weapons the CNO requires for the Navy are the various systems commands (Sea, Air, Space, Supply, Marine Corps, and Facilities Engineering Command), the Office of Naval Research, and the Marine Corps.

Office of Naval Research

Following World War II, naval leaders realized that technological and engineering R&D alone were not sufficient to ensure the long-range technical progress necessary to develop new weapons, equipment, and materials. The Navy thus embarked on a program in the basic sciences that has formed the technical foundation for its R&D effort ever since.

In 1946 Congress authorized the formation of the Office of Naval Research (ONR) in compliance with an earlier recommendation by Navy Secretary James Forrestal. The office was charged with planning and conducting a coordinated research effort in every field of basic science, in conjunction with the Navy's applied research and engineering development programs.

The principal source of fundamental scientific knowledge in the United States traditionally had been university research laboratories. Wartime experience showed there was a need for a mechanism whereby university scientists could help find answers to the Navy's most pressing operational problems. ONR thus started what was for a time the largest peacetime research program ever supported by a federal agency at educational and nonprofit institutions. This Navy program was an outstanding example of effective and beneficial government-sponsored research, and it continues to this day.

A scientist from the Office of Naval Research introduces Octavia to visitors during Fleet Week in New York City. Octavia is a mobile, dexterous, social (MDS) robot that can move around on wheels (mobile), pick up objects (dexterous), and express a range of humanlike facial emotions (social). The ONR human robotics interaction research program focuses on the abilities of teams of humans and autonomous systems to communicate clearly, collaborate to solve problems, and interact both locally and remotely. *John F. Williams*

Known as the Contract Research Program, this ONR-sponsored activity advances the search for new knowledge in those fields of science and engineering vital to naval needs and national security. Under the auspices of the program, the nation's finest scientists conduct research for the Navy at nearly every well-known scientific laboratory in the country.

ONR coordinates, executes, and promotes the science and technology programs of the Navy and Marine Corps through schools, universities, government laboratories, and nonprofit and for-profit research organizations. It provides technical advice to the CNO and the Secretary of the Navy and works with industry to improve technological manufacturing processes.

Departments within ONR conduct research in information, electronics, and surveillance technologies; ocean, atmosphere, and space technology; engineering, materials, and physical science; human systems; expeditionary warfare; industrial and corporate programs; and industrial programs. ONR also oversees several special technical programs, among which are ongoing research into future naval capabilities, special science and technology programs, and grand challenges in science and technology for the future.

Areas of focus within the ONR Naval Science and Technology program in recent years include power generation and energy; maritime domain studies; information, analysis, and communication; naval warrior performance and protection; survivability and self-defense, including missile and torpedo defense; defense against IEDs; and many other cutting-edge technologies pertinent to naval warfare. Much of the basic and applied research supported by ONR relates closely to the programs of a number of other federal agencies.

Among the most technologically advanced ships in the U.S. Navy are the trimaran-design littoral combat ships such as the LCS *Independence* (LCS 2). It has water-jet propulsion, a top speed above forty knots, a total crew of about a hundred, and can be outfitted with one of several different mission package modules, including surface warfare, undersea warfare, and mine warfare. Starting in 2019, new ships of this class are slated to be designated as fast frigates, with increased firepower including missiles and heavier armor.

Naval Research Laboratory

The Naval Research Laboratory (NRL) in Washington, D.C., is ONR's corporate R&D laboratory. It conducts a broadly based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, equipment, and systems; and ocean, atmospheric, and space sciences and related technologies.

The NRL engages in research in the physical, engineering, space, and environmental sciences areas. It conducts exploratory and advanced development programs in response to the Navy's present and future needs and furnishes broad, multidisciplinary support to the Naval Air Warfare Center, the Naval Command, Control and Ocean Surveillance Center, the Naval Surface Warfare Center, and the Naval Undersea Warfare Center.

The auxiliary general oceanographic research (AGOR) vessel R/V *Sally Ride*, is operated by Scripps Institution of Oceanography under a charter lease agreement with ONR. The ship has multibeam bottom-mapping and ocean current–profiling sonars, advanced meteorological sensors, and satellite data transmission systems, as well as a specially designed hull that improves sonar acoustic performance. *John Williams*

Naval Oceanographic Research Program

The primary military objective of the Navy's oceanographic research program is to advance the knowledge of ocean, coastal, and seabed areas for the purpose of increasing the effectiveness of naval as well as other military weapons systems. This objective includes the design of ships and other equipment to satisfy oceanographic data collection requirements.

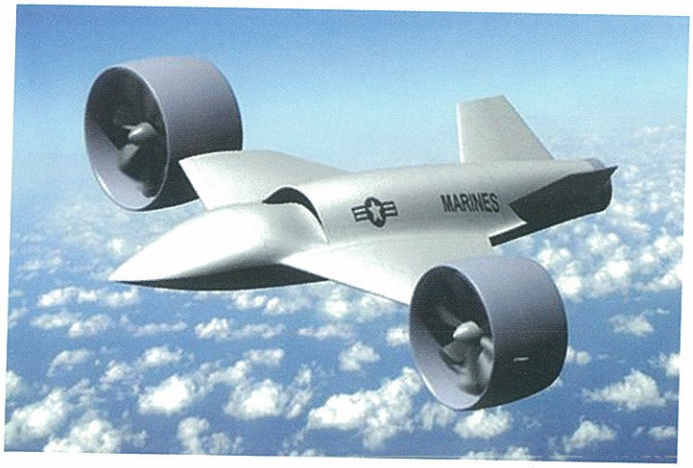
A secondary, nonmilitary objective is to advance the knowledge of all aspects of the ocean, coastal, and seabed areas to enable their successful exploitation for economic, scientific, social, political, and prestige gains. This includes cooperation in formulating proposed international law applying to the high seas, territorial seas, continental shelves, and seabed areas.

National defense takes priority over other goals of the oceanographic effort. The Navy, however, is obligated to support the nonmilitary objectives of the national oceanographic program, so it manages ships and facilities to meet both requirements. The largest portion of knowledge gained from Navy oceanographic activities is not classified and is made available to national, international, and private organizations. Consistent with its own effort, the Navy also cooperates with national and private organizations devoted to the study of the marine environment.

Some of the Navy's work in oceanography is also carried out by private oceanographic organizations such as the Scripps Institute of Oceanography in California and Woods Hole Oceanographic Institute in Massachusetts. Other work is done by universities and various technical agencies.

Advanced Research

Projects in advanced research are conducted by the Defense Advanced Research Projects Agency (DARPA), a special agency of the Defense Department. DARPA sponsors research in areas of high risk in terms of commercial applicability and profit potential to prevent technological surprise from harming U.S.



Artist's rendering of a new drone proposed for the Marine Corps that will be able to operate from the flight deck of an aircraft carrier or amphibious assault ship and fly at 300 mph with a 500-pound payload of precision weapons or guns. *American Dynamics Flight Systems*

security. Private enterprises are reluctant to take on such projects. DARPA seeks transformational change rather than incremental advances. DARPA has approximately 220 government employees in 6 technical offices, including nearly 100 program managers, who together oversee some 250 R&D programs.

High risk in pursuit of high payoff is a hallmark of DARPA's programs. They address three major areas: *national-level problems* involving threats to U.S. national security; *operational dominance*, developing advanced systems and technologies that will give U.S. military forces a decisive edge over prospective enemies; and *high-risk high-payoff technologies* that will enable quantum leaps in U.S. military capabilities.

Under the national-level problem areas are programs that provide support for the global war on terrorism and protection against biological warfare, among other things. Current operational dominance projects include development of advanced manned and unmanned combat systems, advanced C4 (command, control, communications, and computer) systems, and sensors. Areas being addressed under high-risk high-payoff technologies include advanced networking, brain-machine interface technology, biochemistry and biomagnetics, and microelectromechanical systems.

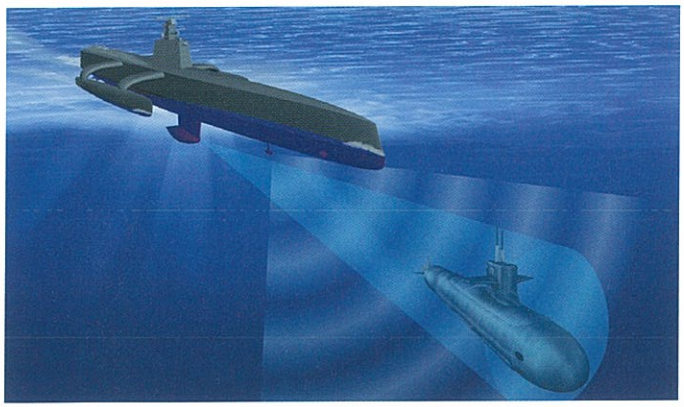
One of the recently announced DARPA projects is a design for an experimental plane with a stacked wing frame that has a series of rotors mounted in between. The rear-mounted wing would create vertical thrust for takeoff and landing, then rotate to provide horizontal thrust for cruise flight. A second, smaller wing near the nose of the airplane would work the same way. DARPA says its X-plane would fly as fast as 460 mph and could be in the air by 2018. Initial models likely will be unmanned

An early test model of the Navy's experimental X-47B UAV, shown here undergoing launch and recovery tests on board the aircraft carrier USS *George H. W. Bush* (CVN 77) as part of the Navy's Unmanned Carrier-Launched Airborne Surveillance and Strike (UNCLASS) R&D program. The drone is designed for carrier-based operations, with 2 weapon bays providing for up to 4,500 pounds of ordnance, about 85 percent of the payload of an F-35 Joint Strike Fighter, and twice the range. It is capable of semiautonomous operation and aerial refueling. A slightly larger model is slated to be in full-service production by 2019. *Jane Campbell*

A later test model X-47B UAV receives fuel from an Omega K-707 tanker over the Chesapeake Bay in April 2015, marking the first in-flight refueling of an unmanned aircraft.

and could be used for military applications like resupplying soldiers in the field or evacuating wounded personnel.

Several other advanced R&D initiatives are currently being developed for use by U.S. naval forces at sea. These include autonomous UAVs that would have the same capabilities as today's manned fighter and attack aircraft, able to land on and take off from aircraft carriers at sea. Prototypes designated the X-47B have already been successfully tested on board a carrier, and operational models may join the fleet within the next several years. The prototypes have a range of 2,100 nautical miles, almost twice that of the Navy's new F-35C manned fighters, and 2 weapons bays capable of carrying 4,500 pounds of ordnance, about 85 percent of the F-35's.



Artist's rendition of an ASW Continuous Trail Unmanned Vessel (ACTUV) autonomous surface vessel. Currently in research and development, this USV is designed to operate and patrol autonomously for sixty to ninety days and to hunt for submerged submarines while avoiding surface ships. It will have a cost of about one-tenth of a modern diesel submarine and could be fully operational by the 2018–19 time frame.

Several prototypes of semiautonomous **unmanned surface vehicles** (USVs) have been developed and successfully tested in conjunction with the mine countermeasures modules of several of the Navy's new littoral combat ships (LCSs), and these may be given expanded missions in the years to come. They are also seeing extensive use as target craft in live-fire exercises simulating attacks against Navy ships by fast enemy patrol boats and other small craft.

Unmanned underwater vehicles (UUVs) have been operational for several years and are also a part of the planned equipment to be used with the LCS mine countermeasures modules. Several of this type of craft, called **autonomous underwater vehicles** (AUVs), outfitted with advanced side-scanning sonar equipment were employed in the extended and as yet unsuccessful underwater search for the remains of Malaysian Flight 370, which disappeared in the Indian Ocean on a flight from Kuala Lumpur to Beijing, China, in March 2014.

Critical Thinking

1. Should R&D efforts for the military be done exclusively by government laboratories, by private laboratories under contract to the government, or by both? Give the rationale for your answer.

Study Guide Questions

1. Who manages the Navy's R&D program?
2. What is the mission of the Office of Naval Research?
3. What kinds of research does the Naval Research Laboratory do?
4. A. What is DARPA?

   B. What are the three main DARPA program areas?
5. What are the new airborne platforms described in this chapter that are currently under development by DARPA and other agencies for the U.S. Navy?

New Vocabulary

ONR
R&D
UUVs
DARPA
NRL
USVs
AUVs

Unit 3

Military Law

In any organization of people, whether a business, school, community, athletic team, or military unit, there has to be an understanding of what can and cannot be done. There must be a code of law, rules, and established regulations by which all group members conduct themselves. Accordingly, civilized human beings have developed a number of law codes, each designed to fit a particular society.

Some of these law codes, or lists of laws, often studied in high school civics, government, or political science classes, are civil law, common law, constitutional law, criminal law, and international law (discussed in unit 4). This unit will be primarily concerned with another code of laws: military law.

11

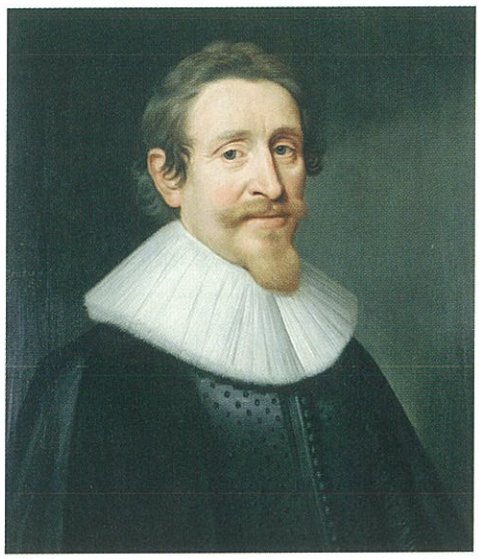
Introduction to Military Law

The force of government behind customs and codes of law transforms them into practical laws regulating the daily lives of people. In the United States these laws are further defined by court decisions and rulings by judges. To introduce the study of military law, the following sections will briefly cover the development of our various law codes and how they relate to each other in our society.

History of Law Codes

Most nations of the world today have one of two major kinds of traditional law: civil law or common law. Although some principles of both of these systems of law had their beginnings in ancient times, the systems of civil and common law that we have today both originated for the most part during the Middle Ages in Europe.

The term *civil law* comes from the Latin *ius civile*, the ancient Roman law that applied to all Roman citizens, or *cives*, from the fourth century BC to the sixth century AD. Between AD 529 and AD 534, the emperor Justinian compiled all the imperial enactments and extracts from Roman jurists from the preceding thousand years into a collection called the *Corpus Iuris Civilis* (Body of civil law). Justinian's compilation was lost for many centuries during the Dark Ages but rediscovered afterward, and it became the basis for legal instruction in eleventh-century Italy. By the sixteenth century it had morphed into a body of codified civil law that was adopted throughout Europe. At that time the Catholic Church was an institution central to medieval culture, politics, and higher learning in Europe. Contemporary medieval scholars of Catholic Church law were strongly influenced by the *Corpus Iuris Civilis*. They incorporated it along with religious legal codes into their system of law and governance for Catholicism, which body of law came to be called *canon law*. By the late Middle Ages, both of these two law systems—civil law and canon law—were taught at most universities, and they became the basis of the legal system of most of Europe. In 1631 a Dutch legal scholar named Hugo Grotius published a landmark treatise titled *Introduction to the Jurisprudence of Holland*, in which he combined the precepts of earlier Roman law and Dutch customary law into a single system of codified national law. Later, during the Enlightenment of the eighteenth century, this effort was further advanced in Austria, Prussia, and ultimately in France by Emperor Napoleon I in 1804. It is probably the greatest legacy that great leader passed on to modern society. Napoleon's Civil Code, as it was called, became the basis of the European Civil Code subsequently practiced throughout most of Europe and still prevailing in modern times in much of the world.



Contemporary painting of Hugo Grotius (1583–1645) by Michiel van Mierevelt.

Countries that abide by civil law systems have comprehensive, continuously updated legal codes that specify all matters that can be brought before a court and the appropriate punishment for each offense. *Substantive law* establishes which acts are liable for criminal or civil prosecution; *procedural law* establishes how to determine whether a particular act constitutes a criminal act; and *penal law* establishes the appropriate penalty. The assumption is that this law regulates almost all cases that could occur in practice. If there are any exceptions, the courts seek to apply the general principles on which a comparable statute of the Civil Code was founded. Thus, legislation is considered the primary source of European civil law, and judges tend to make judgments that will fit into the system, taking into account the intention of the legislator who passed a particular rule or code of the law. In a civil law system, the judge's role is

to establish the facts of the case and apply the provisions of the applicable code.

With the exception of Arabic countries, most of which have adopted some form of Islamic *sharia law* based on the Koran, civil law based on the European Civil Code is practiced by a majority of some 150 countries in the world today, including those of the European Union and most countries in Asia, Africa, and South America. Under the Civil Code the accused must, to a large extent, prove himself or herself innocent of any criminal charges filed against him or her by the state.

The development of *common law* in English-speaking countries was different. English common law emerged as a result of the centralized powers of the king during the Middle Ages. Legal actions by the crown functioned through a system of *writs*, or royal orders, each of which provided a remedy for a specific wrong in each specific case that occurred. In time this proved to be too cumbersome, however, and courts called *equity courts* were established, authorized to apply principles of equity based on many sources to achieve just outcomes. These courts of law functioned separately until the writs system was abolished in the mid-nineteenth century. Thus developed the body of *civil* or *equity law* in England, most of the British Commonwealth, and later the United States referred to as common law. It is used to restore rights, compensate damages, and correct injuries in civil cases.

Criminal law was derived from that part of English common law designed to punish or deter wrongdoers by bringing them to court for justice. Trial by a jury of peers—citizens of equal status under the law—is a specific right under English common law and is guaranteed to each American citizen in the Sixth Amendment to the U.S. Constitution.

In contrast to civil law based on the European Civil Code, common law is said to be *uncodified*, meaning that there is no comprehensive compilation of legal rules and statutes by which all cases are to be adjudicated. While there are legislated statutes that often apply, it is based largely on *precedent* set by judicial decisions made in similar cases. These precedents are maintained over time through court records and collections of case law in published law books and journals. The precedents to be applied in each case are determined by the presiding judge. A jury of ordinary people without legal training decides on the facts of the case, and the judge then determines the appropriate sentence based on the jury's verdict. A fundamental feature of Anglo-American common law is that in criminal cases the accused is presumed innocent until the evidence brought before the jury proves guilt beyond any reasonable doubt.

Anglo-American common law is the basis for the national law of some eighty of the world's nations, including England, Ireland, and the United States, as well as former members of the British Commonwealth such as Canada, Australia, and New Zealand. It is also the type of law practiced by many former British colonies in Asia and Africa such as India, Pakistan, South Africa, and Malaysia.

Even though European-based civil law and Anglo-American common law may predominate in the various countries that operate in accordance with them, in fact there is almost always some exercise of traditional common law practices in civil law countries, and vice versa. This is particularly true in the United States, where in states like California and Louisiana, which started out as Spanish and French colonies respectively, there still exists a legacy of some of the civil law precepts of their mother countries, even though American common law prevails in them.

The U.S. Constitution and Military Law

In the United States, all law is **constitutional law**; that is, it is based on the U.S. Constitution. The Constitution guarantees the rights of all citizens to equitable treatment under the law. It gives the Congress the power to provide and maintain a Navy and to establish rules and regulations for its operation, which collectively are referred to as **military law**.

In civilian life, criminal law seeks to protect society from the acts of irresponsible members without infringing upon their individual rights under the Constitution. Military law similarly restrains individuals for the protection of the whole military society, but it also establishes the prescribed conduct that all members must follow to preserve order and discipline. Military law is therefore different in some degree from the civil criminal law code.

Some acts considered rights in civilian society might be offenses in the military. For instance, "telling off the boss" might result in getting demoted or fired, but it is not unlawful for an American civilian to do so. In the military services, however, that could be an offense punishable by court-martial. Civilians can quit their jobs if they do not like them; in the military, that is a major offense called *desertion*. In civilian life, if people decide to jointly protest their working conditions or pay, they may strike; in the naval service, that action would be the offense of *mutiny*.

The defense of the nation is not the kind of business in which citizens can do their own thing when, or if, it pleases them. The demands of military service are such that positive control and an established code of conduct are required always. Readiness for emergencies, as well as coping with the emergency itself, demands a code of law differing in some degree from the normal civil code.

Military law is the law regulating the military establishment, including the military justice system. It is designed to preserve good order and discipline within the military service, in the same way that state and federal laws are designed to preserve good order in the civilian community. U.S. military law,

like U.S. common law, requires that the rights of each individual be protected and seeks to assure every person in uniform of equal justice under the law.

The laws that govern the U.S. Navy had their origin in 1775, when the "Rules for the Regulation of the Navy of the United Colonies" were first established. These first laws were based largely on British civil and Royal Navy admiralty law. Over the years since their formulation, the U.S. Navy laws have undergone constant modification and improvement to meet changing requirements up to the present day.

Navy Regulations

Navy Regulations is the basic set of laws governing the Navy. It provides the broad guidelines for the organization and administration of the Navy, and specifies particular actions that can and cannot be done, and how the chain of command should handle these actions.

Important Navy Regulations

On all ships and stations, the most important articles of *Navy Regulations* are posted on bulletin boards or included in the *Ship's Organization and Regulations Manual.* Often, selected articles are quoted in the *Plan of the Day*, a schedule of planned events plus important notes published daily and posted throughout the command. Some Navy regulations often posted and quoted are excerpted below:

1110. Standards of Conduct

All Department of the Navy personnel are expected to conduct themselves in accordance with the highest standards of personal and professional integrity and ethics.

1145. Service Examinations

Persons in the Department of the Navy, without proper authority, shall not have in their possession, obtain, sell, publish, give, purchase, receive, or reproduce any examination paper, or any copy thereof, or answer sheet thereto, for any examination whatsoever which has been, is, or is to be, administered within the Department of the Navy.

1151. Direct Communication with the Commanding Officer

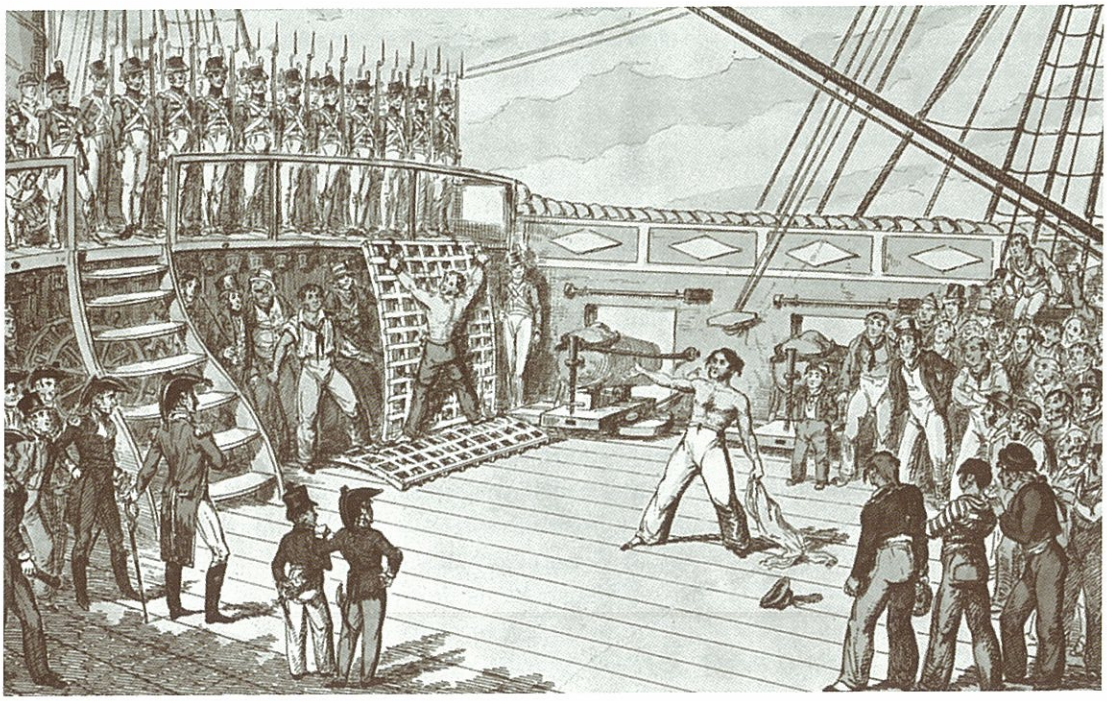
The right of any person in the naval service to communicate with the commanding officer in a proper manner, and at a proper time and place, shall not be denied or restricted.

1162. Alcoholic Beverages

Except as may be authorized by the Secretary of the Navy, the introduction, possession or use of alcoholic beverages on board any ship, craft, aircraft, or in any vehicle of the Department of the Navy is prohibited.

1164. Equal Opportunity and Treatment

Equal opportunity shall be afforded to all on the basis of individual effort, performance, conduct, diligence, potential,



Cruel and unusual punishments are forbidden under the UCMJ, in contrast to the days of sail, when flogging with a cat-o'-nine-tails was common.

capabilities, and talents without discrimination as to race, color, religion, creed, sex, or national origin.

1165. Fraternization Prohibited

Personal relationships between officers and enlisted members that are unduly familiar and that do not respect differences in grade or rank are prohibited.

1167. Supremacist Activities

No person in the naval service shall participate in any organization that espouses supremacist causes; attempts to create illegal discrimination based on race, creed, color, sex, religion, or national origin; advocates the use of force or violence against the government of the United States or the government of any state, territory, district, or possession thereof . . . or otherwise engages in efforts to deprive individuals of their civil rights.

The Uniform Code of Military Justice

The trial and punishment of offenders in the U.S. armed forces are covered by a set of laws named the Uniform Code of Military Justice (UCMJ). The word *uniform* here means that the code is the same for all the services. The *Manual for Courts-Martial, United States* (*MCM*) and the *Manual of the Judge Advocate General* supplement the UCMJ and deal particularly with the administration of the law as decreed in *Navy Regulations* and the UCMJ.

All military leaders, especially officers, are responsible for ensuring that their knowledge of the code is adequate. They must know the fundamentals of military law. Officers must know the basics of court procedures because they may be called upon at any time to participate in the conduct of a military court or to investigate matters that have some bearing in such a court.

Since Navy personnel agree to abide by the Navy's laws and regulations in their oath of enlistment, it stands to reason that each Navy person must learn what these laws are. Congress and the Navy have taken steps to ensure that all persons entering the Navy will know the laws and regulations most likely to affect them at their ship or station. Article 137 of the UCMJ directs that particular articles of the code be carefully explained to every enlistee at the time of entry on active duty, after six months of active duty, and at the time of reenlistment. It also requires that a complete copy of the UCMJ be made available to every enlisted person.

Overview of UCMJ Articles

The 146 articles making up the UCMJ are divided into 12 groupings. The first nine deal with general provisions, rules for apprehension and restraint, and the conduct of nonjudicial punishment (NJP) and courts-martial. Group 10, comprised of articles 77–134 and dealing with specific infractions of military law, is known as the *punitive articles*. These articles address acts that are in direct violation of acceptable military and, in many cases, civil law, and that would constitute a court-martial offense. They include offenses such as murder, assault, and larceny, and infractions against military behavior such as disobedience of lawful orders, absence without leave, and insubordination.

Under article 55 of the UCMJ, cruel and unusual punishments are prohibited. In the days of sail, punishments by flogging, branding, or tattooing on the body were not uncommon. Today they are strictly forbidden. Public punishments that might tend to ridicule—such as shaving the head, placing offenders in the stocks, tying them up by the thumbs, and forcing them to carry about placards or heavy loads—are also prohibited by the UCMJ. Placing a prisoner "in irons," except for handcuffs when traveling in custody, is likewise not allowed.

More detailed study of the articles of the UCMJ may be done by referring to the *MCM* or to the text *Naval Law*, published by the Naval Institute Press.

Critical Thinking

1. Research the fundamental difference between the presumed guilt or innocence of the accused under the English and U.S. system of law as opposed to the European Civil Code based on the Napoleonic code. Which do you think is better? Why?

Study Guide Questions

1. Why have societies developed codes of laws?
2. How do laws come into force?
3. What are the two major kinds of traditional law in effect in most nations of the world?
4. A. What was the *Corpus Iuris Civilis?*
   B. Of what system of law did it ultimately become the basis?
5. What is the main conceptual difference between civil law based on the European Civil Code and Anglo-American common law?
6. What is meant by a trial by a jury of peers?
7. Why is there a separate body of military law?
8. What is the relationship between discipline and military law?
9. What is the basic requirement of both military and civil law pertaining to individual rights?
10. What is the purpose of *Navy Regulations*?
11. Under *Navy Regulations*, what is the rule concerning the following subjects?
    a. Communications with the commanding officer
    b. Examinations
    c. Equal opportunity
    d. Alcoholic beverages
12. Which three publications explain all matters concerning U.S. military law?
13. Why must naval personnel be familiar with the UCMJ?
14. What kinds of cruel and unusual punishments are prohibited by article 55 of the UCMJ?

New Vocabulary

regulations
common law
criminal law
civil law
nonjudicial punishment
larceny
court-martial
UCMJ articles

12

Discipline and Punishment

Military leaders must be alert to all actions by subordinates, praising when a job is done well but correcting, and even punishing, if poor work or breaches in military discipline (infractions) occur. The senior's approach must be one of continuing alertness, with consistent and fair actions taken in all cases.

A breach of discipline cannot be disregarded one day and rebuked the next. Under such conditions, personnel do not know where they stand and cannot establish a pattern of conduct that is consistent. If rules are ignored or regulations disobeyed and no one in authority seems to care, there is bound to be confusion. If regulations cannot or will not be enforced, it is better not to issue them in the first place.

Discipline can be strict without being stiff and formal. For a first offense, a light punishment that is prompt and just may serve far better than a severe one; a private reprimand at the start of a potential problem may prevent a later appearance at mast or court-martial. Timely action is essential because it leaves no doubt in the mind of the offender about the reason for the punishment. Delay fosters resentment toward the system.

Punishment must be just. In order to accomplish its purposes, it must be recognized as just and fair by the offender and shipmates. Penalties imposed must not be out of proportion to the seriousness of the offense. If the leader is exacting but fair, subordinates will not only live up to the leader's demands but will also respect and admire his or her attitude.

The *Bluejacket's Manual* states that when offenses against good order and discipline are punished by proper naval authority, punishment is imposed for three reasons: to deter offenders from breaking the rules again, to encourage them to do their duty, and to set an example. Note that these are positive reasons, not negative ones.

The Navy's desired goal is positive discipline based on respect for leaders, confidence in their justice and fairness, and the compulsion of moral force. Discipline based on force alone cannot endure. Long-term discipline must be stimulated or induced from within the individual. True discipline develops loyalty and intelligent initiative.

Punishment is not personal, and it is not vindictive. It is not inflicted as revenge for misconduct, nor can it serve to right any wrong that might have resulted from any dereliction of duty. When seniors find it necessary to reprimand or to place a person on report, they are officially doing their duty. All personnel in the Navy are obliged to obey and strictly follow the regulations, and to do so promptly. Those who are derelict in their duties should expect, and receive, the appropriate lawful punishment. When fair punishment is meted out, it should be accepted and regarded constructively; that is, a lesson should be learned from the experience.

George Washington, like all great leaders, was a sound disciplinarian. He counseled his officers in 1776, "The best general advice I can give is to be strict in your discipline; that is, to require nothing unreasonable of your officers and men, but to see that whatever is required be punctually complied with. Reward and punish every man according to his merit, without partiality or prejudice."

Apprehension, Arrest, Restriction, and Confinement

Apprehension is the taking of a person into custody. **Arrest** is the restraint of a person by an order directing that person to remain within certain specified limits. Arrest is not imposed as punishment for an offense; the restraint is binding upon the arrested person by virtue of a moral and legal obligation to obey the arrest order, not by physical force. If under arrest, a person cannot be required to perform full military duty.

Instead of arrest, an accused person may be **restricted** to specified areas. The person may be required to perform all usual military duties while under such restriction. This is the usual form of restraint for persons awaiting captain's mast or those awaiting court-martial on other than the most serious charges.

Confinement is physical restraint depriving a person of freedom, normally in a brig or jail. Confinement is not imposed pending trial unless deemed necessary to ensure the presence of the accused or because of the seriousness of the offense

charged. Confinement must be imposed legally by oral or written orders.

Persons under arrest or confinement must be advised that they have the right to consult with a lawyer, that the lawyer may be present at any investigations, and that the lawyer may be either retained at the individual's own expense or appointed by the military authority without cost. No self-incriminating statement made in violation of article 31 is admissible in a trial by court-martial.

Initiating and Preferring Charges

In the Navy the usual procedure for initiating and preferring charges against enlisted personnel consists of submitting a written report detailing the alleged offense to the executive officer or another officer designated by the commanding officer. The form utilized is called a *Report and Disposition of Offenses Slip*. It contains all the information necessary to process the case, including names of witnesses. Any commissioned officer or petty officer who observes a breach of discipline afloat or ashore may place naval personnel on report. For example, in the case of lateness in returning to the ship from liberty, the officer of the deck would place the offender on report as that person came on board.

The formal written report consists of two parts: the technical charge and the specification(s). The charge tells what article of the UCMJ the accused is alleged to have violated. The specifications set forth the specific facts and circumstances involved with the violation. The executive officer (XO) must check the charges and specifications to ensure they are legally correct. The XO advises the accused of all particulars in the case, including the charges, witnesses, accuser, constitutional rights under the UCMJ, and rights concerning possible nonjudicial punishment or court-martial proceedings.

After the XO reviews the charges, a preliminary investigation of the charges is effected, either by the XO or by an investigating officer he or she appoints. If the facts in the case are found to warrant disciplinary action, the investigating officer will fill out a charge sheet. If the investigating officer feels that a court-martial is not warranted, as is the case for most reported offenses, the facts are reported to the XO, and the accused is brought to **nonjudicial punishment** (NJP, or captain's mast—see below) for adjudication of the alleged offense.

Preliminary Inquiry

Before taking any kind of disciplinary action, it is always both necessary and wise to review all the facts. A step somewhat beyond the preliminary investigation leading to a captain's mast is the preliminary inquiry. Essentially, the inquiry is an informal investigation conducted for the purpose of determining whether or not an alleged offense chargeable under the UCMJ has been committed, and whether reasonable grounds exist to support the allegation that the accused committed the offense. The officer making the preliminary inquiry collects and examines all evidence that could bear on the guilt or innocence of the accused. The officer also looks for facts in **mitigation** or **extenuation**; that is, circumstances that might tend to provide some plausible reason for the offense or lessen the punishment imposed.

If naval personnel are found to have violated either *Navy Regulations* or the UCMJ, they may then be subject to appropriate disciplinary procedures. Such procedures can range from informal oral or written rebukes to military trials called **courts-martial** in the more serious cases. The following sections will go into the conduct of these disciplinary procedures, including the makeup and conduct of military trials, the punishments that can be awarded by them, and the infractions of the UCMJ that may lead to such awards.

Disciplinary Actions

There are two basic classes of official naval disciplinary action: nonjudicial punishment, better known as **captain's mast**, and courts-martial. Captain's mast, often simply referred to as "mast," is a name that has come down from early sailing days when the usual setting for naval justice was on the weather deck, at the foot of the ship's mainmast. Often the whole crew was assembled to hear the proceedings and to observe the punishment, sometimes flogging with a cat-o'-nine tails. In the Marine Corps, captain's mast proceedings are referred to as "office hours."

Commanding officers (COs) may impose NJP for minor offenses upon subordinate officers and enlisted personnel. This authority cannot be delegated unless COs are generals or flag officers or have unique senior responsibility in which they exercise general court-martial jurisdiction. Captain's mast is the cornerstone of the whole structure of naval justice and discipline.

Military offenses, as distinguished from common misdemeanors or minor crimes, may be divided into two classes: those involving neglect of duty, and those involving deliberate violations of instructions, orders, or regulations. Offenses classified as neglect of duty may result in punishment ranging from loss of liberty to that awarded by a court-martial. Deliberate violations of instructions, orders, or regulations are usually tried by court-martial. Such an offense is often of concern more for the defiance of authority it displays than for the consequences of the act itself. Offenses involving moral turpitude, such as theft, forgery, or serious acts against others, invariably result in adjudication by court-martial.

Military courts are conducted with the same care and formality as civilian courts. The officers or petty officers assigned

court duties bear great responsibility. The court must be conducted with dignity and ensure swift, efficient administration of justice. Being dealt with fairly and forthrightly in all matters brought before a court is the right of each person accused under the Constitution, the UCMJ, and the *MCM*.

Nonjudicial Punishment

Prior to a captain's mast, the XO will normally hold a preliminary mast. Often called the **screening mast**, it is usually conducted almost exactly like captain's mast, except that the XO's purpose is to determine the seriousness of the case and to ascertain the facts so that action may be recommended to the CO. XOs may not assign punishment, but if conditions justify, they may dismiss the charges, since they have the responsibility for the routine, efficiency, and discipline of their units under their commanding officers.

Following the screening mast, the XO will furnish the CO with a list of any personnel upon whom charges have been preferred whom the XO believes should appear at mast. The captain will hold captain's mast at a time and place most convenient for all concerned. All arrangements, including notification of the accused and witnesses and the accused person's division officer and leading petty officer, will be made by the XO and staff, including the master-at-arms force, the legal yeoman, and the personnel officer.

At the start of captain's mast, the captain will first warn the accused and any witnesses about the possible effect of their answers and explain their rights. These rights are similar to those recited by an investigating officer in a preliminary inquiry.

As each individual case is called before the CO, the accused and his or her division officer step forward. The **charges and specifications** (details of the infraction) are read, and the accused is asked if these charges are understood. The captain then hears the accused person's statement and that of any witnesses. The captain may ask the person's division officer and leading petty officer for comments concerning performance of duty. The personnel officer will provide the person's official record to the captain so that careful review can be made before any decision in the matter is reached. At all times during the procedure, the dignity, formality, and seriousness of a court are strictly maintained.

In passing judgment, the CO may dismiss the case, officially warn the accused, administer an oral or written admonition or reprimand, administer punishment, or order the accused to be tried by court-martial. Punishments that may be awarded at captain's mast to enlisted personnel include an official admonition or reprimand, confinement on bread and water for a period not exceeding three days (E-3 and below), correctional custody not exceeding thirty days, forfeiture of one-half pay not exceeding two months, restriction not exceeding sixty days, and reduction in pay grade to the next inferior level. The commanding officer may apportion the punishment among two or more of the above options.

Officers may be awarded NJP by senior officers in command, but they may not be confined, put in correctional custody, given extra duty, or reduced in rank. They may be placed under arrest in quarters and/or restricted from going ashore on liberty (often referred to as "being in hack"). One-half of their pay may be forfeited for not more than two months. In any event, an official letter to the CNO from the commanding officer is required, and notation on the officer's next fitness report will be made.

Any person who considers the punishment to be unjust may make a written appeal to the CO's superior authority. If the senior feels there has been a miscarriage of justice, the punishment may be modified or set aside, but it may not be increased, and a different punishment may not be awarded.

The Military Courts-Martial

When nonjudicial punishment is considered to be inadequate for an offense charged, the commanding officer may refer the case to one of three types of court-martial. In increasing order of severity, these are the summary, special, and general courts-martial. Severity in this case means the maximum punishments that may be awarded by the court.

Summary Court-Martial

A **summary court-martial** is convened by a CO to administer prompt justice for relatively minor offenses through a simple court procedure. Only enlisted personnel may be tried by a summary court-martial. A summary court consists of one commissioned officer appointed by the CO, in naval courts preferably a lieutenant (O-3) or senior. This officer should be neither the accuser nor the investigator in the case, and should not be associated closely with the accused.

A summary court is unique in that the summary court officer represents both the government and the accused; in other words, that person is both prosecuting attorney and defense counsel. Although the accused is not entitled to a military defense council, he or she may hire a civilian lawyer at his or her own expense. The summary court investigates both sides of the matter and ensures that the interests of both the government and the accused are safeguarded. Investigation beyond fair inquiry and ensuring that the person understands the charges is not required if the accused pleads guilty. If found guilty, the accused is advised of his or her right to present matters in extenuation or mitigation to be considered by the summary court when awarding punishment.

Punishments authorized by the summary court are similar to those that may be awarded by the CO at mast: confinement

for not more than thirty days, forfeiture of two-thirds pay for one month, and reduction in pay grade. At the end of the trial the verdict is announced, and if the accused has been convicted, the sentence of the court is pronounced. A record of the conviction and any punishment awarded is made in the individual's service record. Following the proceedings, the person is restored to duty within the limitations imposed by the summary court's punishment.

Special Court-Martial

A **special court-martial** can be convened by a CO to try cases involving offenses that warrant greater punishment than a summary court can award. The special court-martial has jurisdiction to try anyone subject to the UCMJ for any noncapital offense made punishable by the code, and some capital offenses if authorized by the President. The CO, as convening authority for the court, draws up a convening order that specifies the time and place of meeting of the special court and appoints not less than three members to it.

The convening authority may also have a military judge—a law officer certified by the judge advocate general—appointed to the court if one is available. After consultation with the defense counsel, the accused may request to have only this military judge serve as the special court. If the judge approves, he or she will serve as a one-person special court, with sole responsibility for conduct of the trial. An accused enlisted person may also request that one-third of the special court be made up of enlisted personnel. The convening authority may grant this if enlisted people with suitable qualifications are available from another unit to sit on the court. All members of any court should be senior to the accused.

The convening authority appoints an officer as trial counsel to conduct the case for the government; this person acts as prosecuting attorney. Another officer is appointed to act as defense counsel for the accused. The accused is afforded the right to have his or her own counsel for the defense. The accused can choose a civilian counsel paid at his or her own expense, military counsel of his or her own selection if such is reasonably available, or the appointed defense counsel.

The senior member of the special court-martial is the president, unless a military judge is detailed. Then that person will be the president of the court, even if the judge is not the senior

A Navy legal assistant acting as trial counsel makes an opening statement during a mock court-martial staged for a group of NJROTC cadets.
Scott Thornbloom

member assigned. The grade of the president should be lieutenant or above. The president rules on legal procedures during the trial and instructs the court on the elements of each offense charged prior to closure of the court for vote, as well as what constitutes the presumption of innocence, reasonable doubt, and burden of proof. Before the court closes for the vote on the sentence, the president advises it regarding the maximum authorized punishment for each offense. If president, the military judge is not considered a member of the court and does not vote on the guilt or innocence of the accused, so there must be at least three other individuals serving as members.

The accused, on advice of counsel, may exercise what is called a **peremptory challenge** of any member of the court. If the challenge is exercised, the challenged member is dismissed from court duties by the president. No reason for the peremptory challenge need be given. If such challenge reduces the court membership below three, the convening authority must appoint another member.

Members of the special court-martial hear the evidence, determine the guilt or innocence of the accused, and if the verdict is "guilty," render a proper sentence. Convictions and sentences require a two-thirds majority. Voting is by secret ballot, and all members must vote.

A special court-martial may award punishment including a bad conduct discharge (BCD) for enlisted personnel, confinement not exceeding twelve months, forfeiture of pay not exceeding two-thirds pay per month for up to twelve months, or (for enlisted) reduction to the lowest pay grade. Apportionment of punishments may be made as by a summary court-martial.

General Court-Martial

The **general court-martial** is the highest military tribunal. It may be convened by the President, the secretaries of the various services, a flag officer in command of a unit or activity of the Navy or Marine Corps, a general officer in command, the CO of a naval station or larger shore activity beyond the continental limits of the United States, and other commanding officers specifically designated by the President or service secretary. A general court-martial consists of a military judge and at least five members, with twelve required in capital offense cases in which the death penalty may be awarded. Enlisted members may serve on the court if the accused so requests. As with a special court-martial, the accused may request in writing, subject to the approval of the military judge, that the case be heard by the military judge alone.

A general court-martial has jurisdiction to try persons subject to the UCMJ for any offense punishable by the code. A general court-martial may also try any person who might be subject to trial by military tribunal, including civilians in situations in which martial law has been officially declared because of a breakdown of normal civilian authority.

Court procedures and responsibilities of the judge and members of the court and counsel are the same as in a special court-martial. The principal difference between the two is the greater severity of punishment possible in the general court-martial. Any of the punishments authorized in the UCMJ for the offenses the accused is found to have committed may be awarded by a general court-martial. These include death (for desertion in time of war, mutiny, sedition, or spying), confinement for life or a set number of years, dishonorable or bad conduct discharge (for enlisted), dismissal of an officer, and total forfeiture of pay during the remaining period of a person's obligated service. Convictions and punishments involving the death penalty require a unanimous decision by all twelve members of the court. All other convictions and punishments require a two-thirds majority, except for punishments involving more than ten years' confinement, which require a three-fourths majority.

Review of Courts-Martial

After a court-martial has been completed, the convening authority performs an automatic review to make sure that the trial court acted correctly, the accused person was not denied any rights to which he or she was entitled, and any sentence adjudged was not illegal or too severe. Recommendations from a staff judge advocate or legal officer will be given as necessary. After this careful review the convening authority may approve or disapprove the finding and sentence, and may change either or both of them. He or she may reduce or suspend the sentence or change it to a different one, although the severity of the punishment cannot be increased. When a trial results in an acquittal (finding of "not guilty"), the convening authority may not change it or send the case back for retrial.

This review process is similar to the appeal of a conviction of a civilian in a civil criminal court, except that in the military the review is done by higher authority in the chain of command and is automatic. An appeal of a civil criminal court conviction is made to a higher court in the system, and will be granted only if reasonable grounds for one can be shown.

In the case of a summary or special court-martial, the convening authority forwards the trial record, along with recommendations, to the next superior with general court-martial jurisdiction for that officer's review. There, the staff legal officer furnishes a second legal opinion on the case. The senior may override the convening authority's recommendation if an error is found, call for a retrial, set aside in whole or in part findings of guilt and the sentence, or mitigate or suspend any part of an unexecuted portion of the sentence. Again, an acquittal may not be changed, nor any punishment increased.

A finding of any court-martial that awards a bad conduct discharge must be sent beyond the officer exercising general court-martial jurisdiction to the Office of the Judge Advocate

General (JAG) of the Navy. There, a Court of Military Review consisting of a three-judge appellate review panel carefully reviews every case in which an approved sentence affects a flag officer, or in which a sentence imposing the death penalty, dismissal of an officer, a dishonorable or bad conduct discharge, or confinement for one year or more has been imposed.

Above the Court of Military Review is a "supreme court" of military justice, the Court of Military Appeals. This court is composed of three civilian judges appointed by the President and confirmed by the U.S. Senate. An offender whose conviction has been upheld by the Court of Military Review has the right to petition the Court of Military Appeals to review the case. Such appeals are not automatic. If the petition is granted, the convicted person is entitled to a lawyer who will prepare a brief and argue the case before the court. Civilian counsel may be employed if desired.

Civil Jurisdiction

Military service does not free a person from the obligation to obey laws governing the civilian population when he or she is among them. Military personnel are subject also to civil courts when they are within civil jurisdiction. In general, offenses committed by a service person off base in civilian clothes against a civilian, or against some element of the civil government, lack the necessary service connection to make them military offenses punishable under the UCMJ. Since there are many possible sets of circumstances, it is often necessary for a court to make the determination as to whether or not the offense was service connected.

Examples of civil cases of this type that have occurred include not paying personal debts, wrecking a borrowed car, damaging furniture in a hotel, speeding on city streets, assault, and disorderly conduct out of uniform in a public place. While these cases may initially fall strictly within civilian jurisdiction, they may also become involved with military law. For instance, suppose the local police file speeding and drunken and disorderly charges and hold the service person in jail pending disposition of the case. If that imprisonment extends beyond the time of authorized leave or liberty, the service person is then chargeable under the UCMJ for unauthorized absence. Additionally, the person could be charged under article 111 for drunken or reckless driving and under the general article for bringing discredit upon the Navy.

If a service member is held by civil authorities, immediate steps should be taken to notify the CO. If the person is acquitted of the charges, military charges normally will not be filed for the period of enforced absence. If the accused is found guilty and detained, the entire period of absence is considered as lost time for pay purposes, and that period is charged as unexcused absence.

Separations from the Service

Separation or discharge from the military service by award of a court-martial is considered an extremely severe punishment. A bad conduct discharge may be awarded by either a special court-martial or a general court-martial; a dishonorable discharge may be awarded only by a general court-martial.

Less severe separations from the service, however, may be administered in special cases under the UCMJ and other legislation and statutes established by Congress. Officers may have their commissions revoked prior to the time they complete three continuous successful years of commissioned service. This may be for disciplinary reasons or for other overriding needs of the service. Regular Navy officers holding permanent commissions may be discharged if their performance is adjudged unsatisfactory at any time prior to completion of twenty years of service. Lieutenants (junior grade) and lieutenants are subject to discharge if they twice fail selection for promotion. An officer facing disciplinary action may submit a resignation from the service; if the Secretary of the Navy accepts the resignation, the separation will be effected.

The "character" of the discharge from the naval service is very important. The separation may be "under honorable conditions" or "under conditions other than honorable." The character of the discharge represents the opinion of the Navy concerning the circumstances of the separation. This character is very important in connection with veterans' benefits such as GI Bill education, reemployment rights, and pensions. Further, many employers are inclined to refuse employment to persons who have an inferior type of separation from the armed forces. Most large employers and professional schools inquire deeply into armed forces experience and the character of the separation received. They often prevent entry into their company or school if the conditions are other than honorable.

Administrative separations with either character of discharge are also legally permissible under certain conditions. Broadly grouped under a heading of "undesirable," such conditions include incompatibility with service life; educational level and potential below-minimum standards (which precludes advancement to higher pay grade); persistent irresponsibility in financial management (which tends to bring discredit upon the Navy); and immoral standards of conduct evidenced by drug use or alcohol abuse, failure to pay just debts, repetitive sexually transmitted disease infections, or other abnormal social behavior.

Critical Thinking

1. Compare and contrast the rights of the accused under U.S. civil law as opposed to military law. Under which system, if either, do you think the rights of the accused are better protected?
2. What are the fundamental differences between lawful conduct of corporate officers in civilian life as opposed to leaders in the military services?

Study Guide Questions

1. Why must discipline be handled in a consistent manner?
2. What is the basic difference between arrest and restriction?
3. Who may place offenders on report, and under what circumstances?
4. What is the purpose of the executive officer's screening mast?
5. What five judgment possibilities exist for the commanding officer after hearing a mast case?
6. What are the three types of courts-martial, in ascending order of the severity of the punishments that may be awarded?
7. What is unique about the tasks of a summary court officer?
8. What are the duties of the convening authority concerning a court-martial?
9. What are the tasks of a military judge if assigned to a four-person special court?
10. What are the court duties of the trial and defense counsels?
11. What is a peremptory challenge?
12. What punishments may be awarded by a special court-martial?
13. Who may convene a general court-martial?
14. When may a general court-martial try civilians?
15. A. What punishments may be awarded by a GCM?
    B. What are the requirements for the imposition of the death penalty, as opposed to other possible penalties?
16. What is the purpose of a court-martial review?
17. How does the military review of a court-martial compare with an appeal of a conviction in a civil criminal court?
18. What are the functions of the Court of Military Review and the Court of Military Appeals?
19. When are service personnel subject to civil law?
20. What two kinds of adverse discharges may be awarded by courts-martial?

New Vocabulary

arrest
restriction
breach of discipline
infraction
allegation
self-incrimination
mitigation
extenuation
jurisdiction
nonjudicial punishment
custody
reprimand
peremptory challenge
appellate
convening authority
dishonorable discharge
administrative discharge
court-martial
captain's mast
bad conduct discharge

Unit 4

International Law and the Sea

Just as there are dealings, arrangements, and contracts between people and companies, so there are international relations among the different countries of the world. These relations have evolved over many centuries, during which time the countries have developed their own culture, language, traditions, and codes of law. Each nation has always considered its most important objective the protection of its people and its boundaries against outside threats. Various countries have devised many concepts and policies to assist in this endeavor, such as isolationism, alliances, diplomacy, and powerful armed forces. They have worked out commercial and trade agreements to benefit their economies. They have cooperated to exchange culture and science. They have established the International Court of Justice and the United Nations as means of settling disputes. And they have gone to war with each other for good reasons and bad, both to survive and to conquer.

During the course of these events, the nations of the world have developed a body of rules under which they deal with each other. These rules, and their application, are called **international law**. Some of this law is formal, set forth in treaties and agreements, and some is informal, unwritten yet legally binding because of tradition and custom. The need for such a body of law has become increasingly great as the world has become increasingly more complex. Near-instantaneous communication, rapid travel, and the increasingly interdependent nature of the world economy all give rise to the need for an effective body of international law.

This unit provides an overview of international law and the collective security arrangements that govern much of the present-day relationships among the sovereign states of the world. It also discusses the fundamental precepts of the international law of the sea and the laws of war at sea.

13

Fundamentals of International Law

In order for nations to be able to conduct relations with each other on matters such as trade, exchange of money, tourists, boundary questions, communications, mail, and a host of other subjects, each of the contracting parties must be an independent and sovereign state. This means that the nation is free of foreign control and is able to conduct its own business in a legal manner.

In the United States, the Department of State handles most of our government's relations with other nations. Often, the business between our nation and others is conducted by our **ambassadors**—senior accredited diplomats who represent our government in the capitals of the world. These ambassadors, on direction of our government, often engage in talks called **negotiations** with representatives of the host government. From these negotiations come treaties of friendship, military alliances, and commercial agreements that are mutually beneficial.

International Law and Diplomacy

In order to reach an understanding of what international law is, it might be helpful to consider the two component words individually. *International* means between nations, or between citizens of different nations. *Law* may be defined as "all the rules and principles of human conduct established and enforced by the authority, legislation, or custom of a recognized governing power." In combination, *international law* is "the system of rules and principles, founded on treaty, custom, precedent, and consensus, that civilized sovereign nations recognize as binding on the mutual relations between them." Some of this law is formal as prescribed in treaties and agreements, and some is informal, unwritten but legally functional because of tradition and custom. International law is divided into *public* and *private* bodies of law. The former deals with relations between sovereign states, and the latter with relations between individuals in different countries. Public international law is our main focus here.

The United States has always regarded international law as an important part of our national laws. In fact, the Constitution itself directs that treaties form part of the supreme law of the land. Likewise, the Supreme Court has ruled that international law is part of the law of the land, and must be administered by U.S. courts of law whenever legal questions arise in litigation.

Former Secretary of State Dean Rusk once emphasized the importance of international law to Americans by explaining that

> law is the guardian of the presumption of good faith, which is the cement that holds our society together. In international affairs the steady consolidation of the rule of law is the alternative to the law of the jungle, and is an essential condition, in this nuclear age, for the survival of man. The law plays a vastly more important role in world affairs than occurs to most people. It provides international goals to which we must bend our national efforts . . . forms the basis for collective action by which nations guard the peace . . . knits together countries in an ever stronger fabric of agreements about common policies and goals . . . [and] provides the tools with which mankind can deal with the utterly new problems we encounter on the Earth and in space around it.

Diplomacy is defined in the *Oxford English Dictionary* as "the management of international relations by negotiation, and the method by which these relations are adjusted and managed by ambassadors and envoys." The main point to emphasize is the method of negotiation. Diplomacy is a substitute for force. It is the means of obtaining the maximum benefit to the nation without resort to force while keeping and improving friendly relations with other nations.

Diplomacy always depends in some degree on the power—military, economic, moral, or allied—of the state on whose behalf the diplomat is acting. There may or may not be a threat of force, but without any power behind it, there is no likelihood of meaningful success in any diplomatic negotiations over important issues between nations.

History of Diplomacy

The development of the art of diplomacy began well before the birth of Christ. The pharaohs of Egypt and other early rulers had agreements with rulers of other states concerning sovereignty, military assistance, refugees, and immigrants. The Greek city-states of Athens and Sparta built on this early experience, and by the time of Plato, about 400 BC, they had developed and defined treaty law and methods of negotiation, principles of international arbitration, the rights and duties of aliens, the immunity of ambassadors, and the right of asylum.

During the Middle Ages, relationships based on diplomacy began between the kingdoms on the Italian peninsula. Venice, Florence, Genoa, Rome, and Naples, among others, were essentially independent city-states that were either at war or in alliances with each other much of the time. Agents called *ambassadors* were sent from one city-state to another to conduct the relations between them. The dwellings in which they lived on the foreign soil became known as **embassies**.

In the beginning, many of these ambassadors were merely spies, using bribes, lies, and other disreputable means to steal political documents or gain information of potential value to their rulers. Undoubtedly the most famous of these early diplomats was Niccolò Machiavelli of Florence. In 1513 he wrote *The Prince*, which described his experiences and the often unscrupulous diplomatic practices of the time. Not all European ambassadors went to such extremes, but there is little doubt that the term **Machiavellian**, which to this day is used to describe unethical political activities, applied to many of the royal courts of that time. Being an ambassador in these early days was not always conducive to long life, since bearers of bad news were sometimes executed.

In the late fifteenth century the Republic of Venice became the first government to establish permanent resident embassies in other countries. During the sixteenth century many of the Italian states developed two specialized government services: the **diplomatic service**, which looked after political matters, and the **consular service**, which concerned itself with trade and commerce. These two services together brought about closer relations between the states and formed the basis for modern international law.

Sources of International Law

International law is not compiled into a handy text that you can draw from the library. It is, rather, a body of law that has developed from a number of sources, some of which are unwritten. The International Court of Justice in The Hague, Netherlands, which rules in cases on the basis of "internationally accepted law," has provided that international law may be based on the following:

- International treaties, conventions, and executive agreements.
- International custom (customary law) and general practice long established.
- General principles of law and humanity as recognized by all civilized nations.
- The commonly accepted works of highly qualified publicists (writers) and scholars in the field of international law such as Hugo Grotius, who as noted in chapter 11 wrote the landmark book on Dutch jurisprudence. He authored numerous other writings on natural law and the laws of war, including in 1625 the treatise *On the Law of War and Peace*, which had a profound impact on the development of international law. In tribute to his body of work he is nowadays referred to as the "Father of International Law."
- The decisions of various national courts, including admiralty, prize, and consular courts.

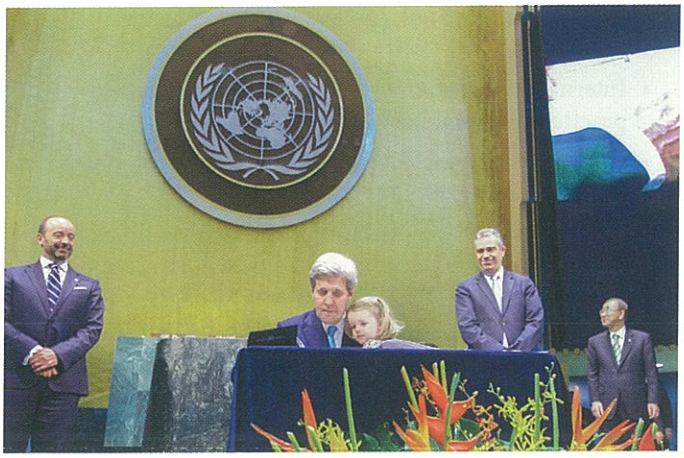
Additionally, certain diplomatic correspondence contributes to the body of international law, in that these papers are a source of information regarding the attitude of states toward particular problems. Over a period of time this correspondence can gain international acceptance as definitions of what the law is concerning particular issues.

Treaties, Conventions, and Agreements

Treaties, conventions, and agreements in various forms are sources of international law that legally bind countries together just as a contract binds the parties to it under national law. A **treaty** is a formal written accord between independent nations specifying various rights and duties, and depends for its enforcement on the interests and honor of the governments that are parties to it. Breaking a treaty will normally result in international repercussions at the least, and in extreme cases may lead to war. Treaties mostly cover the more vital areas of international relations, such as political commitments, military alliances, and settlement of territorial claims. A *bilateral treaty* is a treaty between two parties, and a *multilateral treaty* involves three or more. A *charter* is a particularly formal and solemn treaty, such as the Charter of the United Nations that established that organization in 1945.

Conventions are multilateral treaties with a broad number of parties, often negotiated under the auspices of an international organization like the United Nations, such as the Law of the Sea conventions that will be discussed in chapter 14.

The term ***agreement*** can apply as a generic term to any international accord or *instrument* recognized by international law or, more traditionally, to any such instrument less formal than a treaty. Among the latter are *oral agreements* between heads of state or other government representatives; *declarations*, nonbinding international agreements that set forth



Secretary of State John Kerry, with his granddaughter Isabelle looking on, signing the COP21 Climate Change Agreement on behalf of the United States in April 2016 at the UN General Assembly Hall in New York.
State Department photo

aspirations and understandings; an *exchange of notes* between two governments, recording a routine agreement or understanding on an issue; and *protocols*, instruments that amend treaties and conventions or establish additional rights or duties under them. In recent years the term has also been adopted to designate accords entered into within the framework of constitutional treaties establishing regional organizations such as the European Union (EU) and the Organization of American States (OAS). The EU, for example, was formally created by the Maastricht Treaty on European Unity in 1993, but treaties concluded since then between the EU and other countries are usually designated agreements. In modern international law, the generic term *agreements* is now the preferred term for *any* international accord, including even treaties.

The Sovereign State

The terms *country*, *nation*, and *state* are commonly thought of as synonymous, but there are subtle differences in their precise meanings under international law. ***Country*** generally refers to the territorial limits or geographic boundaries on a map. ***Nation*** pertains to people and their common blood ties, language, customs, and, perhaps, religion. The word ***state*** stresses the governmental authority of the political entity.

In discussing international law, we normally are talking about the relationships between **sovereign states**—that is, legal entities that are considered capable of speaking for themselves. Under customary international law as codified (formalized) by the 1933 Montevideo Convention and signed by the United States and fifteen major South American nations of that time, a sovereign state has four specific characteristics:

- a permanent population
- a defined territory free from control of any other state
- an established government
- the ability to enter into associations with other states

It is important to note that the geographic size of the state does not affect its sovereignty; the prime consideration is whether or not the state is independent of any outside jurisdiction (control). The tiny states of Luxembourg and Monaco are examples of this. The traditional doctrine of sovereignty also includes the right of a state to decide how to conduct its international affairs, and to resort to war when judged necessary to defend its national interests.

Sovereign states send diplomats to other sovereign states and conclude treaties with one another without interference. They are expected to live up to their treaty commitments, though an absolute definition of the term *sovereignty* would imply complete freedom to break treaties as well as make them if it is in the national interest of the state to do so.

While most of the world today is composed of sovereign states, there are some political entities that have a status that differs somewhat from the strict definition of the word. Switzerland, for instance, has been officially regarded as a **neutralized state** since the Congress of Vienna in 1815. It has been successful in maintaining its neutrality and, consequently, avoiding any invasion of its territory or involvement in any war since that time. The formal permanent status of **neutrality** or neutralization by a treaty guaranteed by other states differs from self-proclaimed neutrality, which is the voluntary nonparticipation in a particular war. There are no guarantees in such neutrality other than the rights normally granted to neutrals in time of war by international law.

The Commonwealth of Nations (formerly known as the British Commonwealth) is a unique group in international law comprised mainly of nations that were at one time under British colonial rule. Great Britain and its dominions of Australia, Canada, New Zealand, and some fifty other countries enjoy complete sovereignty and independence in their internal and external affairs but acknowledge an ideological allegiance to the British crown based on common tradition and economic interest. India, for example, remains a member of the Commonwealth even though it is a republic with no ties to the crown.

Rights and Duties of Sovereign States

All sovereign states have certain rights, and with them, associated duties. Although there has never been complete agreement among the nations of the world as to exactly what all the rights and duties of a sovereign state should be, some rights are universally regarded as fundamental: specifically, the right of continued existence, the right to freedom from interference or

intervention, and the right of self-defense. The associated duties are to refrain from attempts to intervene in the internal affairs of other states, occupy their territory or otherwise coerce them, or to use aggressive military force against them. These rights and duties are so basic that they have always been reserved for interpretation by each state in accordance with its own national policy, with each state free to determine its own policies and conduct in upholding these rights and complying with these duties. This implies that a sovereign state can do no wrong when acting on these matters in its own behalf—a situation that makes the quest for peace in a warlike world difficult.

Each state has the right of equal access to international courts. Also, each one can control its diplomatic relations with other countries. While all do not maintain diplomatic missions in every country, most have **accredited** (formally appointed) ambassadors who visit those countries regularly, even though they might not reside there. States have the right to enter into treaties and other agreements with other states on matters of common interest.

The rights of existence and self-defense are of special interest to the armed forces of a nation. Of particular importance in this regard is the long-recognized legal right under international law for a threatened state to take military action in self-defense, in some cases even before an attack is clearly imminent. For example, if a given state builds up its forces, that is considered sufficient grounds for a neighboring state that feels threatened to respond with a similar buildup in its own defense. Going a step further, the state being threatened has the right to wage *preemptive war* in self-defense by making a first strike when attack is imminent. However, *preventive war* in the absence of a confirmed imminent threat without the approval of the United Nations is prohibited under modern international law, since such a war by definition is based on the presumption that there *might* be an attack and not on the basis of proof that an *actual* attack is imminent.

This is the gist of arguments that have persisted to this day over the legality of the invasion of Iraq by the United States in 2003. According to President George W. Bush, as annunciated in his Bush Doctrine at that time, the United States had a right to launch a *preemptive* invasion into Iraq because the threat posed by rogue states such as Iraq and terrorists it harbored being equipped with weapons of mass destruction (WMD) was so severe that it justified such a measure. Opponents have argued ever since, however, that this was instead an illegal *preventive* attack, because even if Iraq and any al Qaeda terrorists operating within it had indeed been in possession of such weapons, an attack by them was not considered *imminent*, as required by international law to justify such an action. Subsequent failure to find WMD in Iraq has given further support to the opponents' case over the years since, notwithstanding other relevant circumstances that existed at the time.

As stated above, for each right there is a corresponding duty in international law. For instance, duties of **belligerents** (states at war with each other) to observe treaties, care for prisoners of war, follow rules of warfare, protect aliens, protect human rights, and so forth are considered duties of states under the law. The fact that some nations have varying interpretations of the law does not exempt them from their responsibilities.

Diplomatic Recognition

Sovereign status can be attained in a number of ways. The act whereby one sovereign state recognizes the sovereign status of another is called **diplomatic recognition**. Such recognition of a state can be done either ***de jure*** (by law) or ***de facto*** (in fact). The former refers to the formal legal recognition of a state, most of the time because it satisfies the four criteria for a sovereign state mentioned earlier, while the latter refers to recognition of the actual circumstances that exist, as, for example, if one state unlawfully takes and establishes permanent control over the territory of another. Diplomatic recognition, either de jure or de facto, can be a declaration to that effect by the recognizing government or an act of recognition such as entering into a treaty with the other state. Former colonies may be granted sovereignty by their mother country. A vote by a country in the United Nations in favor of the membership of another country is considered an implicit recognition of that country by the country so voting, because only sovereign states may be members of the UN.

The acceptance of the new state into the world community of nations by other sovereign states, however, is largely a matter of the foreign policy of each state. For example, the United States's view is that membership in the United Nations does not in itself constitute sufficient grounds for de jure recognition by our government, especially in cases where the United States has not so voted. Our relationships with many of the unrecognized states in the UN, therefore, are only de facto. There may be some cultural or commercial understandings, or low-level exchanges of consular missions, but no formal diplomatic recognition and exchange of accredited ambassadors has occurred.

If a sovereign state has a serious issue with another state regarding its continued right to exist, it may withdraw diplomatic recognition of that state. However, withdrawal of recognition of one state or government in a geographic area must be accompanied by recognition of another, according to most authorities on international law. Therein lay the legal problem concerning the United States's longtime recognition of the Nationalist Republic of China, with its seat of government in Taipei, Taiwan, as the de jure government of China following the end of the Chinese Civil War in 1949. In 1972 the United States opened an American affairs mission in Peking, seat of the government of the Communist People's Republic of China, acknowledging its de facto presence. The United States

considered it contrary to U.S. interests in Asia to officially recognize and exchange ambassadors for thirty years after the People's Republic was established. But on 1 January 1979, the United States withdrew formal diplomatic recognition of the Taipei government, while retaining cultural and commercial relations with it, and formally recognized the People's Republic as the de jure Chinese government.

There is, however, a step short of formal withdrawal of de jure recognition that nations more often exercise when cooperation between them becomes very difficult for whatever reason. This is called a **breach** or **break in diplomatic relations**. In this procedure, ambassadors are recalled, consular stations are closed or drastically reduced in size and number, and treaties either remain in force or are suspended for the duration of the breach, depending on the circumstances. This is the relationship that had been in effect for many years between the United States and Cuba until President Barack Obama reestablished formal diplomatic relations in 2015. A breach of formal diplomatic relations had existed since 1961, when then head of state Fidel Castro announced to the world his communist affiliations and alliance with the Soviet Union. (When diplomatic relations were severed, the United States made it clear that it considered the treaty granting America rights to the naval base at Guantánamo Bay remained in full force. Both nations continued to observe the treaty during the entire time that a breach of diplomatic relations existed, and they continue to do so at this writing.)

Diplomatic Missions and Staffs

Independence in foreign affairs carries with it the right to diplomatic representation. The right of a state to have representatives in other states for carrying on diplomatic negotiations, and to receive similar representatives from others for the same purpose, is called the **right of legation**. This is somewhat misleading, however, because a state is not *required* to send or receive diplomatic envoys; the exercise of this right depends on the mutual consent of the nations involved. However, most states presently exercise the right of legation. It is general practice for the receiving state to accredit the chief or head of mission as the sending nation's authorized representative upon official presentation of the appropriate credentials to the chief of the state and its foreign office.

A permanently established site at which a diplomatic mission is established in a foreign country, along with the mission's staff, is called an *embassy*. An embassy is usually located in the capital city of a foreign nation; there may also be subordinate stations called **consulates** located in other major regional cities. An embassy or consulate is considered part of the territory of the country it represents. International rules, therefore, do not allow representatives of the host country to enter embassies or consulates without permission—even for emergencies like putting out a fire—and consider an attack on them as an attack on the country they represent.

The Vienna Convention on Diplomatic Relations of 1961 established the three classes of heads of diplomatic missions that are currently accepted by the United States and most other nations: *ambassadors* accredited to heads of state; *envoys* and *ministers* accredited to heads of state; and *chargés d'affaires* accredited to ministers for foreign affairs. The three are considered equals when serving as heads of missions (except in the areas of precedence and etiquette observed at official functions) and are considered the personal representatives of the head of state of their country. A **chargé d'affaires** is the lowest rank of a head of mission.

A typical American embassy is fairly representative of most nations' embassies throughout the world. Within the embassy, the ambassador or other head of mission is supported by a deputy chief of mission, various commissioned Foreign Service officers and other specialists who perform routine duties, and representatives of many other U.S. agencies, such as the Departments of Defense, Commerce, Justice, and Agriculture. The main building of the embassy is called the *chancery*, and there are usually other additional buildings that house the staff offices. For security the embassy compound is usually surrounded by a high wall or fence, with a main gate guarded

The U.S. embassy in London, England. *Veedar*

The U.S. ambassador's residence in Dublin, Ireland. *Noelfirl*

by a U.S. Marine detachment. The head of mission's residence, especially an ambassador's residence, is often used for diplomatic and public functions. It is sometimes located inside the embassy compound as well, but more often is elsewhere in the city.

Consulates are headed by a lower-ranking diplomat called a **consul general** who reports to the head of mission at the embassy. Consulates carry out many of the same functions in provincial or regional capitals that the embassies do in national capitals.

According to international law, so long as the embassy diplomats and their staffs conduct themselves in an overt and law-abiding manner, and do not attempt such things as bribing officials, stealing documents, or taking sneak photos of forbidden areas, the host country welcomes them and their families and gives them special privileges, including **diplomatic immunity** (freedom from arrest or prosecution for alleged violations of host country laws). If they are caught violating this trust or intentionally breaking the law, however, the host government may declare them ***persona non grata*** (not acceptable) and demand that they be recalled. In an extremely serious case like murder or espionage involving major threats to national security, the host country may request a **waiver** (relinquishment) **of diplomatic immunity** by the accused's home country in order to prosecute the wrongdoer, but this is relatively rare. Overt intelligence collection is a legitimate duty of diplomats, so they are not considered to be spies under international law.

Diplomatic immunity may or may not be accorded to consulate staff by the countries in which they are located, and in some cases it applies only to performance of official duties.

Military Attachés

Among the DOD personnel assigned to American embassies and consulates are the various *military attachés* who report to the DIA and their associated military services. Military attachés are regarded as high-ranking members of the official staff. They and their families enjoy the same diplomatic immunities and protection as the other staff members.

Military attachés of the United States are selected by their services and assigned by the Defense Attaché System under the DIA to American embassies and consulates overseas. They are required to be officers in pay grades from O-4 to O-6 (Navy ranks from lieutenant commander to captain) and may come from any of the armed services and the Coast Guard. The senior attaché, regardless of service, is called the *defense attaché*; any others assigned are called *assistant defense attachés*. The latter are also identified in accordance with their branch of service as a **U.S. naval attaché**, **Army attaché**, or **air attaché**. Officers from the Navy, Marine Corps, and Coast Guard are all eligible to serve as naval attachés. Warrant officers and senior enlisted personnel may also receive assignments through the Defense Attaché System as administrative support staff in embassy and consulate defense attaché offices.

A group of foreign naval attachés receive a briefing at a naval warfare center lab in Corona, California. DOD encourages such interactions with attachés of other countries. *Greg Vojtko*

The U.S. naval attaché has traditionally been termed the **ALUSNA**, the acronym for American Legation, U.S. Naval Attaché.

Collective Security

The idea of forming an international organization for the purpose of peacefully settling disagreements between nations was proposed after every major war, beginning with the Congress of Vienna following the abdication of Napoleon Bonaparte in 1814. After World War I, substantial progress was made toward this goal with the formation of the League of Nations. Although the league failed to preserve peace and was ultimately disbanded, it provided the world with valuable experience in the association of states to settle political, economic, and social problems by peaceful means. Following World War II, on 24 October 1945, the United Nations Organization officially came into being with the ratification of its charter by the majority of the original fifty member states. There are currently 206 member states in the UN.

The United Nations

The UN's basic purposes are to maintain international peace and security; to take effective collective action to prevent or mitigate (reduce) threats to world peace; and to cooperate in solving international economic, social, cultural, and humanitarian problems. To accomplish these goals, the principle of the sovereign equality of all members is recognized. All members have agreed to fulfill the obligations of the charter, to settle their international disputes by peaceful means, and to give the UN every assistance in any action it takes in accordance with the charter.

UN headquarters in New York. The tall, rectangular building to the left is the UN Secretariat, with the Conference and Visitors Center below, and the low building in the center with a partial domed roof is the General Assembly. *Neptuul*

Action in the UN is centered mainly in the Security Council. The council comprises fifteen members. The five major powers—the United States, Great Britain, France, Russia, and the People's Republic of China—are permanent members, and ten other nonpermanent member nations are elected for two-year terms. Procedural matters acted on by the council require at least nine affirmative votes for passage. In all substantive measures, however, the nine affirmative votes must include those of the five permanent major powers for passage. If any one of the so-called Big Five casts a negative vote, called a **veto**, the measure is defeated. Known as the Yalta Formula, this voting arrangement was based on the assumption that if the Security Council was to carry out its UN responsibility effectively, agreement of the five major world powers was essential for any real action.

The UN Security Council can make recommendations and pass measures to maintain or restore international peace and security whenever it identifies the existence of any threat to the peace, breach of the peace, or act of aggression. These measures may be actions not involving the use of armed forces, such as economic sanctions (penalties) or severance of diplomatic relations; or the action may be military operations by air, sea, or land forces to maintain or restore peace. The charter obligates member nations to place armed forces under UN command to carry out whatever military actions are decided upon by the council.

International, Regional, and Collective Arrangements

In addition to the power of the Security Council to take action in cases of aggression, the UN charter specifically recognizes the right of members to act in self-defense, individually or collectively. The charter suggests possibilities of such arrangements, including regional associations, and allows such treaties as long as their activities are consistent with the purposes and principles of the UN. On this legal basis, the United States and most other nations have concluded many such treaties with states having common concerns. Membership in such regional organizations and **collective defense pacts** (regional defensive alliances) has given the United States major military and economic commitments with some forty nations throughout the world. In addition, the United States has concluded defense pledges or agreements with about 30 additional countries and has negotiated economic foreign aid deals with some 140 of the current 206 member states of the UN. Our present worldwide collective security system has bound us to defend Latin America, Western Europe, and almost every noncommunist state in the western Pacific.

Regional organizations are arrangements between member states designed to address many of the political, technical, cultural, and educational problems that are of concern to the UN and its functional organizations. "Regional" does not necessarily imply a common geographic region, but rather that the countries in the pact have common interests in a given region.

Collective defense pacts are designed, as their name implies, for mutual and collective self-defense. Their legality comes from the fundamental right to self-defense recognized by the UN charter. Since this is a right of all sovereign states, a nation need not hold membership in the UN to be a party to such a treaty.

A key provision of all these pacts is that an attack on one member state is considered an attack on all, and the other member states will come to its assistance. The knowledge that an attack on any member will result in collective and individual action by all parties to such a pact makes aggression much less probable, and consequently such treaties are a strong deterrent to any potential aggressor nation.

The United States has been closely involved with the security of all the countries in the Western Hemisphere ever since 1823 when the Monroe Doctrine was annunciated. The doctrine stated that the United States would henceforth regard as an unfriendly act any attempt by a European nation to interfere in the affairs of the American countries or increase its possessions on the American continents. The resulting regional solidarity among the American states that has endured since has set an example for the world and has become the model for many other regional treaties and declarations.

In 1948 an organization that comprised almost all of the thirty-five independent states of the Western Hemisphere was formed (Cuba dropped out in 1962). Called the Organization of American States (OAS), its aims are to promote peaceful settlement of disputes among member states; to provide for collective security; and to encourage cooperation in economic, social, and cultural matters. Largely anticommunist in its philosophy, the OAS is based on the general principles of the

Map showing the current composition of NATO and the dates of entry of its members. *NATO*

Monroe Doctrine, especially the provision that an attack on one American state will be considered an attack on all. Most of the business of the OAS is conducted in its general assembly, which meets once a year.

Another very important regional defense pact in which the United States is a key member is the North Atlantic Treaty Organization (NATO) formed in 1949 in the early years of the Cold War. It is somewhat similar to the OAS, except that its primary purpose is collective defense. Like the OAS treaty, the NATO agreement states that an armed attack against one member shall be considered an armed attack against all members, and it provides for measures to meet such an attack. The North Atlantic treaty also endorses the doctrine of mutual aid, under which the United States has long provided our NATO allies with arms and equipment in order to develop their "individual and collective capacity to resist armed attack."

Based on the NATO concept, legislation for foreign military assistance has been enacted by Congress not only for NATO members, but also for other countries in our mutual defense system such as Japan and the Philippines, with whom we have bilateral treaties. A key consideration in these pacts is mutual assistance; that is, the involvement of other countries in assisting and contributing to their own defense. A good example of this is NATO and other allied countries making available areas for U.S. overseas bases, an extremely valuable contribution to the mutual defense effort. From 2004 to 2011 NATO undertook extended training and support missions in Iraq in support of the U.S. efforts there, and combat missions during the war in Afghanistan from 2003 to 2014. In the latter case, its participation marked the first time that the "attack on one is an attack on all" provision was formally invoked.

The membership of NATO consists of the United States, Canada, Iceland, most of the nations of northern and Western Europe, Greece and Turkey, and, more recently, many of the former satellite states of the old Soviet Union. Notwithstanding its Cold War origin, the United States continues to regard NATO as a main bulwark against the expansion of Russia under its current president, Vladimir Putin, into the Ukraine and other territories controlled by the former Soviet Union, and for defense against militant groups and states in the Middle East, including ISIS/IL, Syria, and Iran.

Because the United States has historically provided more than 70 percent of the total direct (administrative) and indirect (military equipment) costs of operating the NATO alliance, for several years some members of Congress and other prominent individuals and commentators have urged that more pressure should be applied to other member nations to help sustain it; others have even begun to question the need for continued American participation in it at all. The Trump administration that took over the reins of government in January 2017 has echoed many of these same sentiments. It will be interesting to see how or if these concerns are addressed in future years.

Critical Thinking

1. Research the legal rights of foreign diplomats accused of a crime in the United States. Under what conditions do diplomats receive full diplomatic immunity?
2. Research the main types of economic foreign aid currently given to more than 140 foreign countries by the United States, and the total dollar amount of this aid being furnished in the most recently completed calendar year.
3. Select one of the collective defense arrangements of which the United States is a participant and research the legal obligations of the United States with regard to it.

Study Guide Questions

1. What are the official representatives of our government in foreign capitals called?
2. What is the body of rules that has evolved to regulate many of the relations between nations called?
3. What aspect of international law pertains to relations between sovereign states?
4. How does the U.S. Constitution regard international treaties?
5. What is diplomacy?
6. Where did the principles of early international law originate?
7. Which official world body rules in cases involving application of international law?
8. Under international law, what are treaties, conventions, and agreements?
9. Under international law provisions established in 1933 by the Montevideo Convention, what four characteristics are necessary for a state to be regarded as sovereign?
10. What unique relationship still applies between Britain and its former colonies?
11. A. What are universally regarded as the fundamental rights of a sovereign nation?
    B. What are the associated duties of a sovereign nation?
12. What are the legal rights of a nation if it is threatened by another country?
13. A. What is the act whereby one sovereign state recognizes the sovereign status of another?
    B. What are the two forms by which this can be done?
14. What is the step short of formal withdrawal of diplomatic recognition that countries may take when cooperation between them becomes very difficult?
15. What is the right of legation?
16. A. What is the permanently established site at which a diplomatic mission is established in a foreign country?
    B. Where is it usually located?
    C. What are subordinate stations located in provincial or regional cities called?
17. What are the three classes of heads of diplomatic missions?
18. A. What is meant by diplomatic immunity for embassy diplomats, staff, and their families?
    B. What may a host country do if an embassy staff member violates its trust or intentionally breaks the law?
19. A. What is the title of the senior U.S. military service attaché assigned to an embassy?
    B. What does the acronym ALUSNA mean?
20. What is the basic purpose of the United Nations?
21. Who are the five permanent members of the United Nations Security Council?
22. What actions can the Security Council take to maintain or restore peace and security in a given world situation?
23. A. What areas of the world has our current system of security pacts bound the United States to defend?
    B. What are the two main collective defense arrangements in which the United States is an active participant?
24. What is the key provision of each of our collective defense treaties?

New Vocabulary

ambassadors
international law
embassy, -ies
diplomatic service
envoy
bilateral
conventions (law)
instruments (law)
protocols
nation (international law)
sovereign state
neutrality
preemptive war
belligerent
de jure
breach of diplomatic relations
consulates
consul general
persona non grata
ALUSNA
pact
negotiations
diplomacy
Machiavellian
consular service
treaty
multilateral
agreements (law)
declarations (law)
country (international law)
state (international law)
neutralized state
accredited
preventive war
diplomatic recognition
de facto
right of legation
chargé d'affaires
diplomatic immunity
waiver
veto

14

International Law of the Sea

The international law of the sea as we know it today has evolved over centuries from both tradition and formalized legal precepts and precedents. It consists of a body of customs, treaties, and international agreements by which order, productivity, and peaceful relations are maintained on the seas, and deals with navigational rights and procedures, mineral rights, and jurisdiction over internal and coastal waters. A closely related branch of international law called **admiralty law** is a combination of national and international law that deals with contracts, torts (civil damages), injuries, or offenses that occur on the navigable waters of the world.

Since ancient times the world has become ever more dependent upon the use of the sea for trade, transportation, and as a source of food. One of the oldest and most basic precepts of the international law of the sea, therefore, is a principle formally stated by Hugo Grotius, the "Father of International Law", in 1604: "No part of the sea may be regarded as pertaining to the domain of any given nation." It arises from the simple fact that it is not right for any nation to claim or reserve any part of the sea for exclusive use. The sea does not lend itself to possession or occupation, so any attempt to establish ownership would be difficult to defend either with logic in court or with military force.

For centuries up until the 1900s, a littoral nation's territorial sea was considered to extend out to three miles, the approximate maximum range of a cannon shot from a shore battery in the late seventeenth century. *Tiefkuehlfan*

Nevertheless, it had long been established that a sovereign coastal state with the right of self-defense should have the right of sovereignty over a narrow band of the sea adjacent to its coast for national security reasons. The appropriate extent of this band, however, became a major issue of contention among the major European seafaring nations, especially after the Age of Discovery began in the fifteenth century. Eventually by the seventeenth century most of the major European seafaring nations of that time came to the consensus that this *territorial sea*, as it came to be called, should extend out to three miles, the approximate range of a cannon shot from a contemporary shore battery of that era.

It was not until the early 1900s, when Imperial Russia claimed a twelve-mile offshore exclusive fishing zone, that the three-mile limit was challenged. After the Bolsheviks took over Russia, it was not long before they declared that this fisheries zone was in reality a territorial sea in which the Soviet Union had exclusive sovereign rights. As the twentieth century progressed, advances in technology, population growth with attendant demand for coastal sea resources, and political change resulting from two world wars caused much contention among governments worldwide not only on this issue but also many other hitherto widely accepted but never formalized conventions of the international law of the sea. Not surprisingly, the desire to form an international consensus on these issues became a major objective of the United Nations after its formation in 1945.

Precepts of the Law of the Sea

By the mid-twentieth century there were three main well-established precepts of the international law of the sea:

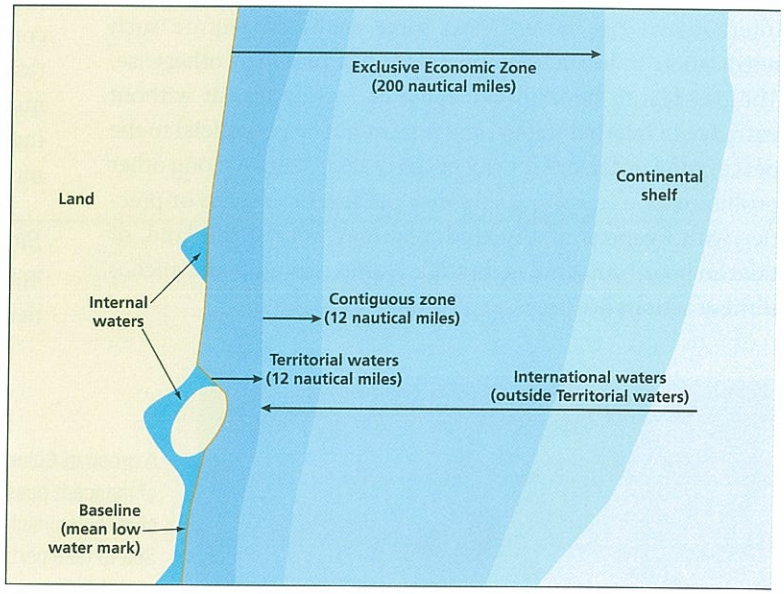
- **freedom of the high seas**, in which no nation could restrict any areas or resources to its exclusive use or sovereignty

- the **territorial sea**, which contended that coastal states had near absolute sovereignty over a narrow band of territorial waters adjacent to their coasts
- **special contiguous zones** extending beyond territorial seas, wherein special limited jurisdiction (lawful authority) prevails, and where neither the rules of the high seas nor territorial seas pertain

In order to try to iron out an international agreement that would formalize these and other related concepts under international law, the UN held several extensive Law of the Sea Conferences that met a number of times in 1956–82 "to develop rules for peaceful use of the seabed beyond the continental shelf to the entire spectrum of ocean uses." Ultimately, the third and last conference, which extended from 1973 to 1982 with some 160 nations participating, succeeded in drafting a number of conventions concerning these concepts that would henceforth become the accepted international law of the sea after they were formally ratified in 1994.

One of the main provisions, still in effect today, concerns the definition and limits of the various waters within internal and offshore areas of littoral (coastal) states, and the continental shelf. They are as follows:

- **Internal (inland) waters** consist of all waters and waterways within the boundaries of a coastal state inland of a carefully defined *baseline* or *line of demarcation* conforming to the low-water line of its beaches, except where the coastline is deeply indented, has fringing islands, or is highly unstable, in which cases a straight demarcation line may be used. Such straight lines are also extended across the mouths of various internal rivers, bays, and harbors along the coastline. The coastal state has complete jurisdiction in internal waters and has the right to set laws regulating them, including navigation rules, and the use of any resource in them. Foreign vessels have no right of passage within such internal waters.
- **Territorial waters** (territorial seas) extend out twelve nautical miles (22 km) from the baseline demarcation lines. Within them the coastal state may set laws, regulate use, and use any resource. Foreign vessels, including warships, have the **right of innocent passage** through them, defined by the convention as "passage in an expeditious and continuous manner" (the right of innocent passage through territorial seas will be further discussed below).
- **Archipelagic waters** consist of waters containing a group of islands composing an **archipelagic state** (such as American Samoa or the Philippine Islands) and are defined by a baseline drawn between the outermost points of the outermost islands. The archipelagic state has sovereignty over these waters similar to internal waters, but foreign vessels have right of innocent passage through them, similar to territorial waters.
- **Contiguous zones** extend out an additional twelve nautical miles beyond the limits of territorial waters. Within them the state can continue to enforce laws relating to customs, taxation, immigration, and pollution if an infringement action began within the state's territory, internal waters, or territorial sea. This is sometimes referred to as the right of **hot pursuit** (direct and continuous pursuit of an offender) within the contiguous zones.
- **Exclusive economic zones (EEZs)** extend from the outer edge of territorial waters out to two hundred nautical miles (370 km) from the baseline demarcation lines. Within this area the coastal state has exclusive rights of exploitation of all natural resources including fish and other sea creatures. Foreign vessels have freedom of navigation in these waters, and aircraft have freedom to fly over them, subject to the regulation of the coastal state.
- **The continental shelf** for purposes of the convention is defined as the *natural prolongation* (gradual downslope) of the land territory to the outer edge of the *continental margin* (transition to the deep ocean basin), or 200 nautical miles from the baseline demarcation lines, whichever is greater, but not to exceed 350 nautical miles (648 km) from the baseline or 100 nautical miles (185 km) beyond the 2,500-meter *isobath* (the bathymetric line along the seabed delineating the depth of 2,500 meters). Coastal states have exclusive right to any minerals or other nonliving material within their adjacent continental shelf. They also have exclusive rights to any living plants or creatures



The various coastal sea areas as defined by the UN Law of the Sea Conferences.
Historicair

attached to the continental shelf, but not to sea creatures living in the water beyond the limits of their EEZ.

The various applications of the law of the sea within each of these are discussed later in this chapter.

In addition to specifying the extent of and rights within the foregoing sea water areas, the Third UN Conference on the Law of the Sea also established general provisions for safeguarding the marine environment and protecting freedom of research on the high seas, and it established legal procedures under a new agency called the International Seabed Authority for the exploitation of mineral resources in deep seabed areas. As had been the customary practice for many years, landlocked states were formally given right of access to and from the sea without any taxation of traffic through the states transited.

To date, the conventions adopted by the Third UN Law of the Sea Conference have been ratified by some 166 nations plus the European Union. The United States remains among several nations that have not joined in ratifying the conventions, primarily because of certain provisions that would tend to limit freedom of navigation on the high seas, and because it has been resistant to the regulation of seabed mining by the International Seabed Authority. The United States does, however, still abide by almost all of the customary provisions of international law of the high seas embodied in the conference conventions.

Innocent Passage and Territorial Seas

Innocent passage is the right of vessels of one nation to navigate peacefully in an expeditious and continuous manner through the territorial waters of another nation. Although no advance notification or authorization is normally required under international law, nevertheless some states do require such notification unless a bilateral treaty has provided otherwise. The passage, to be innocent, must be merely transit without entrance to internal waters, and it must not be prejudicial to the peace, good order, or security of the coastal state. Among other prohibitions, a transiting ship may not fish or exercise or practice with weapons of any kind, and may not launch, land, or take on board any kind of aircraft. A ship may stop and anchor if these actions are necessary for safe navigation.

The coastal state must not hinder innocent passage. It must observe the principle of freedom of communication and prevent acts in its territorial sea that are prejudicial to the rights of other countries. It may not arrest anyone on board a transiting foreign ship for any crime except when it was committed within the coastal state. It must give adequate publicity to known dangers to navigation in its territorial sea. It can, however, protect itself from acts harmful to its security, and it may require that customs and health inspectors board the ship prior to its entry into internal waters if that is the ship's intention. The coastal state may temporarily suspend the right of innocent passage of foreign ships if this is necessary to protect its security or to conduct weapons exercises.

Foreign ships in passage through territorial seas must comply with the laws and regulations of the coastal state as well as the rules of international law. In particular, such ships must observe rules concerning:

- the international rules of the road for maneuvering
- the safety of traffic and protection of channels and buoys
- pollution of the waters
- conservation of the living resources of the sea
- the rights of fishing and hunting
- hydrographic surveys
- display of the ship's national colors and salutes as prescribed by the coastal state

Rules that apply specifically to submarines require that a submarine must transit a territorial sea surfaced and show its national flag unless a specific bilateral treaty provision exists to the contrary. Under international law, the coastal state may conclude that an unauthorized submarine submerged in its territorial sea constitutes intent to infringe upon its security. It may take whatever defensive actions it deems necessary, including sinking the submarine. Aircraft, including naval aircraft, must request overflight permission over a territorial sea.

Straits and Archipelagoes

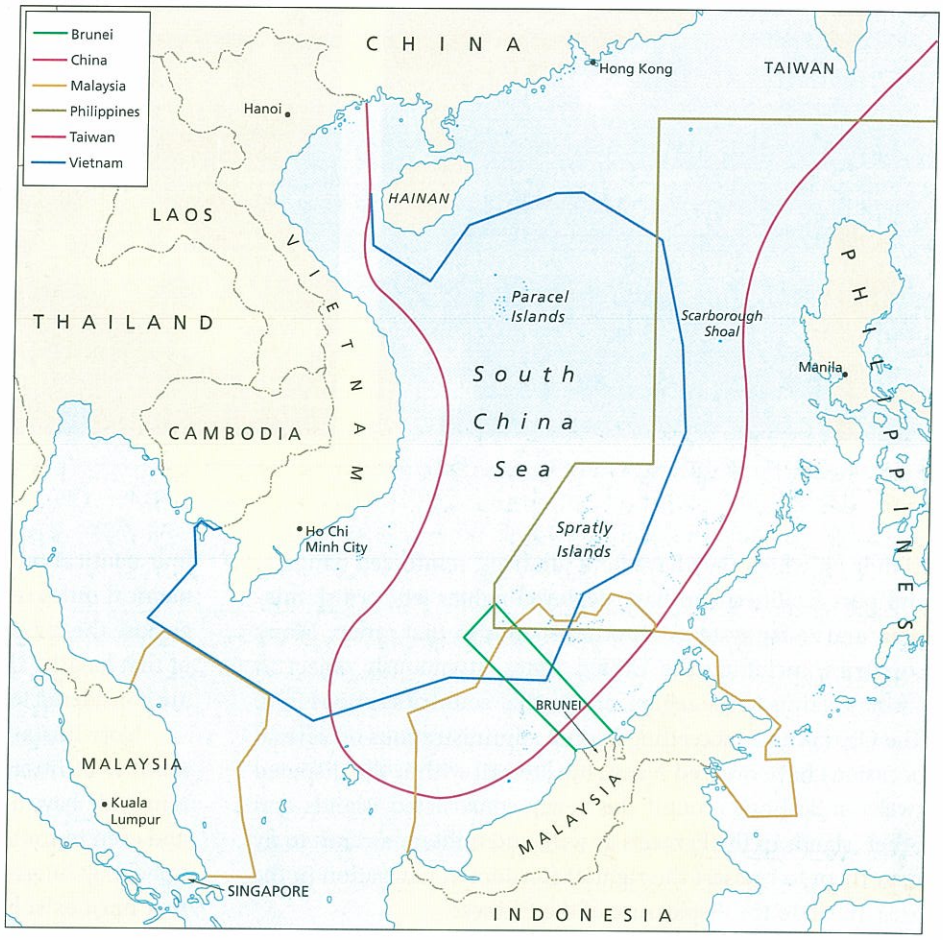
The increase of sovereign territorial sea jurisdiction to twelve nautical miles by the Third UN Conference on the Law of the

A group of Chinese warships similar to those shown here exercised the right of innocent passage without incident en route between the Russian Kamchatka Peninsula and the American Attu Island while proceeding to the Bering Sea to take part in Russian sea exercises in 2015. Upon completion of the exercise, the group transited east of Attu and through the Aleutians to return to the northern Pacific. Closer to home, however, China jealously guards its own maritime boundaries and has at times required prior notification for ships and planes making innocent passage through and above its own territorial waters.

Sea in 1978 placed more than a hundred straits previously navigable as high seas in the category of territorial waters. The United States has since maintained that transit of such straits, which include Gibraltar and Malacca, should continue to be allowed under the right of innocent passage and, as it has stated, "should be regarded in law for what it is in fact: an inherent and inseparable adjunct of the freedoms of navigation and overflight on the high seas themselves."

However, unless multilateral or bilateral treaties are enacted on a case-by-case basis that ensure such transit to U.S. naval ships and aircraft, there is always the possibility that coastal states adjacent to such straits may attempt to impose unilateral restrictions on passage through them. Advance notice of transit and the banning of nuclear-powered vessels are possible examples of such restrictions.

If restrictions on passage through straits in territorial waters were imposed, access to and from the Baltic, the Mediterranean, the Persian Gulf, and the Red Sea could be severely impaired. Entry to semienclosed sea areas such as the Caribbean, Sea of Japan, and South China Sea could also be affected adversely. Constraints on aircraft overflights, particularly those intended to bring rapid logistic support to allies, could also be imposed.



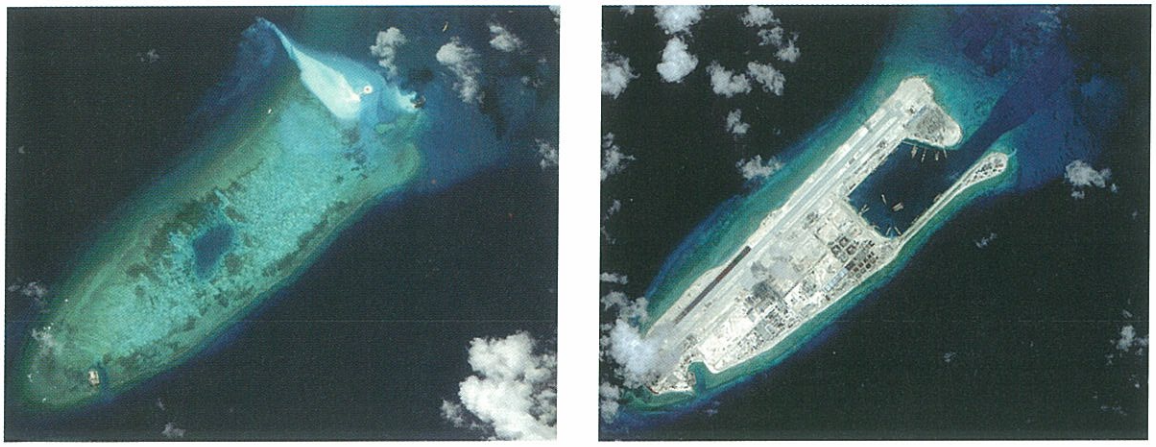
This map shows the conflicting claims to various parts of the South China Sea by various littoral nations on its borders. The red line indicating China's claim boundary is referred to as the *nine-dash line*, a reference to nine line segments outlining the disputed territory on Chinese charts of the area. Taiwan (aka the Republic of China) also claims the territory within the nine-dash line, going back to the days when it was considered the legitimate government of all of China—a notion that the current Chinese government (the PRC) strongly rejects. *Voice of America*

Similar constraints could also apply to the passage of vessels and aircraft through the waters of archipelagic states such as Indonesia and the Philippines, and many smaller groups of islands that have attained sovereign status such as American Samoa, Tonga, the Maldives, Solomon Islands, and Fiji. The United States backs the right of "archipelagic sea-lanes passage" on routes designated by the archipelagic nation and on routes normally used for safe international navigation.

A particularly troublesome situation has arisen in recent years in regard to China's claims of sovereignty in the South China Sea. Since the 1940s China has asserted that the Paracel Islands southeast of Hainan in the South China Sea and the Spratly Islands farther south should be considered part of China, with Chinese territorial waters adjusted accordingly to include an additional million square miles of what has traditionally been considered international waters—in effect creating a Chinese-controlled strategic strait. The Spratlys' contested ownership developed into an international conflict after several claimants began extracting resources from the seabed contiguous to their EEZs.

The South China Sea comprises a massive 1.4 million square miles and is bordered by eight countries with a combined population of about 2 billion people. Those waters handle about half of the world's daily merchant shipping, one-third of global oil shipping, two-thirds of all liquid natural gas shipments, and more than one-tenth of the Earth's fish catch. China's claims have been hotly disputed by Vietnam, which also lays claim to both island groups, and by the Philippines, which lays claim to part of the Spratly Islands. Malaysia, Taiwan, and Brunei have also asserted claims to some of the islands in the region.

To support their claims, the Chinese have built up a number of reefs in the Spratly Islands group to form artificial



Two views of the Fiery Cross Reef in the Spratly Islands in the South China Sea, obtained from NASA imagery before (left) and after (right) Chinese reclamation efforts from 2013 to 2015. *NASA/Center for Strategic and International Studies*

islands on which they have built airstrips, reinforced hangars, and port facilities; and have deployed fighter jets, cruise missiles, and radar systems on other islands in that group. Many countries, including the United States, strenuously object to China's claims to the region, and to that country's actions in it. The Obama and succeeding Trump administrations on several occasions have ordered Navy ships to sail within the disputed twelve-mile limit around the newly constructed islands and other islands in the Paracels as well, and military aircraft to fly near them to reassert the right of freedom of navigation in the area, much to the displeasure of the Chinese.

The Philippines took China to court over the Spratlys, filing a claim in 2013 with the international Permanent Court of Arbitration over the disputed islands. In July 2016 the court announced its ruling that the portion of the South China Sea claimed by both China and the Philippines belongs to the Philippines alone. Thus far China has refused to abide by the decision. Because of a bilateral defense treaty with the Philippines, the United States could be drawn into any future military conflict between China and the Philippines that might develop over these islands. Conflict between China and Vietnam over the Paracels and Spratlys could also threaten stability in the region. It remains to be seen at this writing what the ultimate resolution of this situation will be.

Bays and Gulfs

Even after the provisions of the Third UN Conference on the Law of the Sea were ratified in 1994, controversy continued over the question of where internal waters of certain bays and gulfs end and territorial seas begin. A gulf is larger than a bay and extends deeper into the land. By the convention established in 1994, if the entrance to a bay or gulf is twenty-four nautical miles or less wide, a straight demarcation line is drawn seaward of the narrows at the entrance, with the waters thus enclosed considered internal waters. If the entrance width exceeds twenty-four nautical miles, a straight demarcation line of twenty-four nautical miles is drawn within the bay in such a manner as to enclose the maximum area of water that is possible with a line of that length. The next twelve nautical miles outside that line are considered territorial waters.

Notwithstanding these rather clearly defined limits, a number of littoral nations persist in claiming that all of certain wide bays and gulfs adjacent to them are territorial seas, and even in some cases internal waters. Rarely are these claims upheld by international law. The UN lists three basic elements that must exist before any such claim can be deemed valid: an effective claim to sovereignty by a national government, a continuous exercise of the authority claimed, and acquiescence by other nations. For example, in past years Libya has tried unsuccessfully to claim the entire Gulf of Sidra as territorial waters. Canada has long claimed Hudson Bay, with an entrance fifty miles wide, but many countries, including the United States, have never recognized this claim. Great Britain claimed the Bay of Fundy, with a sixty-five-mile-wide entrance, as Canadian waters in 1852, but a subsequent international commission declared the claim to be invalid.

Denial of, or restrictions on, access to semienclosed bays, gulfs, and seas could pose a severe hardship on the U.S. Navy in carrying out its mission. As an extreme case, there have even been proposals by some emerging Third World littoral states located on the Indian Ocean to declare that entire ocean a "zone of peace and security" from which all warships would be barred. Such curtailments would severely limit the Navy's capability to carry out strategic deterrence, projection of power, and naval presence missions in the region.

Internal Rivers, Lakes, and Canals

Rivers that lie entirely within one country, such as the Potomac and Mississippi in the United States, the Thames in England, and the Seine in France, are considered part of those countries'

internal waters. They are called *national rivers*. Rivers that form a boundary between two or more countries are called *international rivers*. If such a river is not navigable, as, for example, the Rio Grande between the United States and Mexico, the territorial boundary lies in the geographic center of the river. If it is navigable, as with the St. Lawrence between the United States and Canada, the center of the deepest channel often varies from the geographical center, so the channel centerline is used to mark the boundary; such a channel boundary line is known as a **thalweg**.

International rivers are open to navigation by all ships, just as on the high seas. The same rule applies to rivers that pass through the territory of one state and serve as lines of communication for an interior state. The first state may not impede free flow of traffic to and from the interior state. The Paraná, leading to Paraguay through Argentina, is one example of this; the Rhine in Western Europe, the Danube in Eastern Europe, the Congo of Central Africa, and the Amazon system through Brazil also carry much international traffic. The use of these rivers is controlled by international treaties and agreements between the **riparian** (bordering on the river) countries.

Lakes entirely within the boundaries of a country are the exclusive property of that country. Treaties usually set international boundaries in those that lie in more than one country. The Great Lakes, for example, are subject to agreements between the United States and Canada. Treaties between the two countries define the territorial limits of each country and address jurisdictional questions such as admiralty law, navigation, and limitations of warships.

Passage through manmade international canals is controlled by agreement among the countries through which they run, unless there are international treaties to the contrary. There are currently three such canals of major importance to international shipping: the Suez Canal that links the Mediterranean Sea with the Red Sea and Indian Ocean; the Kiel Canal that connects the Baltic Sea with the North Sea and the North Atlantic Ocean; and the Panama Canal between the Pacific and Atlantic Oceans. In peacetime they are all open to the use of all nations' ships, subject to a transit toll. If nations not holding title or interest in a canal are at war, belligerent warships from either side may use it. A canal may be closed to belligerents at war with the controlling state; for example, the Suez and Panama Canals were not open to Axis powers during World War II.

Law of the High Seas

As defined by a UN Convention on the High Seas ratified in 1962, the term **high seas** means "all parts of the sea that are not included in the internal or territorial waters of a state." Alternatively, the high seas are sometimes referred to as **international waters**. More than 70 percent of the world's surface is high seas, free for all the world to use in commerce. Every state has the right to grant its nationality to ships and has the right to sail them under its flag on the high seas. Such ships, whether military or civil, are subject to the exclusive jurisdiction of the nationality of the flag flown. In return for these rights the state must take all measures necessary to ensure the safety of the ship, crew, and passengers.

Freedom of the high seas includes freedom to conduct maritime commerce, to navigate, to fish, to lay submarine cables and pipelines, to fly over, and to undertake scientific research. Like other high-seas freedoms, the right to engage in deep seabed mining is also an inherent (basic) right of all sovereign nations under customary international law. In exercising these freedoms, reasonable regard must be given to the rights of others to use the high seas. For instance, it has been ruled that in the interest of general safety, countries conducting weapon tests at sea should stay clear of traveled sea-lanes. If a ship does enter the area, the test, not the ship, is stopped.

The fact that the sea is common to all does not prevent international agreements concerning it. Indeed, the world community of states has seen fit to establish a body of maritime law to ensure that freedom of the seas will apply equally to all. Consequently, many international conventions and treaties have been concluded on safety of life and traffic at sea, salvage, international signals, fisheries, mineral rights, the laying of cables and pipelines, oil pollution, and the suppression of piracy and the slave trade.

Despite these international conventions and accords, there have been several continuing areas of contention concerning international law of the high seas. Two of the more significant of these problem areas in recent years have concerned unauthorized fishing in the EEZs of littoral nations and exploitation of minerals in the continental shelves and the deep ocean seabeds.

Economic Zone Fishing Problems

Fish have been harvested from the seas since the dawn of history, providing the peoples of the Earth with food, income, and adventure. Freedom to fish on the high seas has long been a part of customary international law. Since World War II there has been a steady increase in fishing activity in all the oceans of the world. New fishing fleets with factory ships serving as mother ships for dozens of smaller trawlers comb the principal fishing grounds of the world. The worldwide demand for fish protein is so great, however, that sometimes these fishing fleets have routinely fished unlawfully within the EEZs of various coastal states lacking sufficient military assets to adequately police these areas. In a number of cases these fleets have depleted fish stocks in both the EEZ and the high seas to the point where important fisheries have been lost to the world, perhaps forever.

There have been more disputes over the protection of rights concerning fisheries in the EEZs of the world than over any other international maritime issue since the Third UN Conference on the Law of the Sea concluded in 1982.

The fisheries problem remains real and vital to many countries. Fair and intelligent agreements, both bilateral and multilateral, are necessary to satisfy the coastal states and the distant-water fishing nations. Along with these there will have to be a strict application of conservation measures, and it is likely that these will have to be enforced by coastal states under international law designed to benefit all humankind.

Mining in Continental Shelves and the Deep Ocean Seabed

The exploitation of the resources of the continental shelves and the deep ocean seabed and its subsoil has become a matter of vital importance to many coastal states. In general, this activity has concentrated on the continental shelves, but technology has now advanced to the point that exploitation of deep ocean seabeds is also well within the grasp of states with the means to pursue it.

Almost all littoral countries with continental shelves are in various stages of exploration for and exploitation of oil, natural gas, and other minerals, and many have been successful. Foremost among these are Mexico and the United States in the Gulf of Mexico; Venezuela and Colombia in the Caribbean Sea; Norway, Scotland, and Britain in the North Sea; Russia in the Arctic seas off its northern coast; and the United States in Prudhoe Bay off Alaska and off the California Pacific coast. Oil and gas drilling platforms are considered an impediment to navigation, so international regulations specify that a safety zone must be established around such rigs up to a distance of five hundred meters (.27 naut. mi.) for the mutual protection of shipping and the installation itself.

Scientific research has determined that extensive deposits of many strategic minerals lie on or close to the surface of the deep ocean seabeds, along with inestimable amounts of oil and natural gas in the subsoil. Since this discovery, nations have tended to try to assert exclusive rights for exploration and exploitation of the oil, gas, and other minerals they might acquire in the deep seabeds of the world. One of the most successful seabed mining ventures to date has been the mining of manganese nodules (which also contain nickel and cobalt) from deep seabeds worldwide, begun in the early 1970s.

Under customary international law, states may explore and exploit the deep seabed as long as they do not claim sovereign rights to it and conduct their exploration and mining with reasonable regard for the rights of other nations to engage in the same activities. In keeping with this convention, the United States has proposed that the deep seabeds not be subject to any kind of exclusive claim by any state, but rather that all such exploration and mining activities be governed by international law in accordance with UN conventions and other principles of humanity. Even though the United States is not a party to the Third UN Conference on the Law of the Sea conventions, and may never be, and is therefore not subject to regulation by the International Seabed Authority, it nevertheless has an interest in securing legal rights for its citizens to engage in deep seabed mining. It may secure those rights in the traditional way by making claims to specific seabed areas pursuant to domestic law; by giving notice to the international community regarding U.S. claims; and, when necessary, by signing bilateral or multilateral agreements with other nations to ensure mutual respect for each other's seabed claims.

Nautical Rules of the Road

The nautical rules of the road were devised for the purpose of standardizing ship movements on the seas in various situations in order to avoid collisions. The fundamental rules of meeting, crossing, and passing have evolved in response to the need for safety of waterborne vessels, their passengers, and cargoes. Without such rules, chaos would surely exist.

The international law regulating the nautical rules of the road that vessels must follow at sea is called the *International Regulations for the Prevention of Collisions at Sea, 1972*, commonly referred to as the **international rules of the road** or simply by the acronym **COLREGS**. The current law was revised in 1972 and came into effect in 1977. It was only the third revision since 1895, when British and French sailing rules gained international acceptance. These standardized rules are worldwide in application and cover all aspects of safe conduct of a vessel on the high seas, including running lights, whistle signals, day shapes, and ship maneuvers under different circumstances. The international rules of the road are within the purview of a specialized UN regulatory agency called the International Maritime Organization (IMO), comprised of representatives from all the major shipping nations of the world.

The rules of the road are positive international law, standardized throughout the world. They are specific and have proven to be completely enforceable. The rules are applicable to all vessels, large and small, warship and merchant. In the event of a collision, the case is heard in the admiralty court of the maritime nation having jurisdiction (federal, district, and state courts in the U.S.), and the governing international law is uniformly applied to ships of all nationalities.

The international rules of the road generally apply worldwide on the high seas, in territorial waters, and in national internal waters unless special rules for the latter have been adopted by a particular nation. In the case of the United States, specialized **inland rules** differing somewhat from the standard international rules prevail in all U.S. internal waters. Mariners from all nations must be proficient in the international rules

of the road, and they must acquaint themselves with all other rules such as the U.S. Inland Navigation Rules that may apply to the waters of any nation they are about to visit.

A more complete discussion of the particulars of the international and inland nautical rules of the road is presented in chapter 10 of the Naval Skills section of this textbook.

Future Concerns

The United States must continue to seek to ensure that future legal developments within the international law of the seas concerning their use do not adversely affect our ability to carry out naval missions. In this effort the United States must take the lead in defending existing international legal rights and argue against any attempts to impose restrictions or bans in the following areas:

- navigation through or overflight of economic zones
- innocent passage of warships through territorial waters
- transit or overflight of disputed straits in territorial waters
- entrance of naval vessels into disputed international gulfs and bays

The growing pressures for exploitation of the seas' resources worldwide, and the Arctic Ocean in particular, make it exceedingly important for the maritime nations to continue to reach agreement in many areas. Our capacity to exploit the seabeds, engage in advanced scientific research, fish, conduct ocean commerce, regulate pollution, conserve natural resources, and conduct peaceful naval operations are all interrelated issues, each dependent in some respect on international accords on the law of the sea.

Critical Thinking

1. Given the increased range of modern artillery and missiles, do you think the current twelve-mile limit for territorial seas is still valid, or should it be extended? Why or why not?
2. Research the kinds of minerals being extracted from the continental shelves around North America and the other continents and seabeds of the world. Where are the most significant of these efforts being undertaken today?

Study Guide Questions

1. What was the most basic tenet of sea law stated by Hugo Grotius in 1604?
2. What are the three main precepts of the international law of the sea that have evolved by the mid-twentieth century?
3. What was the purpose of the UN Law of the Sea Conferences held in the latter part of the last century?
4. What are *internal* or *inland waters*?
5. What are *territorial waters*?
6. What are *archipelagic waters*?
7. What are *contiguous zones*?
8. What are *exclusive economic zones*?
9. A. What is meant by the term *innocent passage*?
   B. How are submarines affected by rules applying to innocent passage?
10. How did the Third UN Law of the Sea Conference define the term *continental shelf*?
11. What provisions concerning the rights to navigate through certain straits and archipelagic waters have caused the United States not to ratify the conventions passed by the Third UN Law of the Sea Conference?
12. What contentious activity in the South China Sea in recent years has caused alarm to countries contiguous to that sea and to the United States?
13. What has been the basic controversy concerning gulfs and bays as regards the territorial seas of littoral nations adjacent to them?
14. A. What are rivers that lie entirely within one country called?
    B. If rivers form a boundary between two or more countries, what are they called?
15. What factor determines the boundary line between nations on an international river?
16. What rules govern the use of major international canals?
17. What does *freedom of the high seas* include within the meaning of the phrase?
18. What two areas of contention concerning international law of the high seas have been of continuing concern in recent years?
19. What resources are now being obtained from the seabed and subsoil of the continental shelf?
20. What rules exist under customary international law concerning exploitation of the deep seabed?
21. What are the nautical rules of the road designed to do?
22. A. Where do the international rules of the road apply?
    B. Where do U.S. inland rules apply?

New Vocabulary

admiralty law
territorial sea
contiguous zones
territorial waters
archipelagic waters
hot pursuit
continental shelf
bay
thalweg
high seas
COLREGS
jurisdiction
internal waters
innocent passage
archipelagic state
economic zones
exploitation (of resources)
gulf
riparian country
nautical rules of the road
inland rules

15

The Law of War at Sea

The high seas in time of peace are free for the lawful use of the ships and people of all nations. Because the high seas are not under the sovereignty of any state, the preservation of law and order thereon falls within the scope of international law. Until the technological advances of the past century opened the seabeds, mariners and ships were the only users of the seas. Consequently, a large portion of international law is concerned with ships—their rights and privileges, their traffic rules, admiralty law, and laws of conduct in peace and war.

Warships and the Law

Under international law, two specific requirements must be met in order for a ship to be considered a **warship**. First, the vessel must be commissioned as a part of the naval forces of a state and authorized to display an appropriate flag or pennant that identifies it as such. Second, the vessel must be commanded by a member of the military forces of that state and must have crew subject to military discipline.

Warships represent the sovereignty and independence of the state to which they belong. The jurisdiction of this state over them is exclusive under all circumstances, and any act of interference with them by a foreign state is an act of war.

This does not mean that a warship on the high seas is free of all restrictions. Rather, as always, responsibility accompanies privilege. The aspect of leadership, ever present in naval matters, appears here with vivid importance. In representing their countries, commanding officers of warships head their officers and crew in the same manner as ambassadors head their legations. U.S. maritime courts have stated it this way: "The immunity granted to diplomatic representatives of a sovereign and to its vessels of war . . . can be safely accorded, because the limited numbers and the ordinarily responsible character of the diplomats or agents in charge of the property in question and the dignity and honor of the sovereignty in whose services they are, make abuse of such immunity rare."

Just as interference with a warship on the high seas is an offense against the sovereign in whose service the warship is employed, the abuse of privilege by a warship is a direct reflection upon the honor of that same sovereign. For this reason, every nation with a navy of its own has, by tradition and regulation, attempted to ensure that its warships conduct themselves at all times in a manner that brings credit to the nation they represent.

With privileges, of course, come duties. Commanding officers of U.S. Navy ships at sea, as well as COs of ships of other nations, in conformance with the 1962 UN Convention on the High Seas and *Navy Regulations* in the case of U.S. Navy ships, must

- render assistance to any person found at sea in danger of being lost
- proceed with all possible speed to the rescue of persons in distress if informed of their need for assistance, insofar as such action may reasonably be expected
- after a collision, render assistance to the other ship, its crew, and passengers

Warships of all nations have a duty to suppress piracy, the slave trade, illegal narcotics trafficking, and unauthorized

A visit, board, and search team from the guided-missile destroyer USS *Bainbridge* (DDG 96) assists a stranded Somali fishing boat after an engine failure. Such aid is required both by the UN Convention on the High Seas and by *Navy Regulations*. The *Bainbridge* provided food and water to the crew, then towed the boat to safety into territorial waters.
Peter Pagano

broadcasting on the high seas. Under international law, therefore, a warship, military aircraft, or other duly authorized ship or aircraft has the **right to approach** any vessel in international waters to verify its nationality, which can be exercised in either peace or war. Moreover, unless the vessel encountered is a warship or government vessel of another nation, it may be stopped, boarded, and the ship's documents examined, provided there is reasonable ground for suspecting that it is

- engaged in piracy
- engaged in the slave trade
- engaged in illegal narcotics trafficking
- engaged in unauthorized broadcasting
- without nationality

If the ship boarded is confirmed to be engaged in piracy, it can be immediately seized by the boarding party. If found to be engaged in illegal narcotics trafficking, the boarding party must request authorization from the state under whose flag the vessel is operating to take appropriate action. In the remaining cases they must first obtain guidance from higher national authority before taking further action.

Warships as a matter of routine practice, therefore, request the name and nationality of all merchant ships encountered at sea, usually by flashing light. This activity can keep a signal bridge busy indeed when a naval vessel approaches navigational chokepoints. The CO must justify any action beyond this standard inquiry. Any such action is done at the CO's own risk, because if a foreign ship is hindered in violation of the freedom of the seas, this could cause a diplomatic protest and embarrassment to his or her government.

It is clearly the right of any country to forbid foreign warships to enter any of its ports, although it is customary for nations to grant access to warships of nations with which they are at peace. Sometimes such visits are based on reciprocal rights by the other nation to return such a port call within a reasonable period of time. In the case of the Western allies, particularly in the Mediterranean, special agreements for visits have been concluded with certain countries in which U.S. Navy ships call regularly. In the absence of such agreements, however, the usual procedure is to secure permission for a warship visit through diplomatic channels, usually via the department of state and the naval attaché in the nation to be visited.

When in a foreign port, under international law a warship is considered an extension of the territory of its sovereign state and is not subject to any interference by local authorities. Police or port authorities are never entitled to board the ship without first obtaining the permission of the commanding officer, who is never required to submit to a search of the ship. The officers and crew of a warship, and anyone else aboard accused of offenses against local laws or seeking asylum, are completely immune from local jurisdiction while aboard the ship in a foreign port. Similarly, it is customary for local authorities to waive all jurisdiction over officers or crewmembers ashore on official business.

Such immunities do not mean the ship or its crew can act in a lawless manner. Responsibility and leadership are again the key to such privileges. By accepting the hospitality of the port, the warship consents to comply with harbor regulations concerning speed and traffic control, sewage disposal, health and quarantine restrictions, and so forth. While ashore the crew

The guided-missile submarine USS *Ohio* (SSGN 726) arriving at the Republic of Korea's Busan Operating Base for a port visit. In a foreign port, a warship is not subject to any interference by local authorities, but the ship must abide by normal harbor regulations and laws of the country being visited.
Barry Hirayama

should comply with all local laws, rules, customs, and regulations at all times. If the ship and crewmembers on official duty ashore do not meet such standards, there are valid grounds for complaint through diplomatic channels.

The situation is different when officers and enlisted personnel of a Navy ship go ashore unofficially for leave or liberty. In most countries, local jurisdiction will apply to the visitors in the event they are apprehended and/or detained for violations of local laws or regulations. In the case of U.S. Navy visits to allied nations, there often exists an arrangement called the Status of Forces Agreement, which specifies in detail how any such problems are to be handled. All military personnel on leave or liberty in a foreign country should be well advised on the local law and what to do should they get in trouble there.

There is a difference in the case of merchant ships visiting a foreign port. International law states that a merchant ship is subject to the jurisdiction of the nation being visited. This illustrates the fact that a merchant ship is not considered an extension of the "territory" of the nation of registry, as is a warship. This difference is probably best exemplified in the matter of **asylum** (protection and immunity from extradition granted by a government to a foreign refugee). In the case of a warship, local authorities may not come on board to arrest or remove an individual seeking asylum for political or personal safety reasons. In the case of a merchant ship, however, local police may come on board, arrest, and remove an accused offender or political refugee. The doctrine of asylum, then, is not applicable to merchant ships.

When on leave or liberty in a foreign port, like these Sailors in Ho Chi Minh City, Vietnam, crewmembers from a Navy ship are subject to local laws and jurisdiction. *John Beeman*

General Rules of War on Land and Sea

Navy Regulations states, "In the event of war between nations with which the United States is at peace, a commander shall observe, and require his command to observe, the principles of international law." Naval officers must thus have a thorough knowledge of the rules of warfare.

Many definitions of ***war*** exist, but for this particular discussion the simple definition of war as "a legal condition of armed hostility between states" is applicable. It generally implies armed, physical conflict between nations, but in the legal sense, a state of war may exist before or after the use of force. The violence of war existed from 7 December 1941 until the Congress legally declared war on Japan the next day. The treaty of peace with Japan did not come into force until 1952, even though all fighting had ceased on 15 August 1945 and the surrender document was signed on 2 September. The Korean War ended in July 1953 when an armistice was signed, but no formal peace treaty was ever successfully negotiated. In March 2013 the North Korean dictator Kim Jong-un abrogated this armistice agreement, so technically a state of war has since existed between North Korea and South Korea. It would seem that such legal details would be unimportant, but such is not the case. Various provisions in international law, war clauses in insurance policies, certain provisions of the Uniform Code of Military Justice, and certain U.S. presidential powers, among other things, are dependent on the legal state of war, not necessarily the violence of conflict.

Because of the events of the Cold War, it is now generally recognized that the rules of war apply in all armed conflicts of an international nature, regardless of whether or not war is formally declared. In other words, military and naval actions between warring nations should follow the rules of war, whether the details of legality are present or not. It should be pointed out that the 1907 Hague Peace Conventions, in their attempts to broadly codify the laws of war, first recognized that the avoidance of war should be attempted as an

ultimate goal in all cases. Second, they recognized that war is sometimes unavoidable and has to be accepted as a regrettable but legitimate means of settling disputes between nations. Because of this, it was agreed that the best that could be hoped for was a general acceptance of humanitarian rules of warfare. Therefore, the Convention on Laws and Customs of War states that if any laws concerning certain aspects of war are absent from the code, "then the inhabitants and belligerents remain under the protection and the rule of the principles of the law of nations, as they [have been] established among civilized peoples, from the laws of humanity, and the dictates of the public conscience."

The Hague Conventions state that the rules of war do not apply except between contracting powers, and then only if all the belligerents are parties to the conventions. In World War II, some of the belligerents had not ratified the conventions. After the war, when defendants in war crimes trials from these countries claimed immunity because their nations had not ratified the Laws of War, the judges rejected this defense. Today the rules of war are considered customary rules of international law and are binding on all nations, whether or not they have signed specific agreements.

Rules of warfare are restrictive; that is, they are designed to restrain the belligerents from the excessive use of force. Belligerents, therefore, are not free to use any means possible to inflict injury on the enemy. Limitations exist so belligerents do not escalate a conflict to total war, with all of its devastating implications.

The limitations on land and naval warfare are, in general, similar. The first group of restrictions concerns the conduct of the war itself; for example, prohibitions on the use of certain weapons such as poisons, poison gases, and "dumdum" bullets. The second group protects persons who are not involved in the actual conduct of the war: civilians, sick and wounded members of the armed forces, and prisoners of war.

The three basic principles underlying the rules of civilized warfare have historically been humanity, chivalry, and military necessity. Of these, the **principle of humanity** is unquestionably the most important; human beings should be treated humanely in all circumstances by saving lives and alleviating suffering while ensuring respect for the individual. It is the basis for all prohibitions imposed by international law on belligerents for the purpose of limiting excessive violence. **Chivalry** involves the qualities of bravery, honor, courtesy, respect for noncombatants, protection of the weak, generosity, and fairness to enemies. The principle of **military necessity** permits a belligerent to apply only the degree and kind of regulated force not otherwise prohibited by the laws of war. The rules of international law come above military necessity because the latter does not constitute an acceptable defense for lawlessness in the conduct of war.

War at Sea

The major distinction between land warfare and war at sea lies in the fact that land warfare takes place primarily on the territory of the belligerents while sea warfare is mostly fought on the high seas. These high seas are not within the sovereignty of the belligerent states but are open to lawful use by all nations of the world. In such circumstances there are bound to be conflicts between the interests of the belligerents, whose purpose is to destroy the naval power and maritime commerce of the enemy, and the legitimate interests of neutrals who seek to carry on their ordinary commerce with all nations, including the belligerents. While humanity, chivalry, and military necessity apply equally to war on land and at sea, in the latter, private enemy property, and in some instances neutral property, is subject to confiscation by belligerent warships. In land warfare, such private property is generally required to be left undisturbed by the opposing forces.

Certain weapons that are generally prohibited by international law were mentioned in the last section. In addition, there are prohibitions against the use of certain types of mines and torpedoes unique to naval warfare. The Hague Conventions forbid the laying of unanchored, automatic contact mines, unless they will become harmless within one hour after the person laying them ceases to control them. Automatic minefields are not supposed to be laid solely for the purpose of intercepting commercial shipping, and precautions are supposed to be taken for the security of peaceful neutral shipping. Communist forces consistently violated the rules concerning mines in both the Korean War and the Vietnam War. They indiscriminately dropped mines of all types in rivers, floated them down rivers into the open seas, and laid them throughout harbors and bays without regard for commercial ships and peaceful fishermen. The rules were again violated during the Iran-Iraq War in the 1980s, when drifting mines were released into the Persian Gulf, causing damage to ships of several nations, including the United States.

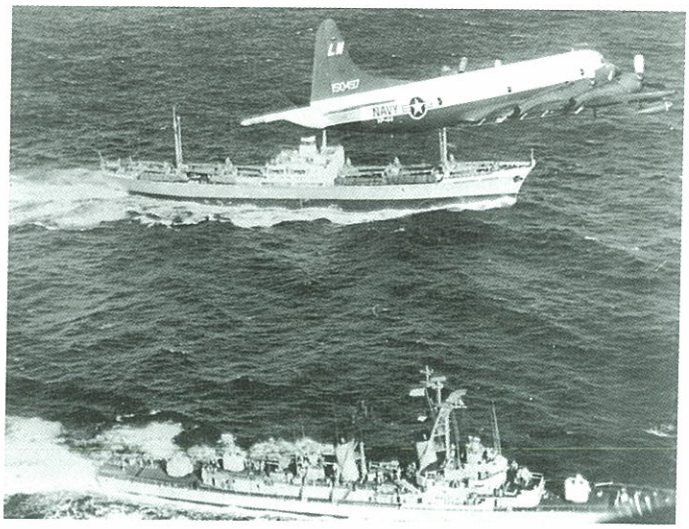
In the United States, weapons associated with chemical, biological, and radiological (CBR) warfare (so-called **weapons of mass destruction**) may be used by U.S. forces only if and when authorized by the President. In general, the use of such weapons has been condemned by the United States, and President Richard Nixon halted the production of chemical and biological agents in the United States in 1969. It is known or suspected, however, that chemical weapons have been used in several conflicts involving land warfare in the years since. Their use by Saddam Hussein's Iraqi military forces against Iran in the 1980s was well documented, as was Syrian president Bashar al-Assad's use of chemical agents against Syrian civilians in 2012–13 during the extended civil war in Syria, and again in early 2017. Their use is also alleged by ISIS/IL against civilians

in the battle for Mosul in Iraq. Such CBR weapons of mass destruction, however, in the absence of international laws to the contrary, must still be regarded as lawful, subject to the general rules of humanity that govern the use of all weapons in wartime. The United States proposed that nuclear weapons be prohibited from use in the deep seabed and ocean floor, and a treaty to this effect was negotiated and approved by the UN in 1970.

Aerial or naval bombardment intended to inflict wanton destruction on populated places or other devastation not justified by military necessity is absolutely forbidden by the rules. The bombardment of undefended cities open for immediate occupation and bombardment for the sole purpose of terrorizing a civilian population is also forbidden. In World War II, it can be said without pride, both sides committed horrifying violations of this rule, the Allies in retaliation for Axis raids on cities in England. Medical establishments, hospital zones, museums, churches, and buildings housing religious organizations are entitled to special protection. Hospital ships and aircraft, when marked and operating as required by the Geneva Convention, may not legally be made the object of attack in naval warfare.

In general, a submarine must follow the rules of warfare applicable to surface ships. Under international law, before a merchant vessel can be sunk, the belligerent warship must give warning and enable the victim's crew and ship's papers to be debarked to a place of relative safety. During World War I and World War II, this rule was abrogated by both sides, each of which claimed that they adopted unrestricted submarine warfare in retaliation for illegal acts by the other. The matter was further complicated when merchant ships were armed, convoyed by warships, and ordered to fire upon or ram submarines on sight. Additionally, merchant ships have now been integrated into the intelligence networks of many of the major maritime nations. While the legality of attack without warning on such vessels is no longer clear, submariners maintain that their actions are legal because of their vulnerability when surfaced or otherwise located.

One permissible method that a belligerent may use to shut off an enemy's trade is the **blockade**. To make a blockade legal in international law, it must be *effective*; that is, if a ship attempts to enter or leave a blockaded port, its capture must be attempted. Today, because of modern radar, patrol aircraft and drones, and submarines, a "distant blockading force" is more probable than a close-in force of warships, as in earlier times. The penalties for trying to breach (evade or run through) a blockade are liability to capture by the blockading force and condemnation by a **prize court**. A prize court is a court of the seizing ship's nation (federal district court in the United States) or a designated individual such as an ambassador authorized to consider whether or not a ship has been lawfully captured or seized in time of war. A prize court can order the confiscation, sale, or destruction of the seized ship and its cargo. A prize court can also order the return of a seized ship to its owners if the seizure was unlawful, such as if the seized ship were from a country that had proclaimed its neutrality.



A Navy P-3 Orion patrol plane flies over the Soviet ship *Metallurg Anosov*, which was proceeding toward the quarantine carried out during the Cuban Missile Crisis of 1962. The destroyer USS *Barry* (DD 963), below, is escorting the vessel. The *Barry* followed the ship overnight, often illuminating it with its searchlight, until it was certain the next morning that it had changed course away from the quarantine zone.
Museum of Naval Aviation

A limited and selective form of naval blockade directed against specific prohibited cargo useful for making war (i.e., **contraband**) is called a **quarantine**. The classic example of a quarantine was carried out by the U.S. Navy in 1962 during the Cuban Missile Crisis for the purpose of stopping more Soviet missiles from being delivered to Cuba. Today, since governments of belligerent nations often take over control of all distribution of food, fuel, and raw materials, few items indeed would not be found on a published contraband list.

Belligerent warships may also cause a merchant ship to halt on the high seas and submit to **visit, boarding, and search** to determine the ship's true character (enemy or neutral), the nature of its cargo (contraband or exempt "free goods"), the manner of its employment (innocent or hostile), and other pertinent facts. In a visit and search procedure, the vessel is directed by international flaghoist or other visual signals and radio to halt so qualified naval officers may board and examine the ship's papers, and if these are suspicious, question the ship's crew and possibly conduct a brief search of the ship and its cargo. If the ship is determined to be neutral and innocent with no contraband on board, an entry to that effect is written into the ship's logbook and the vessel is allowed to proceed. If

A Navy visit, board, and search team from the guided-missile destroyer USS *Halsey* (DDG 97) conducts an inspection of a Yemeni dhow during antipiracy operations in the Gulf of Aden. *Krishna Jackson*

the ship is found to be enemy or hostile, or if contraband is discovered, the ship may either be further searched on the spot or, more commonly, directed to accompany the warship into a nearby friendly port so a more thorough search may be conducted in safety. Under international law, liability of the ship or cargo to confiscation is determined by a prize court, not the boarding officer on the high seas. If a vessel resists or attempts to flee, the warship may fire a warning shot across the bow to attempt to stop it and, if absolutely necessary, may disable or sink it.

Enforcement of the Law

The most effective way of enforcing the laws of war is the official publication of the facts by the wronged nation, with intent to influence world opinion against the offending belligerent. This has proven effective in the world forum of nations. If the laws of war are broken, protests and demands for the punishment of offending individuals, as well as compensation, are probable. **Reprisal** (acts of retaliation) for illegal acts may also be attempted but may not be done for revenge alone. Neither can this measure be taken against civilian detainees or military prisoners of war. Acts of reprisal must cease as soon as they have achieved their specific objective. The final method of enforcement of the laws of war is by the punishment of war crimes. War crimes trials and the publicity that accompanies them can be an effective deterrent against future violations of the laws of war.

Critical Thinking

1. Research the Status of Forces Agreement concerning conduct of military service members in a foreign country that is party to the agreement. What are the rights of such service members concerning travel within and between countries allied with the United States?
2. Research at least two recent conflicts in which U.S. Navy vessels have exercised the right to board and search foreign merchant ships. Under what circumstances can this be legally done under international law of the sea?

Study Guide Questions

1. Why does the preservation of law and order on the high seas fall within the scope of international law?
2. What requirements must be met under international law in order for a ship to be considered a warship?
3. Who has exclusive jurisdiction over a warship?
4. In representing their countries, how do commanding officers of warships compare with ambassadors and diplomats who staff legations in foreign countries?
5. Under the 1962 UN Convention on the High Seas, what must commanding officers of the ships of the United States and other nations do at sea?
6. A. Why do warships have the "right to approach" other ships at sea?
   B. How is this usually accomplished?
7. Under international law, what is the legal status of a warship when in a foreign port?
8. What is the legal status of the officers and crew of a Navy ship on leave or liberty in a foreign port?
9. What is the fundamental jurisdictional difference between naval vessels and merchant ships when visiting foreign ports?
10. A. What is asylum?
    B. How do the rules for asylum differ in the case of a warship as opposed to a merchant ship?
11. Why are the legal details as to a state of war important?
12. When do the rules of war apply to military and naval actions between states?
13. What is the basic purpose of rules of warfare?
14. What are the three basic principles underlying the rules of warfare?
15. What is a significant difference between land and sea warfare as regards private and neutral property?
16. What are the Hague Convention rules concerning mines?
17. What is the U.S. policy concerning weapons of mass destruction used in CBR warfare?
18. Under the rules of warfare, what places, institutions, and ships are supposed to be exempt from attack?
19. Why was unrestricted submarine warfare generally practiced by both sides in World Wars I and II?
20. A. What are the legal requirements for a blockade?
    B. What are the penalties under international law for trying to breach a blockade?
    C. How does a quarantine differ from a blockade?
21. What visit and search actions may belligerent warships take toward merchant ships on the high seas?
22. What is the most effective way to enforce laws of war?

New Vocabulary

warship
asylum
chivalry
CBR warfare
blockade
contraband
reprisal
right to approach
principles of humanity
military necessity
weapons of mass destruction
prize court
quarantine
visit and search

Unit 5

Naval Weapons

The naval power that can best bring its airborne and waterborne weapons to bear on a given area of the sea, land, or air controls that area. Naval weapons have played and will continue to play an important role in achieving victory in battle both on land and sea. The Navy of John Paul Jones's day used muzzle-loaded guns, cannonballs, and Marine sharpshooters in the rigging for combat at sea. Its ability to project power ashore was pretty much limited to the range of a cannon shot. Today, the U.S. Navy has sophisticated jet aircraft and highly accurate long-range gun projectiles, missiles, torpedoes, bombs, and rockets, along with their technical and complex control and guidance systems. Unmanned aircraft that can land on and launch from aircraft carriers are a reality, with a working prototype demonstrating its capabilities having been recently tested at sea. Other unmanned aerial vehicles (AUVs) are routinely used by Navy amphibious ships and the U.S. Marine Corps for intelligence gathering, and autonomous unmanned surface vehicles (USVs) and undersea vehicles (UUVs) will soon be commonplace in the mine countermeasures community.

The ability to project naval power far inland with sea-based ICBMs, naval aircraft, and long-range missiles makes naval weaponry an important consideration in both the strategic and the tactical planning done by national political and military leadership.

The most significant results of the increased range of modern seaborne weapons have been an increase in the importance of naval firepower in land warfare, an increase in the effectiveness of naval as compared with land-based firepower, and an increase in the importance of amphibious warfare. Modern naval gunfire and aircraft can reach many miles inland to attack specific targets, to supplement land artillery in supporting land forces, and to support amphibious operations.

Increases in weapons range have steadily extended the distances between combatant forces in battle. The extreme in this trend toward greater separation between attacker and target is represented by modern missiles, which can cross whole oceans to reach their targets.

The development of nuclear fission and fusion revolutionized not only weapons but also war itself, in light of the possible adverse effects on human beings that might result. One can point out, however, that warfare has often been revolutionized before. The discovery of gunpowder, for example, was once thought to forecast the end of civilization.

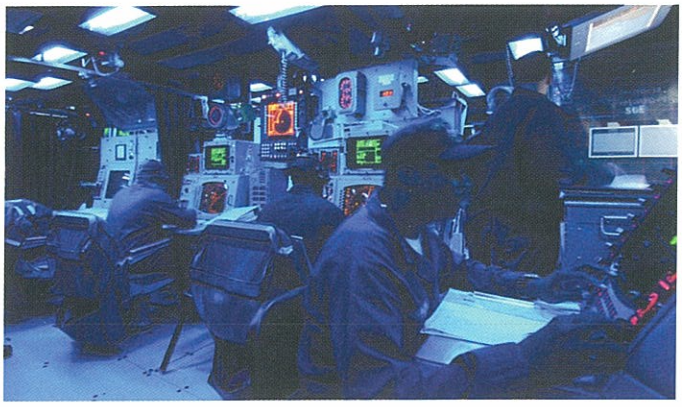
The increased lethal range of nuclear weapons has required the introduction of the tactic of dispersion of military forces to minimize combat damage. Also, improvements in aircraft, undersea craft, and missiles have forced the development and use of early warning systems involving both ships and aircraft on patrol far from the main area of operations.

Ship Weapons Selection

The primary consideration that governs what type of weapons a ship will have is its combat missions. A guided-missile cruiser (CG) employed in escorting and protecting aircraft carrier strike groups (CSGs) will carry a balanced armament of antiair warfare, antisurface warfare, and USW weapons. A dock landing ship (LSD) will carry only such self-defense weapons as the Phalanx close-in weapons system, antiaircraft missiles, and machine guns because the ship is designed to be a carrier of troops and vehicles, not a weapons platform. Small patrol vessels, littoral combat ships, destroyers, and cruisers may carry surface-to-surface missiles for attacks against surface ships or land targets. They may also carry antiaircraft guns and missiles to protect against the air threat and machine guns for defense against small craft. Destroyers, cruisers, and littoral combat ships with USW helicopters carry antisubmarine torpedoes for use against submarines.

Two tactical concepts are of major importance in the design of gun and missile systems: area defense and point defense.

Area defense. If a ship's primary mission is to provide defense as far distant from a formation of ships as possible, its sensors and weapons will be designed to cover an area extending some distance away. The weapons of ships of this kind provide protection for the entire formation, and the weapons are



Watchstanders monitor the tactical situation in the command and control center of the cruiser USS *Cowpens* (CG 63). *Lowell Whitman*

therefore called **area defense weapons**. Cruisers, destroyers, and to a lesser extent littoral combat ships are ships of this type. They can cover a large area with their air and surface search and fire-control radars, and they have weapons capable of engaging any target that enters this defensive envelope. Likewise, destroyers and littoral combat ships provide area defense against enemy submarines.

Point defense. The concept of **point defense** involves providing self-protection for a single unit, regardless of the ship type. A ship armed for point defense will attempt to destroy any target that penetrates a close defensive perimeter centered on the ship. The ship's guns and missiles must be effective at very close ranges to prevent the attacker from damaging it. Almost all combatant ships and many fleet auxiliaries are armed with short-range, point-defense weapons.

Weapon Systems

A weapon system is the combination of a weapon, or weapons, and the equipment used to bring it to bear against the enemy. Ship and aircraft weapon systems, taken as a whole, must include the following:

- Elements that detect, locate, and identify the target (e.g., radar and sonar equipment)
- Elements that deliver or initiate delivery of the destructive payload of the weapon to the target (e.g., a gun delivers a projectile to the target, and a mine itself explodes when a passing ship detonates it)
- Elements of fire control that guide a weapon, set the fuse of its explosive payload, or "program" it to reach the target (e.g., a torpedo or air-to-air guided missile)
- A destructive payload capable of destroying the target when exploded on contact with it or in close proximity to it

The effective use of any naval weapon requires that a payload, usually an explosive device, be delivered to a target, which most often is moving. Accuracy in determining the location and velocity of the target is vital to the success of the attack. Moreover, the threat posed by modern air, surface, and subsurface weapons is such that to be effective, all defensive weapons must be capable not only of individual use but also of use as part of a total weapon system.

The recent trend has been toward design and procurement of complete weapon systems. This is especially so in the case of the newer missile systems, with their complex guidance and propulsion components.

Any weapon system or component designed today must effectively address two basic questions:

- What is the system or component unit supposed to do?
- How well is the system or component supposed to do it?

The answer to the first question, called the **military requirement**, is a statement of the nature of the equipment and its capabilities. Some examples of this might be the range and rate of fire of a gun; the range, accuracy, and sensitivity of a radar; and the speed, accuracy, and limits of operation of a missile control computer.

The answer to the second question concerns general requirements that are applicable to all weapon systems, regardless of the nature of the system or its components. Some of the current general requirements are described below.

Reliability and flexibility. The system must be able to function satisfactorily in spite of some failures in its power supply, or with certain components disabled and others substituted.

Safety. The system should reduce hazardous conditions by interlocks or other means; it must not endanger friendly ships and aircraft, or its own ship's or aircraft's structure or operators.

Simplicity of operation. Even though modern weapon systems are complex, they should be designed for uncomplicated operation by trained individuals with average abilities.

Maintainability. This requires not only the use of long-life components but also convenient or nearly automatic testing and trouble-diagnostic capability, integrated into the system if possible. Failed parts should be able to be replaced quickly with spares so that the equipment will not be out of commission for an extended period.

Before a weapon system is accepted for the fleet, it must go through many tests and tactical evaluations to ensure that all of the military and general requirements are met.

Naval weapon systems, both seaborne and airborne, can be broadly classified into guns, missiles, torpedoes, and mines. Naval guns are described in the next chapter; aircraft and missiles, torpedoes, and mines are covered in the following chapters, followed by a brief discussion of chemical, biological, and nuclear weapons and warfare.

Shipboard Weapon Control Systems

The need for rapid handling and evaluation of target data from detection to destruction has brought into being a system concept more sophisticated than the traditional fire-control system, which was designed to control only one particular battery. Modern computer equipment has made possible a total **weapon control system** (WCS). The WCS integrates all ship's batteries and can operate them in close coordination with those of other ships in company. The basic components of a WCS are a weapon direction system, a tactical data system, and one or more fire-control systems. The WCS concept has in most cases relocated the commanding officer from the bridge to the ship's combat information center (CIC) in an interior compartment as the best location from which to direct the batteries and "fight" the ship.

The WCS acts as a clearinghouse for target information to provide early acquisition and designation of a target. The tactical data system is closely related to the ship's weapon direction system, but it receives input from other ships and aircraft as well. It is made up of data-processing, display, and transmitting and receiving communication modules. The tactical data system makes it possible to exchange target information instantaneously with all ships in the force, so each ship's weapons become part of the total array of weapons available to the task force commander. He or she can designate the ship or ships best equipped and positioned to engage the target.

For example, if an incoming cruise missile were detected by one ship, that ship would automatically pass all target information obtained by its sensors to the other ships via the tactical data links. Every ship's weapon direction system would then be able to feed the target data to its own fire-control system for dissemination to each missile and gun battery. The batteries then would have the necessary preliminary information to acquire and track the incoming missile. Orders to fire can be given by the task force air warfare commander or by an individual ship's CO, as the tactical situation requires.

Aegis cruisers and *Arleigh Burke*–class destroyers are equipped with Aegis, the most sophisticated shipboard combat system developed to date. The Aegis WCS is designed to provide area air defense in a high-density, high-threat, antiship missile environment. The major capabilities of the system include long detection range, automatic detection and tracking of multiple targets, automatic special threat alert, and high resistance to electronic countermeasures. The Aegis system integrates all ship's weapons batteries and can direct their use in coordination with those of other ships in company in a formation. In that way each ship's weapons become part of the total weapons complex available to the force commander, who can designate the ship or ships best equipped and position to engage each target.

A Navy F-35C Lightning. *Lockheed Martin*

Aircraft Weapon Control Systems

Modern combat aircraft also have advanced weapon control systems, called **avionics**, equally as sophisticated as those in the surface Navy. The F-35 Lightning joint strike fighter, soon to be the main strike fighter on board Navy aircraft carriers and amphibious assault ships, has the most advanced array of weapons-related sensors and avionics of any combat aircraft in the world today.

The F-35's electronic sensors and communications equipment provide the aircraft with advanced situational awareness, command and control, and network-centric warfare coordination capabilities. The main sensor is a scanned-array radar, augmented by a nose-mounted electro-optical targeting system (EOTS). These devices use ten radio-frequency antennas imbedded into the edges of the wings and tail. The EOTS system provides infrared threat detection and high-resolution high-definition television for visual threat assessment. Six additional passive infrared sensors distributed over the surface of the aircraft act as a missile warning system, reporting launch locations and detecting and tracking approaching aircraft and missiles at distances far enough away to allow evasion or engagement of them using long-range air-to-air missiles long before being detected by the hostile aircraft.

Using its sensors and communications equipment, an F-35 can communicate with and share information among all other units in a battlespace, and can control an attack made by up to twenty armed AUVs.

Other Navy combatant fighter/attack, early-warning, and surveillance aircraft have impressive weapon and communications avionics as well, though not on a par with the F-35, and can employ these to interact with all other units in a battlespace to give force commanders an unprecedented ability to conduct whatever offensive and defensive operations are warranted by the missions assigned.

Critical Thinking

1. Research and describe how a modern battle force consisting of an aircraft carrier and its screening cruisers and destroyers might be dispersed because of the threat posed by nuclear weapons.
2. Research the effects of modern computer technology on modern weapon systems insofar as their response times and capabilities are concerned.

Study Guide Questions

1. Upon what did early naval guns depend for their effectiveness?
2. What capability did naval gunfire provide in naval warfare when it was introduced in 1453?
3. What factors increased naval gun range to nine miles by the time of World War I?
4. When did the attack carrier supersede the battleship as the principal fleet unit?
5. A. What is the general term used for weapons and related physical equipment?
   B. What is the science of projectile motion?
6. A. What have been the most significant results of the increased range of modern seaborne weapons?
   B. What tactic did the increased lethal range of nuclear weapons introduce?
7. What is the primary consideration that governs the selection of weapons for a ship?
8. What are the two tactical concepts of major importance in the design of gun and missile systems?
9. A. What is a weapon system?
   B. What must a weapon system include?
10. What two basic questions must any weapon system address?
11. What are the basic components of a weapon system?
12. What is the advantage of having a combat system such as Aegis within a force of ships?
13. What do the weapons avionics systems of the Navy's modern combat aircraft allow them to do?

New Vocabulary

ordnance
arsenal
armament
ballistics
internal ballistics
external ballistics
area defense
battery (of weapons)
projectile
fire control
payload
weapon system
weapon control system (WCS)
point defense

17

Naval Ship and Aircraft Guns

Almost all naval ships and many kinds of naval aircraft are fitted with various kinds of guns. Guns may be used against surface, shore, and air targets. Ship guns designed for engaging both air and surface targets are termed **dual-purpose systems**. Most guns in use today are **automatic**; that is, the recoil of the gun ejects the fired powder case and reloads the gun.

Nomenclature

There is a great deal of specialized nomenclature that pertains to ship and aircraft guns and gun mounts. Some of this is also applicable to shipboard guided-missile mounts. A **gun** is basically a tube, or *barrel*, closed at one end, from which a **projectile** is ejected at a high speed by gases produced by a burning propellant. The inside, or *bore*, of the barrel is *rifled* with grooves having a right-hand twist of uniform diameter from one end to the other. Rifling causes the projectile to spin in flight, which keeps the projectile from tumbling after it leaves the barrel, thus providing greater accuracy.

The size of naval guns is expressed in one of several ways. Bore diameter, measured from the tops of the *rifling lands* (high side of the rifling grooves), may be specified in millimeters or, for older guns, in inches. For guns less than 3 inches in bore diameter, their barrel width is often referred to as their **caliber**, expressed in millimeters or decimal fractions of an inch. A 20-caliber machine gun, for instance, is a machine gun whose bore diameter is 20 millimeters. A 32-caliber revolver is a handgun whose bore diameter is .32 inches. For guns larger than 3 inches in bore diameter, however, the diameter is specified in either millimeters or inches, and the *length* in calibers. Caliber for these guns is defined as a number equal to the length of the gun in inches divided by the diameter of its bore in inches. For example, a gun having a bore diameter of 3 inches and a barrel 150 inches long is designated 3-inch, 50-caliber. Similarly, a 5-inch-diameter gun 270 inches in length is called a 5-inch, 54-caliber gun.

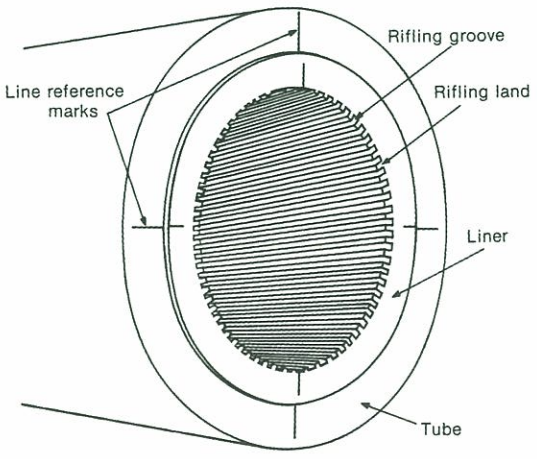


Diagram of the barrel of a rifled gun, showing lands and grooves.

Naval warship guns are categorized as *major* (8 inches or larger), *intermediate* (diameter 4–8 inches), and *minor* (less than 4 inches in diameter). There are currently no U.S. Navy warships that have guns larger than intermediate size.

A **mount** is the entire structure between the gun or a missile and the ship or aircraft's structure. It supports and secures the gun or missile and provides for the weapon's elevation, train, and recoil, if any.

The *arc of elevation* is the total vertical arc through which a gun barrel or missile mount can be raised and lowered. The *arc of train* is the total horizontal arc through which a gun or missile mount may be rotated. If a gun or a missile mount were located well forward on the bow of a ship, it could have a clear field of fire up to about 320°, but an after mount might have only a 180° arc astern. Electrical and mechanical *cutout cams* incorporated in gun and missile mounts prevent their weapons from being fired when they are pointed at a part of a ship or aircraft's structure.

A **battery** of guns or missiles is a group of gun or missile mounts or launchers of the same size and type, normally controlled from the same point. The main gun battery of a ship consists of the largest guns on board, and the main missile battery, the most numerous and capable type of missile. The secondary battery consists of dual-purpose guns or of guns of the

A 5-inch/54-caliber gun of a Navy cruiser fires a round during a live-firing exercise. *Joshua Scott*

A gunner's mate stows a Mark 45 5-inch/54-caliber gun powder casing into a canister in a magazine of the guided-missile cruiser USS *Antietam* (CG 54) in preparation for transporting it to the gun for a live-firing exercise. *Ricardo Guzman*

next smaller size, or less capable or numerous missiles. On ships having both guns and missiles, the most capable system may be designated the main battery and the other the secondary.

The range at which a gun is effective against surface and air targets (the *effective range*) is an important characteristic of a gun system. Range is dependent on the initial velocity imparted to the projectile by the propellant, the weight of the projectile, the caliber of the gun, and the ability of the sensors and fire-control systems to detect and track the target. The ranges of some larger-caliber naval warship gun projectiles have been greatly extended by the addition of rocket assistance. These **rocket-assisted projectiles** (RAPs) have a solid-propellant rocket incorporated into the shell.

Gun Ammunition

The principal components of a round of large-caliber naval gun ammunition are a *propelling charge* (propellant) and a *projectile*. The propelling charge provides the thrust that ejects the projectile at the desired velocity from the muzzle of the gun. The propelling charge assembly includes an ignition system, the propellant, and the container. The payload, or projectile assembly, includes the detonating fuse, the booster, and the burster charge.

In a naval gun the propellant charge is contained in a metal powder case inserted into the gun behind the projectile; the combination is called *case ammunition*. All modern naval guns on active ships today use either semifixed or fixed case ammunition. *Semifixed* ammunition refers to a round that consists of a projectile and a separate case charge loaded one after the other. This type of round is used in most 5-inch guns. *Fixed* ammunition refers to a round in which the projectile and powder case are permanently attached, as with a rifle cartridge. Such ammunition is used in most smaller guns.

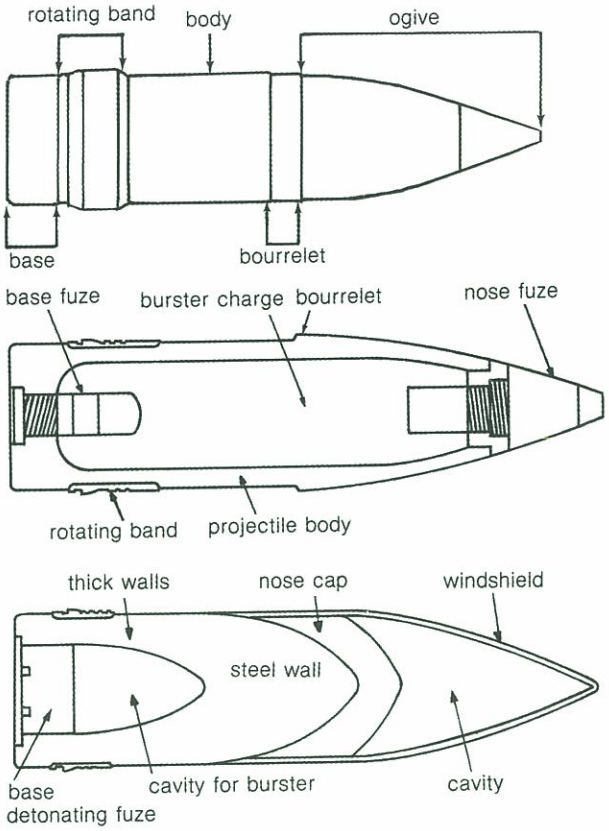
Propellants are relatively insensitive explosive chemical compounds that burn at a rapid rate rather than detonate or explode. They produce a rapidly expanding hot gas that propels the projectile down the gun barrel. The initiating stage in a propellant train, or series, is called a *primer* or *detonator*; it produces a hot flame that sets off the next stage, called the *igniter* or *booster*. The igniter, in turn, sets off the main propellant charge.

Gun Projectiles

The *projectile* is the part of a round that is expelled at high velocity from the gun bore by the gases produced by the propelling charge. Projectiles used in small weapons often consist of solid metal; projectiles used in conventional larger guns, however, are assemblies of several components. The three main parts of a large gun projectile are its metallic *body*, the *fuse* that sets off the main charge, and the explosive *burster charge*. A solid bullet damages by impact alone. Naval high-explosive gun projectiles inflict damage primarily by blast and **fragmentation** (multiple pieces, or *shrapnel*, produced by the exploding burster change).

Projectiles are cylindrical, with a pointed nose called an *ogive*. The shape makes the projectile stable as it spins about its long axis in flight, with minimum friction with air. As was previously mentioned, the bores of modern naval guns are *rifled* in order to impart this spin to the projectile as it travels the length of the barrel.

Various projectiles have different designs because the targets they are intended for differ in character. There are three general classes of naval gun projectiles: penetrating, fragmenting, and special purpose.



Diagrams of a naval gun projectile showing the external features (top), the internal construction of an antiaircraft common projectile (middle), and the internal construction of an armor-piercing projectile (bottom).

Penetrating projectiles are armor-piercing shells designed to penetrate heavy armor such as that of a ship or concrete reinforcement in a shore bunker before exploding. The "AP armor piercing" projectile is an example of a projectile of this type. The burster charge must be insensitive to the shock of impact to permit penetration and subsequent detonation by a delay fuse.

Fragmenting projectiles are designed to damage by blast effect and fragmentation, wherein the projectile walls break up into high-velocity shrapnel. These projectiles have relatively thin walls and large burster charges. The most commonly used projectiles of this type are called HE-PD (high explosive–point detonating) projectiles. They are used against lightly armored surface targets such as patrol craft, shore fortifications, and personnel. Since no penetration is required, the bursting charge is sensitive to impact. Most antiaircraft projectiles are of the fragmentation type; some, such as the widely used "AA common" projectile, are normally fused to detonate in the proximity of the aircraft, and the fragments penetrate the skin.

Special purpose projectiles have a variety of applications, including illumination, smoke, chaff, and target practice. They are not intended to inflict damage by blast or fragmentation. Whatever small amount of explosive may be in the shell is there only to expel the contents to achieve the designed purpose. Special purpose projectiles include the following.

- *Illuminating projectiles*, often called *star shells*, contain a bright flare attached to a parachute. The flare is intended to illuminate an enemy target or terrain as it slowly descends under the parachute.
- *Incendiary projectiles* contain white phosphorus. They can be used to set fire to flammable targets such as fuel and ammunition dumps, to mark the fall of shot during shore bombardment, and to create chaos and confusion among enemy troops. Once released by the exploding projectile, the fragments of burning white phosphorus are almost impossible to extinguish.
- *Chaff projectiles* contain metal foil strips that are scattered into the air by a small burster charge. The foil strips can confuse enemy search and fire-control radar by causing interference that can mask the intended target.
- *Nonfragmenting projectiles*, sometimes called *puff projectiles*, produce bursts of various-colored smoke for antiaircraft gunnery practice.
- *Target projectiles* contain sand or other inert material to simulate the weight and balance of burster charges; they are used for surface gunnery practice.

After they have been ejected from the gun barrel by the propellant charge, all except rocket-assisted projectiles follow a curved ballistic path to the target, meaning that they are acted upon only by gravity and aerodynamic drag. To calculate the precise path of the projectile to a target, a fire-control computer must also take into account a number of other factors such as the motions of the firing platform and target, the gun elevation

Two gunner's mates prepare to transport a 5-inch projectile to the Mark 45 54-caliber gun of the guided-missile cruiser *Antietam*. Note the safety precaution of cradling the projectile in the arms of the person carrying it. *Ricardo Guzman*

angle and muzzle velocity of the projectile, the Coriolis effect (an apparent sideways force caused by the Earth's rotation), and several others.

Once a projectile has arrived at a target, a *fuse* detonates the burster charge. A fuse can be either a mechanical or an electrical device. Fuses are classified according to their function as impact, time, or proximity. They may be located either in the nose or the base of a projectile, again depending on their intended function. Various physical forces of flight, impact on or proximity of target, or passage of a set time can cause the fuse to initiate the explosive train.

Proximity fused (VT-fused) shells were introduced in 1943. A VT fuse contains a radio transceiver that emits pulses of radio energy and receives a reflection of those pulses back from the target. It is designed to detonate the projectile at a position that will cause the greatest damage to the target. If the projectile comes within a hundred feet of the target, the returning pulse is strong enough to set off the fuse. In the case of a projectile fitted with a VT fuse, a near miss can thus be nearly as effective as a direct hit. VT fuses are commonly used in fragmentation shells. A more recent innovation is the *controlled variable time* (CVT) *fuse*, which delays for a set time after the projectile is fired before becoming active (arming), allowing the weapons officer to choose the time at which the fuse arms and begins radiating. For example, if a ship were firing over friendly ships, the arming would be delayed until the projectile was well past those ships.

The *mechanical time fuse* contains a clock mechanism that explodes the projectile after a preset amount of time elapses. Projectiles containing this type of fuse were commonly used in the 5-inch, 40-caliber, and 20-caliber antiaircraft guns of battleships and cruisers during World War II, which put up flak screens to protect fast carrier task forces during enemy air attacks. Flak is heavy antiaircraft barrages through which aircraft must fly to attack the defended targets.

Some years ago the U.S. Army developed a nuclear warhead projectile that could be fired from a large artillery howitzer, but so far as is known, no naval guns with a similar capability have been developed. Artillery projectiles have been produced that can dispense chemical or biological agents, and as mentioned in chapter 15, some of these may have been used by countries involved in the Middle East conflicts in recent years.

Current Naval Guns

The largest guns on Navy warships today are the Mark 45 5-inch/54- and 62-caliber automatic, dual-purpose, single-mount guns fitted on *Arleigh Burke*–class destroyers and *Ticonderoga*-class cruisers. The 54-caliber gun barrel is 270 inches long, and the 62-caliber barrel is 310 inches in length. Both are fully automatic. They are loaded, controlled, and fired

The *Arleigh Burke*–class guided-missile destroyer USS *McCampbell* (DDG 85) fires its Mark 45 62-caliber 5-inch gun during a live-fire exercise. The fired shell is barely visible to the right of the gunsmoke plume. Earlier *Burke*-class destroyers and *Ticonderoga*-class cruisers were fitted with the 54-caliber model, with a barrel some 40 inches shorter. *Soon Kwon*

from remote positions below deck without any need for a gun crew to enter the mounts. The guns can fire up to twenty rounds per minute to a maximum range of about 26,000 yards with a conventional shell and cartridge, and up to 40,000 yards or more with a more powerful extended range cartridge. The standard shell weighs 72 pounds.

The Mark 110 Bofors 57-mm (2.2-inch)/70-caliber automatic dual-purpose gun, currently manufactured by BAE Systems in Louisville, Kentucky, was originally developed in Sweden for use on small patrol craft to combat high-speed surface, aircraft, and cruise missile threats. It was used for many years on smaller surface warships of many foreign navies, and was adopted for use as a standard armament for the U.S. Navy's littoral combat ships. It has a rate of fire of 220 rounds per

The Mark 110 57-mm gun on the LCS USS *Freedom* (LCS 1) fires at a surface target during gunnery practice. *Ed Early*

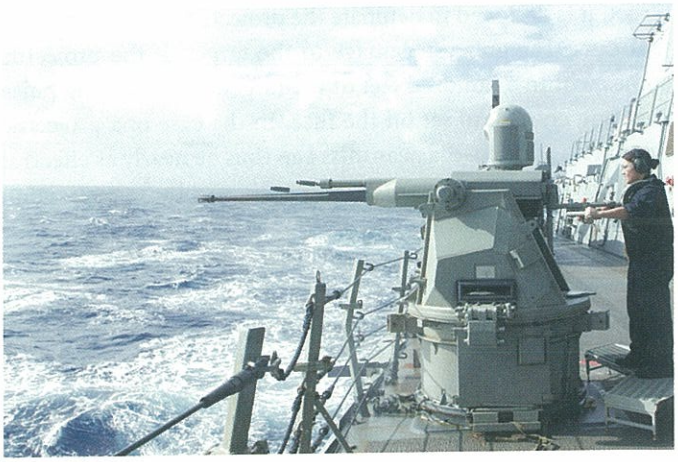
minute, with an effective range of 9,300 yards (8,500 meters) and a maximum range of 19,000 yards (17,000 meters). The gun is remotely controlled, usually by a fire-control computer, but can also be manually operated by instrument panels on the mount.

The Phalanx close-in weapons system (CIWS) is a rapid-fire 20-mm automated gun system originally designed to be a ship's last-ditch weapon against an antiship cruise missile. The Phalanx is a completely automatic unit consisting of a chassis containing search-and-tracking radar, infrared and video trackers, a fire-control system, a magazine containing 1,550 rounds of specialized armor-piercing tungsten penetrator or depleted uranium rounds, and a rapid-fire six-barrel Gatling gun. The latest system currently on board almost all Navy surface ships can detect and engage any antiship missile that penetrates to within five thousand yards, and can also engage fast-moving surface threats and low-flying aircraft. The gun is a six-barrel M61 Vulcan Gatling gun, originally part of the armament of many modern jet fighter and attack aircraft. The current model is capable of firing 4,500 rounds per minute in short bursts to a range in excess of two and a half miles. The Phalanx search radar, infrared scanner, and video inputs are fed directly into a computer, which will identify the target, lock the gun on, and fire it until the target is destroyed; at that point the system will automatically cease firing and begin searching for another target. In addition to the U.S. Navy, the Phalanx is also in use on surface warships of many NATO countries and other allied nations.

The nuclear-powered carrier *Ronald Reagan* (CVN 76) conducts a live-fire exercise of its Phalanx close-in weapons system (CIWS). The CIWS combines a 20-mm Gatling gun with search-and-tracking radar to provide surface ships with terminal defense against antiship missiles, fast-moving surface threats, and low-flying aircraft. The gun is a six-barrel Gatling gun capable of firing 4,500 rounds per minute to a range of about 2.5 miles. *Nathan Burke*

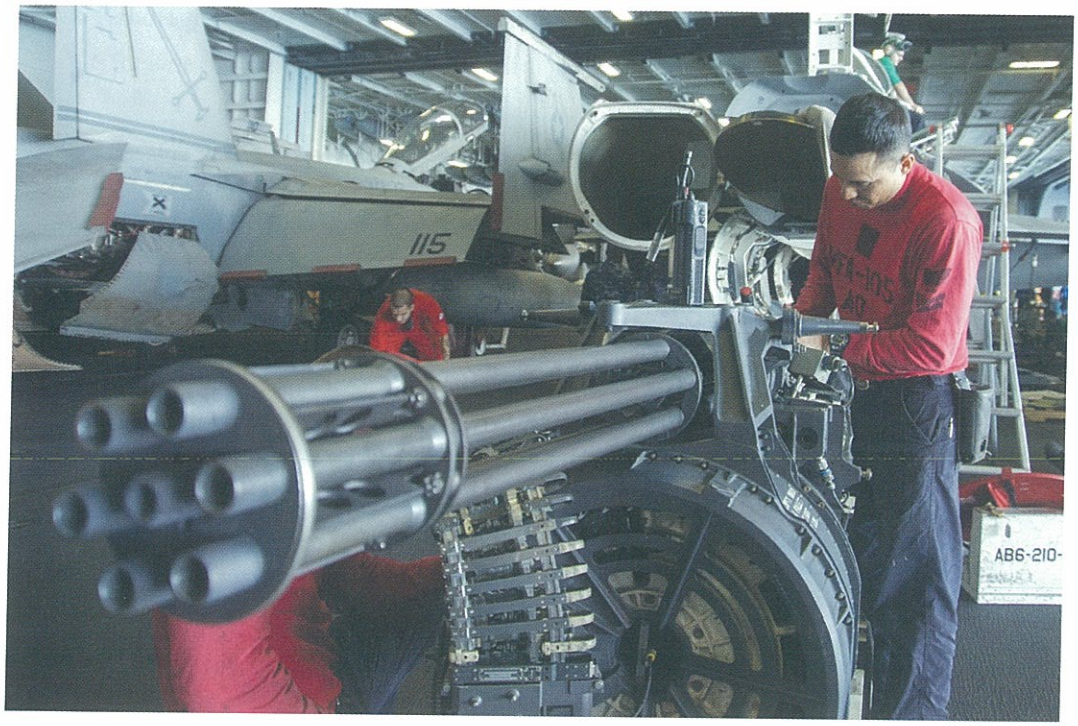
There is also a newly developed model of the Phalanx CIWS that substitutes a short-range high-velocity missile for the Gatling gun. This SeaRAM system is described in the next chapter.

In the early 2000s it was recognized that in addition to larger-caliber guns and guided missiles, Navy surface ships also needed smaller-caliber guns to defend against small, high-speed, highly maneuverable surface and air threats like gunboats and AUVs. Consequently, 25-mm (1 inch) or .50-caliber (.5 inch) machine gun mounts, sometimes both, were placed on board all newer aircraft carriers, cruisers, destroyers, most large amphibious ships, and all littoral combat ships and patrol craft in the U.S. Navy. The weapons are single barrel, air cooled, semi- and full automatic. They can be fired in single-shot



A petty officer fires a Mark 38 25-mm chain machine gun during a live-fire exercise on board the guided-missile destroyer USS *Cole* (DDG 67). The gun can be fired either manually as shown here or remotely from a control console on the bridge. *Brianna Green*

A manually fired .50-caliber machine gun on board the guided-missile destroyer *Roosevelt* (DDG 80). *Taylor A. Elberg*



An ordnanceman performs maintenance on a 20-mm M61 Vulcan Gatling gun from an F/A-18 Super Hornet in the hangar bay of an aircraft carrier. The gun can fire more than 100 rounds per second.
Pasquale Sena

mode or in burst mode, to a maximum range of about 2,500 yards. There are two models of the 25-mm gun. One is manually trained, elevated, and fired; the other is a stabilized newer model that can be either manually or remotely fired, with an electro-optic fire-control system and auto-tracking capability.

Naval Aircraft Guns

Until the end of World War II, most of the armament of naval fighter-type aircraft consisted of small- to medium-caliber wing-mounted machine guns of one sort or another, augmented at times by unguided rockets suitable for use against land targets, ships, and surfaced submarines. To these were added bombs of various sizes and types, incendiaries in the case of fighter-bomber and attack aircraft, and torpedoes. With the advent of nuclear weapons after the war, several models of Navy attack planes such as the A-3, A-4, and A-5 were developed specifically to deliver nuclear bombs, with no other offensive or defensive armament provided in the mistaken belief that it was no longer needed. Fortunately these nuclear capabilities were never called upon in practice, so eventually these aircraft were fitted with conventional weaponry or converted to use as unarmed tanker and reconnaissance aircraft.

During these same years, guided missiles were developed for fighter aircraft, and these saw some use in aerial combat in the Korean and Vietnam Wars. Most aerial dogfight engagements between fighter aircraft in both these wars, however, continued to be decided with nose (bow) or wing-mounted machine guns. Rapid-firing Gatling-type (rotating barrel) machine guns mounted in detachable pods beneath the fuselage began to appear on many attack planes in the late 1960s, as well as on some fighter/bomber aircraft fitted with bow and wing-mounted machine guns. These were intended primarily for use against ground targets by contemporary fighter/bomber and attack aircraft, several models of which, as noted above, had not originally been fitted with any guns at all.

As a result of combat experience in Vietnam and later conflicts, all new fighter aircraft such as the later models of the F-4 Phantom, the F-14 Tomcat featured in the acclaimed movie *Top Gun*, and today's F/A-18 Hornet and F-35A Lightning were designed from the beginning to incorporate fuselage-mounted 20-mm Gatling guns among their armament. The Hornet and the Air Force F-35A version of the Lightning use a six-barrel fuselage-mounted version that can fire more than one hundred rounds per second, while the Marine STOVL (short takeoff and vertical landing) version (the F-35B) and Navy carrier version (the F-35C) can be fitted with four-barrel pod-mounted versions, depending on the mission. They can fire up to fifty-five rounds per second.

All things considered, while guided weapons now predominate, it is likely that some form of gun will remain an important part of naval aircraft armament for many years to come.

Critical Thinking

1. Research and trace the evolution of the modern naval large-bore gun from the smooth-bore cannon of the fifteenth century to the rifled gun of the twentieth century.
2. Describe the process of firing a projectile from a naval gun in terms of the chemical reaction of the burning propellant charge and the physics of the resulting forces on the projectile. Explain how Newton's Laws come in to play during the firing process.

Study Guide Questions

1. What is the purpose of rifling in a gun barrel?
2. How is the caliber of a gun measured?
3. A. On what does the effective range of a gun depend?
   B. What is the purpose of the RAP innovation in certain naval gun projectiles?
4. A. What are the principal components of a round of large-caliber naval gun ammunition?
   B. What are the two types of ammunition used in modern naval guns?
5. What are gun ammunition propellants?
6. What is a projectile, and what are its three main parts?
7. What are the three classes of naval gun projectiles?
8. What are penetrating projectiles?
9. What are fragmenting projectiles?
10. What are special purpose projectiles?
11. A. What does the fuse in a projectile do?
    B. How are fuses classified?
12. What are the largest guns on Navy warships today?
13. A. What is the Phalanx close-in weapons system?
    B. How does it operate?
14. What kinds of small-caliber weapons were placed on board most Navy ships in the early 2000s to defend against high-speed, highly maneuverable surface and air threats?
15. Why were guns not included in the armament of most Navy attack aircraft developed in the years following World War II?
16. As a result of the combat experience in Vietnam and later conflicts, what type of gun was incorporated in all new Navy fighter and fighter/attack aircraft developed since?

New Vocabulary

rifled barrel
effective range
main battery
propellant
fuse
burster charge
RAP
recoil
case ammunition
fixed, semifixed ammunition
shrapnel
projectile
ogive
gun mount
dual-purpose system
arc of train
arc of elevation
caliber
rifling lands
fragmenting projectile
illuminating projectile
star shell
chaff
variable time fuse
proximity fuse
flak

18

Navy Ship, Submarine, and Aircraft Missiles

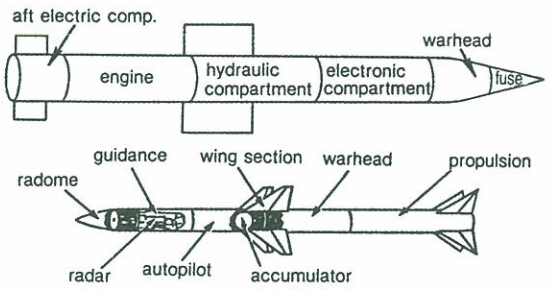
A **missile** is any object that can be projected or thrown at a target. That includes stones and arrows as well as gun projectiles, bombs, torpedoes, and rockets. Today, however, the term usually refers to a **guided missile** or **smart weapon**—an unmanned, self-propelled missile with a guidance system that precisely controls its flight to the target. The term ***smart bomb*** has come into common use to describe non-self-propelled air-dropped munitions fitted with guidance systems that can control the flight path to the target. A **rocket** differs from a guided missile in that it does not have an internal guidance system. A guided missile can carry either a conventional explosive or a nuclear warhead. The aircraft, ship, ground vehicle, or other conveyance from which a missile is launched is often referred to as its **launch platform**.

This chapter offers a brief look at the guided missiles used in the U.S. Navy. Guided missiles have become the main armament of most armed naval aircraft and are considered the main batteries of most surface warships and many submarines. They are also the main antiair weapon in use on board surface ships of all types.

The Navy's antisubmarine homing torpedoes are self-propelled weapons that can be either dropped from USW aircraft or launched from surface warships or submarines. They have elaborate guidance systems that hunt for a target and steer for it on a collision course. They are not technically regarded as guided missiles because they do not travel above the Earth's surface. They are also discussed briefly along with guided missiles in this chapter, however, because they are so important in the fleet's advanced guided weapon systems arsenal.

Missile Components

A guided missile has four basic parts: the airframe, the propulsion system, the warhead, and the guidance system. The **airframe** of a missile is the streamlined body that contains the other parts plus the fuel. Missile airframes are made of aluminum alloys, magnesium, and high-tensile steel sheet, all of which are lightweight materials capable of withstanding extreme heat and high pressure.



Sectional drawings of typical missiles showing the usual location of the various modules (top) and an active homing missile (bottom).

The **propulsion system** must propel the missile at speeds sufficient to minimize its vulnerability while maximizing its probability of intercepting a target. Most missiles designed to operate at supersonic speeds, or partially above the atmosphere or in the water, are equipped with liquid or solid-fuel propulsion systems containing an *oxidizer* (oxygen-carrying agent). Subsonic air-breathing "cruise" missiles carry only a petroleum-based fuel and draw their oxygen from the atmosphere, which limits their operating altitude to about 70,000 feet.

The **warhead** is the payload of most missiles. For all except larger ballistic missiles, the warhead consists of a conventional explosive, or in the case of a practice missile it may contain inert material or telemetry equipment. Large ballistic missiles usually carry a payload of multiple nuclear warheads.

Missile Guidance Systems

With the exception of cruise missiles, most Navy guided missiles have one of five main types of **guidance systems**: preset gyro, inertial, homing, command, or beam rider. GPS-based guidance systems are in wide use on newer models of cruise missiles and precision ordnance, as are data links that enable flight data to be continuously exchanged between a missile and its firing platform or other networked units in line-of-sight contact with an enemy target in a battlespace, regardless of the primary type of guidance system utilized.

Preset gyro guidance uses gyroscopes to keep the missile on a set course, with an onboard computer constantly checking angle of climb and acceleration. When the missile attains the preset course and velocity, power is shut off and it continues to the target as a free (ballistic) projectile.

Inertial guidance makes use of a predetermined flight profile programmed into the onboard missile computer. Missile speed and course are checked constantly, and the computer initiates corrections to keep it on track to the target.

Homing guidance depends on the missile picking up, tracking, and intercepting a target by means of radar, optical, or heat-seeking devices. The homing system will follow any evasive maneuvers attempted by the target, and the missile is fast enough to overtake most targets trying to outrun it.

In *active radar homing* (ARH), a radar transmitter and receiver are incorporated into the missile. The transmitter emits a radar signal that is continually reflected off the target back to the receiver until intercept. Once the missile is launched, active homing is completely independent of the launching platform, which allows the launcher to quickly engage another target. In *semiactive radar homing* (SARH), the disadvantage of a missile having to carry a heavy radar transmitter and antenna is eliminated; the radar transmitter is located on the launching ship, aircraft, or ground vehicle and only the receiver is in the missile. The disadvantage is that the launch platform must continually illuminate the target with the radar until intercept is achieved.

There are also some missile and smart weapon/bomb guidance systems that use lasers rather than radar for semiactive homing. The launch platform illuminates the target with a laser beam, and the weapon incorporates a laser receiver that allows the munition to be guided to the target with much greater precision than would be possible using a radar-based system. Again, a disadvantage is that the launch platform must continually illuminate the target with the laser until the missile reaches it.

In *passive homing* guidance, the missile picks up, tracks, and homes in on a target solely by detecting some form of electromagnetic radiation emitted by it. Sources of energy used for passive homing include light, radio or radar transmissions, and heat. Like active homing, passive homing guidance is completely independent of the launch platform.

Active and passive homing torpedo guidance systems are similar, except that they use sound instead of some form of electromagnetic radiation to provide their guidance.

Command guidance involves missile control by data-link signals transmitted from sources outside the missile. After the missile is launched on an intercept course, a computer on the launch platform, or in some cases on another monitoring platform in the battlespace, tracks both missile and target and transmits to the missile orders to change its track in order to hit the target in spite of any evasive action taken, or to switch to an alternative target. Such missiles usually have some form of active, semiactive, or passive terminal guidance such as terminal semiactive radar homing (TSARH) to increase their probabilities for successful intercepts.

Wire guidance systems are used by some short-range Army missiles and submarine-launched torpedoes. This is a form of command guidance in which a thin wire connected to the missile or torpedo is reeled out from the launch platform. Guidance commands are then transmitted through the wire. It is currently in use for certain Army antitank antifortification missiles and the Mark 48 model of Navy torpedo.

Beam rider guidance requires the missile to follow a radar beam transmitted by the launch platform to the target. It has been used primarily for surface-to-air and air-to-air missiles. A computer within the missile keeps it centered within the radar beam; several missiles may ride the beam simultaneously. If a missile wanders out of the beam, it will automatically self-destruct. Because the width of the beam increases and its strength decreases rapidly as distance from the launch platform increases, it is useful only for shorter-range missiles. The beam is technologically the simplest form of guidance, but beam-riding missiles are also the easiest to evade, so this type of guidance is no longer used in most military missiles.

Many guided missiles in use in the Navy today have **hybrid guidance systems** that are a combination of two or more of the systems discussed above. The Navy's Standard 2 extended-range surface-to-air missile, for example, uses a combination of inertial, mid-course command, and TSARH or passive infrared terminal homing. The terminal active or semiactive radar homing in missiles so equipped is only turned on just prior to intercept, making it almost impossible for the target to detect and evade these missiles.

Uses of Guided Missiles

Guided missiles have added a new dimension to the attack and defense capabilities of the U.S. Navy. While missiles cannot perform all the functions of guns, they can have greater range, accuracy, and payloads. Sea control remains a primary mission of the Navy, but with the advent of the Polaris, Poseidon, and, since the 1980s, the Trident ICBMs, the sea also has become a hiding and launching place for our nation's most potent seaborne strategic power-projection system. These missiles, along with the land-based ICBMs of the Air Force and its strategic bombers, form the U.S. **strategic nuclear triad**, which has served as a deterrent to nuclear war for the last sixty-five years. Modern cruise missiles launched from the sea can also project the Navy's power far inland.

Missiles such as ICBMs and IRBMs (intermediate-range ballistic missiles) launched from silos on land, and other missiles such as cruise missiles and antiship missiles launched by

surface ships at sea against land targets or other surface ships, are called **surface-to-surface missiles**. As will be explained in more detail later in this chapter, the U.S. Navy has largely refrained from placing antiship missiles on board surface warships during the past several decades. They are, however, common in most of the other navies of the world.

Protection against underwater attack is afforded by weapons such as ASROC (antisubmarine rocket) carried by all Navy Aegis-equipped cruisers and destroyers. The rocket delivers a homing torpedo to a water entry point in close proximity to a detected enemy submarine. It is described in more detail later in this chapter.

Surface-to-air missiles have become the main defensive weapons for surface ships and land forces against enemy aircraft and ballistic missiles. Modern military aircraft fly so high and so fast that conventional antiaircraft guns are ineffective against them. The surface-to-air guided missile, however, can successfully intercept attacking aircraft at great heights and ranges.

Such missiles designed to intercept enemy ballistic missiles or their warheads and destroy them before they can reach their targets are called **antiballistic missiles** (ABMs). They must have great acceleration, precise guidance, and long range in order to be capable of such missions. Navy and Japanese Aegis ships equipped with an ABM version of the Navy Standard surface-to-air missile, the SM-3, have been deployed in the Sea of Japan, and on occasion on Navy ships off the U.S. West Coast, as a deterrent to the development of long-range nuclear ballistic missiles by North Korea. Despite Russia's objections, the United States has also deployed the SM-3 to the NATO nations Poland and Romania with the declared intention of providing ABM protection to Europe against ballistic missiles that might be launched by rogue nations in the Middle East.

Two 500-pound laser-guided "smart bombs" are shown here on pylons beneath the wing of an F/A-18 Hornet along with a Sidewinder heat-seeking air-to-air missile on the wingtip for use in air combat.

Guided missiles have become the main weapon used in aerial combat. In the 1980s and 1990s improved guidance systems and better propulsion systems ultimately caused more and more reliance to be placed on **air-to-air missiles** as the main armament for most modern fighter jets. When two jet aircraft are approaching each other head-on, the range can close at speeds in excess of a mile per second. Under these conditions it is difficult even to see an approaching enemy aircraft, and hitting one with gunfire would be just a matter of luck. But an air-to-air missile can "lock on" the hostile aircraft while it is still miles away and pursue and hit it in spite of any evasive maneuvers.

Air-to-surface cruise missiles and precision weapons like smart bombs play major roles on today's attack aircraft. Carrier- and land-based aircraft attacks against enemy buildings, armored vehicles, and fortifications during the Middle Eastern wars of the 1990s, 2000s, and most recently against ISIS targets, and the missiles launched by modern UAV drone aircraft, have shown how devastatingly accurate today's precision-guided air-to-surface weaponry has become.

Modern USW helicopters and other USW aircraft use air-launched homing torpedoes as their principal weapon against enemy submarines.

Guided Missile Designation System

There is a standardized eight-part alphanumeric DOD designation system for guided missiles, similar to the designation system for military aircraft, called the MDS (mission-design-series) Designation System. The basic designation for each missile consists of three letters followed by a design number and name. The first letter designates the *launch environment*, with the most common in the Navy being A for air-launched, B for multiplatform, R for surface ship–launched, and U for underwater-launched. The second letter designates the *mission*, such as G for surface attack, I for aerial intercept, Q for drone, and U for underwater attack. The third letter designates the *type*: B for booster, M for guided missile, N for probe, R for rocket, and S for satellite. These three designation letters are followed by a hyphenated design number and letter signifying the model. Most missiles are also given names and series numbers by which they are commonly identified throughout their service lifetimes, regardless of any modifications they may go through. For example the RIM-161C Standard-3 surface-to-air missile is the 161st design of ship-launched aerial-intercept guided missile, and the third model of that design. It is still named the Standard missile, even though it is two series and many models later than the original design, the RIM-66A Standard-1 missile, which was phased out of U.S. service in 2003.

Ballistic Missiles

Ballistic missiles are large missiles with either conventional or nuclear warheads that are initially powered by rockets but then follow an unpowered ballistic trajectory to their targets. They are classified according to the maximum distance they can travel, which is a function of how powerful their booster rockets are and the size of their warheads. There are four classifications of ballistic missiles:

- *Short-range* ballistic missiles (SRBMs) with ranges less than 1,000 km (620 miles)
- *Medium-range* ballistic missiles (MRBMs) with ranges between 1,000 and 3,000 km (620–1,860 miles)
- *Intermediate-range* ballistic missiles (IRBMs) with ranges between 3,000 and 5,500 km (1,860–3,400 miles)
- *Intercontinental* ballistic missiles (ICBMs) with ranges greater than 5,500 km (3,400 miles)

An unarmed Trident II missile launches from an *Ohio*-class fleet ballistic-missile submarine off the coast of Florida. The successful launch certified the operational readiness of the crew and the submarine's weapon system before returning to operational availability for a deployment. *John Kowalski*

Short- and medium-range ballistic missiles are referred to as *theater ballistic missiles*, and intermediate-range and intercontinental ballistic missiles are called *strategic missiles*. Because most modern large ballistic missiles can carry more than one conventional or nuclear bomb, their warheads are usually referred to as *payloads*, and the individual warheads containing the bombs that may ultimately be released by the payloads are called *reentry vehicles*.

Most modern ICBMs have multiple reentry vehicle warheads that can either be released in sequence to strike multiple targets (*MIRV*s—multiple independently targetable reentry vehicles) or at the same time to strike a single target in a cluster (*MRV*s—multiple reentry vehicles). Once released, the reentry vehicle warheads continue along a ballistic trajectory to their targets, though some, including those on the Navy's Trident ICBM described below, can aerodynamically adjust their flight paths to some extent with small airfoils.

There is currently only one ballistic missile in the Navy inventory, the Trident II ICBM. Called the *fleet ballistic missile* (FBM), it is a 3-stage 44.6-foot 130,000-pound submarine-launched strategic missile with a range in excess of 12,000 km (7,456 miles). Each of the Navy's fourteen *Ohio*-class ballistic missile submarines carries twenty-four Tridents. The Trident can carry between eight and twelve MIRV warheads in its payload.

Models of the cone-shaped nuclear reentry vehicle warheads in the payload of a Trident missile at the National Museum of Nuclear Science and History. *Tim Menzies*

Cruise Missiles

A cruise missile is a low-flying, air-breathing subsonic missile designed to attack surface targets at long range. Most have terrain-contour-matching capabilities that make them very difficult to intercept. The first such missile to be widely used by the Navy was the Harpoon, the Navy's first antiship cruise missile. Later versions are still in use today, not only by the U.S. Navy but also by the navies of almost all NATO and several other allied countries.

First introduced in 1977, the Harpoon has air, surface, and subsurface versions, and can be used for both land attack and antiship missions. It can be launched from carrier-based attack aircraft, the land-based P-8 Poseidon maritime patrol aircraft, most cruisers and destroyers, and nuclear attack submarines. It is a sea-skimming, stub-winged cruise missile, powered by a turbojet engine, with speeds in the high subsonic range. The current submarine-launched version (UGM-84) has a range of 75 nautical miles, and the surface-launched (RGM-84) and air-launched (AGM-84) versions have ranges between 150 and 170 nautical miles respectively. The surface and subsurface versions are 15 feet long, including a booster, and weigh about 1,400 pounds; the air-launched version is 12 feet long and weighs about 1,100 pounds. All have a 500-pound

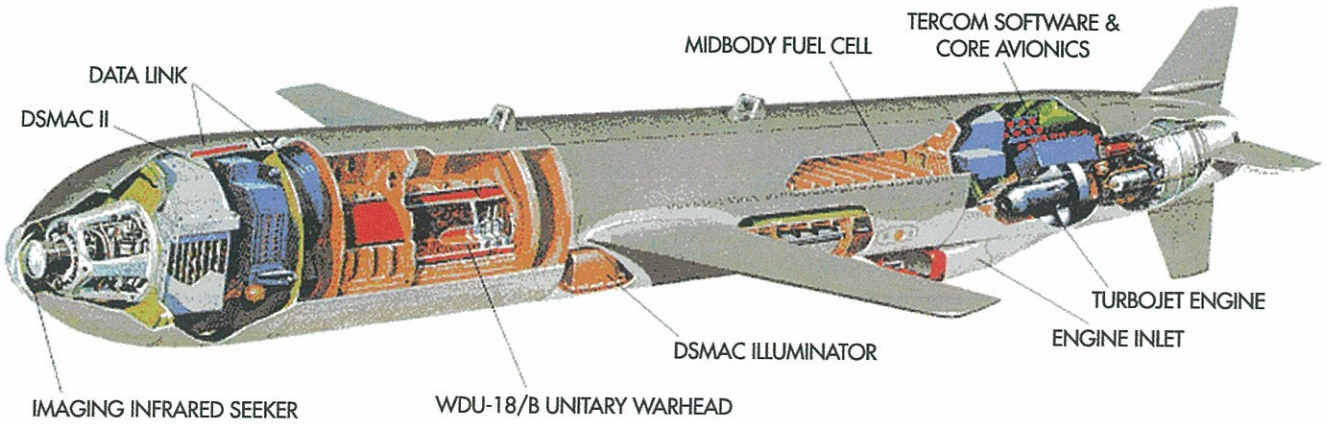
A Harpoon surface-to-surface missile launches from the USS *Coronado* (LCS 4) during an exercise. *Bryce Hadley*

Aviation ordnance handlers load an AGM-84K SLAM-ER cruise missile onto the pylon of a P-8 Poseidon patrol aircraft. *Jason Kofonow*

high-explosive warhead. The submarine version is launched within a capsule from a torpedo tube, and the engine ignites after the capsule breaks the water surface. After launch from the firing platform, it flies at one hundred feet above the water. This sea-skimming flight profile, along with active terminal guidance radar, ensures a high probability of penetrating enemy defenses and hitting the target.

The air-launched AGM-84K SLAM-ER (Standoff Land Attack Missile–Expanded Response) was originally developed from the Harpoon in the late 1980s to give the Navy a surgical strike capability against high-value land targets and ships. An earlier version was used in Iraq in Operation Desert Storm in 1991, and later in Operation Enduring Freedom in Afghanistan. It has a GPS-based guidance system and infrared imaging for navigation and control, and it can strike both moving and stationary targets. It is the most accurate of any cruise missile used by the Navy. It is turbojet powered, 14 feet long, with a wingspan of 7 feet, and a weight of about 1,500 pounds. The SLAM-ER can be launched from a variety of Navy fighter, attack, and patrol aircraft. It has a range in excess of 150 nautical miles.

The BGM-109 Tomahawk is an all-weather, long-range, subsonic land-attack cruise missile first developed in the 1970s. It can be launched from submarines, ships, land, and aircraft. It is 20 feet long with a wingspan of 8 feet 9 inches, and weighs 2,900 pounds including a 1,000-pound warhead. It travels at 550 miles per hour, with a range between 700 and 1,350 nautical miles, depending on the model. The Tomahawk flies at very low altitudes and has terrain-matching and infrared guidance features, making defense against it extremely difficult. Most versions have GPS guidance and can be reprogrammed in flight to an alternate target if deemed necessary. It will interface with



Cutaway drawing of a Tomahawk cruise missile.

An early model of the Tomahawk cruise missile circa the mid-2000s.
Daniel McLain

the Integrated Fire Control system now being implemented by the Navy and will be able to exchange sensor data and receive updated guidance from any platform in the system. The Tomahawk has been used to great effect over the past twenty years in actions such as Operations Desert Storm and Iraqi Freedom in the Persian Gulf region, in attacks against al Qaeda terrorists and the Taliban in Operation Enduring Freedom in Afghanistan, and more recently against ISIS/IL and Syria.

Surface-to-Surface Missiles

Although the surface-to-surface (SSM) antiship missile has long been a staple of many foreign navies, the U.S. Navy, dominant on the high seas after the end of the Cold War in the late 1980s, deemphasized this type of missile until recently. There are some variants of the sea-launched land-attack Tomahawk cruise missile that can be adapted for use in this mode, but at present the only Navy missile specifically designed for long-range use against surface ship targets is the Harpoon cruise missile, discussed above. The SSM version, designated the RGM-84, is 15 feet long with a maximum range of about 150 nautical miles. It is presently carried by Aegis cruisers and destroyers, but a variety of other surface platforms are also presently being considered, including patrol craft and the littoral combat ships.

In recent years the increasing antiship missile threat posed by such potential adversaries as the Chinese, Russian, and Iranian navies has caused greatly increased interest in SSMs within the U.S. Navy. In 2016 it was announced that the Navy is developing an antiship version of the Standard SM-6 surface-to-air missile that will be capable of striking a surface target at ranges in excess of two hundred nautical miles and receiving mid-course guidance from the Navy's new Integrated Fire Control communications network. A new version of the Tomahawk cruise missile incorporating a maritime attack capability is currently under development as well and is scheduled to enter service in 2021.

Surface-to-Air Missiles

From the 1950s through the 1970s, the second line of fleet air defense after the combat air patrol was centered on the "3 Ts," the Navy's first surface-to-air (SAM/RIM) guided missiles: Terrier, Tartar, and Talos. The latter was a long-range missile with an air-breathing ram jet engine; it was phased out in the 1970s. Numerous improvements were made in the Terrier and Tartar missiles over the years, culminating in the late 1960s with the first of the Standard missile series, eventually featuring medium-range (MR), extended-range (ER), and antiballistic missile (ABM) versions. Standard missiles are an integral part of the modern-day Aegis weapon system (AWS) on board *Ticonderoga*-class cruisers and *Arleigh Burke*–class destroyers, and are launched from the MK 41 vertical launch system (VLS).

The Standard-2 (SM-2) has been the Navy's primary SAM air defense weapon since the first model became operational in the 1980s. There are both medium- and extended-range versions. The current RIM-66M Standard-2 MR version, 15.5 feet long and weighing 1,500 pounds, has a range in excess of 90 miles and a ceiling greater than 80,000 feet. The RIM-156A Standard-2 ER (extended range) version, 21.5 feet long and weighing some 2,900 pounds, includes a booster that extends its range to more than 130 nautical miles with a ceiling of 110,000 feet. In addition to their anti–air warfare capabilities, the SM-2s also have a limited surface attack capability and are capable of intercepting incoming ballistic missile warheads at low altitudes. The Navy has committed to keeping the SM-2 MR version in its arsenal until at least 2035.

An upgraded version of the Standard-2 ER, the RIM-174 SM-6 ERAM (extended-range active missile), became operational in 2013. It incorporates a modified advanced medium-range air-to-air missile active seeker into the Standard missile airframe, thus giving it improved terminal homing capabilities against agile cruise missiles and over-the-horizon targets, and greater capability for use in terminal defense against descending ballistic missile warheads.

The RIM-161 Standard-3 ER (SM-3), about the same size and weight as the Standard-2 ER, was developed in the mid-2000s for primary use as an ABM. It has a range of more than 270 miles and a ceiling in excess of 150 miles. Its increased range gives it the capability to intercept short-, medium-, and intermediate-range ballistic missiles in the initial boost (ascent) or mid-course phases of their trajectories, as opposed to the warhead terminal-defense capabilities of the SM-2s and SM-6.

In February 2008 a Standard-3 ER was used to intercept and blow up a falling 1,000-pound National Reconnaissance

A Standard-2 surface-to-air missile launches from a guided-missile destroyer during a live-fire exercise. *Taylor Elberg*

Office satellite some 130 miles above the north Pacific, and in 2013 a SM-3 successfully destroyed a medium-range ballistic test missile warhead high over the Pacific. As mentioned earlier, the SM-3 is deployed on board Navy and Japanese ships in the Sea of Japan, and Navy ships off the U.S. West Coast, as a deterrent to North Korea's efforts to develop long-range ICBMs, and in Poland and Romania to shield Europe from ballistic missiles that might possibly be launched by rogue Middle Eastern countries.

The RIM-7 Sea Sparrow is a radar-guided SAM adapted in the 1970s from the earlier Sparrow air-to-air version for point defense of surface combatants out to a range of about ten nautical miles. It is a semiactive-radar-guided homing missile that makes flight corrections via radar uplinks. Original versions were fired from trainable box launchers, but later versions were capable of being launched from VLSs as well. It is used on Navy CVNs, LHAs, and LHDs, and is also a primary air defense weapon on many NATO surface warships. The latest version, developed in the early 2000s and called the RIM-162 ESSM

An Evolved Sea Sparrow surface-to-air missile being fired from the aircraft carrier *Carl Vinson* (CVN 70). *Matt Haran*

(Evolved Sea Sparrow Missile), is 12 feet long and weighs about 500 pounds. It can be fired from the box launchers on CVNs, LHAs, and LHDs designed for the RIM-7, and from the vertical launch systems of Aegis cruisers and destroyers. The ESSM provides excellent defensive capabilities out to about twenty-seven nautical miles against high-performance aircraft, helicopters, and cruise missiles. It has also been adapted for use as an antiship missile. An improved Block 2 version scheduled to become operational in 2020 will incorporate an autonomous terminal radar guidance feature, an upgrade to the present model that depends on radar illumination of the target throughout its flight by the launching ship's combat radar systems.

The RIM-116 RAM (rolling airframe missile) was originally adapted in the late 1970s from the Sidewinder heat-seeking air-to-air missile for use as a point-defense missile by several allied navies. In the 2000s later versions were placed on several of the newer aircraft carriers and larger amphibious ships of the U.S. Navy, and it is part of the standard armament on older littoral combat ships. It gets its name from its spin stabilization, like the spin imparted to a large-gun projectile. It is the only missile in the Navy inventory with that characteristic, which makes it much more agile than other air defense missiles. It is a lightweight, nine-foot-long, fire-and-forget missile fitted with both passive radio-frequency and infrared terminal guidance seekers, designed primarily for quick response to close-in antiship missile threats. For many years it was fired from a box-type launcher that held twenty-one missiles, and used the firing ship's combat systems to direct the launcher at targets out to a range of about ten miles. In the 2010s the latest version was mated with the Phalanx close-in weapons system mount to produce a completely autonomous system that does not depend on any external information to engage threats. The combination, called the SeaRAM, consists of an eleven-cell box launcher

A rolling airframe surface-to-air (RAM) missile being launched from a box launcher on the USS *Bataan* (LHD 5). *Frank Cottone*

A RAM missile is test-fired from a SeaRAM mount on board the guided-missile destroyer USS *Porter* (DDG 78). Note the Phalanx radar unit above and to the right of the launcher.

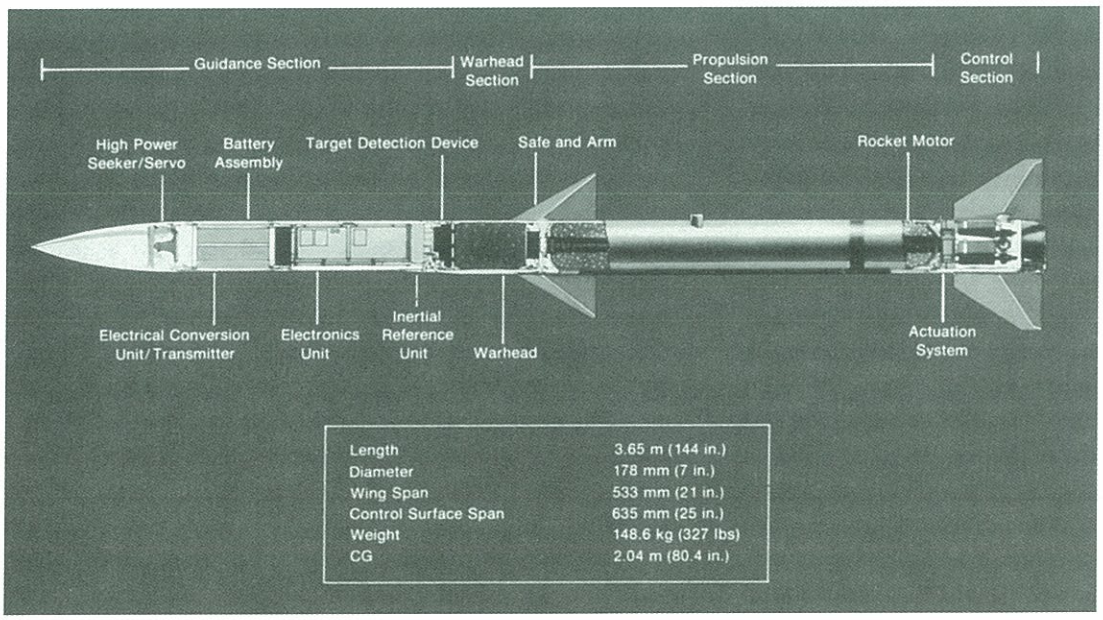
mounted onto the Phalanx chassis and radar unit, replacing the M61 Gatling gun. The system uses the Phalanx's capabilities to automatically search, detect, acquire, track, and engage incoming antiship missiles, aircraft, and high-speed surface threats with the RAM missile rather than the Gatling gun, out to a range of about ten nautical miles. It is being mounted on Navy destroyers and newer littoral combat ships.

Air-to-Air Missiles

The front line of defense for a naval task force is its combat air patrols (CAPs), which range far out from the fleet to meet incoming enemy air threats with highly capable air intercept missiles (AIMs).

The AIM-9 series Sidewinder missile is carried by both Navy and Air Force fighter and attack aircraft and is designed for use in close-range, dogfight-type air engagements. The missile is an infrared-homing heat-seeker air-to-air missile. It varies in weight from 160 to 210 pounds depending on the version, has a speed of Mach 2.5, a range of about 2 miles, and is capable of operating against high-performance aircraft at altitudes from sea level to above 50,000 feet. The improved fuse, warhead, and maneuverability of the latest model provide U.S. pilots with the best possible advantage in close combat.

The AIM-120 advanced medium-range air-to-air missile (AMRAAM) is the latest in the Navy inventory. A follow-on to the old Sparrow missile, it was developed jointly by the U.S. Navy and Air Force working with several NATO nations. It has active radar guidance and an onboard computer system that makes the missile independent of the fire-control system of the launching aircraft. Once the missile closes in on the target, its active radar guides it to intercept. This enables the aircraft pilot to aim and fire several missiles at once at multiple targets



Cross-section of the AMRAAM air-to-air missile.

and then perform evasive maneuvers while the missiles guide themselves to their targets. The missile has a high-explosive fragmentation warhead. A more recently developed version can be used as a land-launched SAM. Several of the missiles are contained in and launched from a box launcher on a mobile launch vehicle.

Air-to-Surface Missiles

The Navy has several different types of air-to-surface missiles (AGMs) and other guided ordnance designed to attack a wide range of surface targets, including armor, air defenses, ground transportation, and ships.

The AGM-65 Maverick missile is used for close air support of friendly ground forces, interdiction of enemy forces, and suppression of enemy weapon systems. It has two types of warheads. One has a contact fuse in the nose so that it will detonate on impact; the other has a delayed fuse that allows the missile to penetrate well into hard targets before exploding. The AGM-88 HARM (high-speed antiradiation) missile is designed to home in on and destroy enemy radars used to locate and track U.S. aircraft, missiles, and ships. The AGM-114 Hellfire missile is a one-hundred-pound short-range laser-guided subsonic Army missile adapted for launching by Navy Seahawk helicopters against tanks and other types of enemy armored vehicles. It has a range of about a quarter mile to eight miles. It can also be used as an air-to-air weapon against helicopters and slow-moving fixed-wing aircraft. Because of its light weight it has been extensively used to arm AUVs such as the Predator, in which role it has been used against many suspected al Qaeda and ISIS/IL terrorists; another version has been adapted for firing from mounts on LCSs equipped with surface warfare modules for defense against swarming fast attack craft.

A Navy Seahawk helicopter fires a Hellfire air-to-surface missile. *Mark Loenesio*

Another more recently developed air-to-surface weapon is the AGM-154 Joint Standoff Weapon (JSOW). It is a large glide bomb developed by a joint Navy–Air Force program to allow aircraft to attack surface targets while remaining at a safe standoff distance, thus greatly increasing aircraft survivability. It will be able to interact with the Navy's new Integrated Fire Control system when implemented. The JSOW has a range of fifteen to sixty nautical miles, depending on the altitude at which it is launched. The standard warhead has a shaped charge for penetrating armor, a fragmenting case, and a zirconium ring for incendiary effects; an alternative has a shaped charge followed by a bomb for penetrating and destroying hardened targets. A turbojet-powered version to be designated the JSOW-ER (extended range) presently under development will increase its range to between seventy and three hundred nautical miles.

As mentioned previously, both the Harpoon and Tomahawk cruise missiles come in AGM versions, allowing Navy

An aviation ordnanceman arms a Maverick air-to-surface missile beneath an F/A-18 Hornet. *Gretchen Roth*

Aviation ordnancemen move an AGM-154 Joint Standoff Weapon (JSOW) from an elevator on board an aircraft carrier during Operation Iraqi Freedom. *Bo Flannigan*

aircraft to attack surface targets at sea and on land while remaining far outside the range of enemy guns and missile defenses.

There is also a guidance kit called the Joint Direct Attack Munition (JDAM) that converts conventional 1,000- and 2,000-pound bombs into precision-guided munitions using the satellite-based GPS system for guidance. Weapons of this type are often referred to as *smart bombs* to distinguish them from older unguided bombs that follow ballistic trajectories after being released from the delivering aircraft.

Undersea Warfare Weapons

Today, the Navy's primary operational undersea warfare (USW) weapons are antisubmarine rockets (ASROC) and antisubmarine (ASW) torpedoes.

The ASROC is a supersonic, solid-fueled, antisubmarine ballistic missile fitted with an ASW torpedo warhead that is carried by Aegis cruisers and *Arleigh Burke*–class destroyers and fired from vertical launch tubes. The ASROC missile has a length of 16.7 feet, weighs 1,650 pounds, and has a range of up to 11 miles. Surface ships of many other nations allied with the United States also are fitted with ASROCs launched from older box-type launchers mounted on their decks.

The purpose of ASROC is to destroy enemy submarines at long ranges. It does this by delivering an ASW homing torpedo through the air to a point in the water from which it can begin a search pattern to find and home in on the target submarine. An ASROC-equipped USW ship can launch its weapons before the submarine is even aware that it is under attack.

In addition to ASROC, Navy ASW homing torpedoes can be launched by submarines, from deck-mounted launch tubes on surface ships, by helicopters, and by USW patrol aircraft like the P-8 Poseidon. After they enter the water, most of these torpedoes are guided by devices that acquire and then home in on the sound of the submarine being attacked (*passive acoustic homing*), on reflected echoes from it (*active acoustic homing*), or both. They are powered by electric motors and batteries.

A Mark 46 practice ASW torpedo launches from torpedo tubes on the deck of the guided-missile destroyer USS *Mustin* (DDG 89) during a USW exercise.

Crewmen of the attack submarine USS *Virginia* (SSN 78) practice loading a Mark 48 training torpedo during an ordnance-loading exercise. The Mark 48 is a primary antisubmarine weapon for the Navy and can be launched from USW aircraft, deck-mounted tubes on surface warships, and submarines. *Michael Barton*

As previously mentioned, the Navy's submarine-launched Mark 48 antisubmarine torpedo can be launched using either wire guidance or an onboard acoustic active/passive homing system, with the wire guidance used to avoid countermeasures such as decoys or acoustic jamming. The wire is severed just prior to impact after the torpedo has acquired the target on its terminal acoustic homing system.

Guided Missile Trajectories

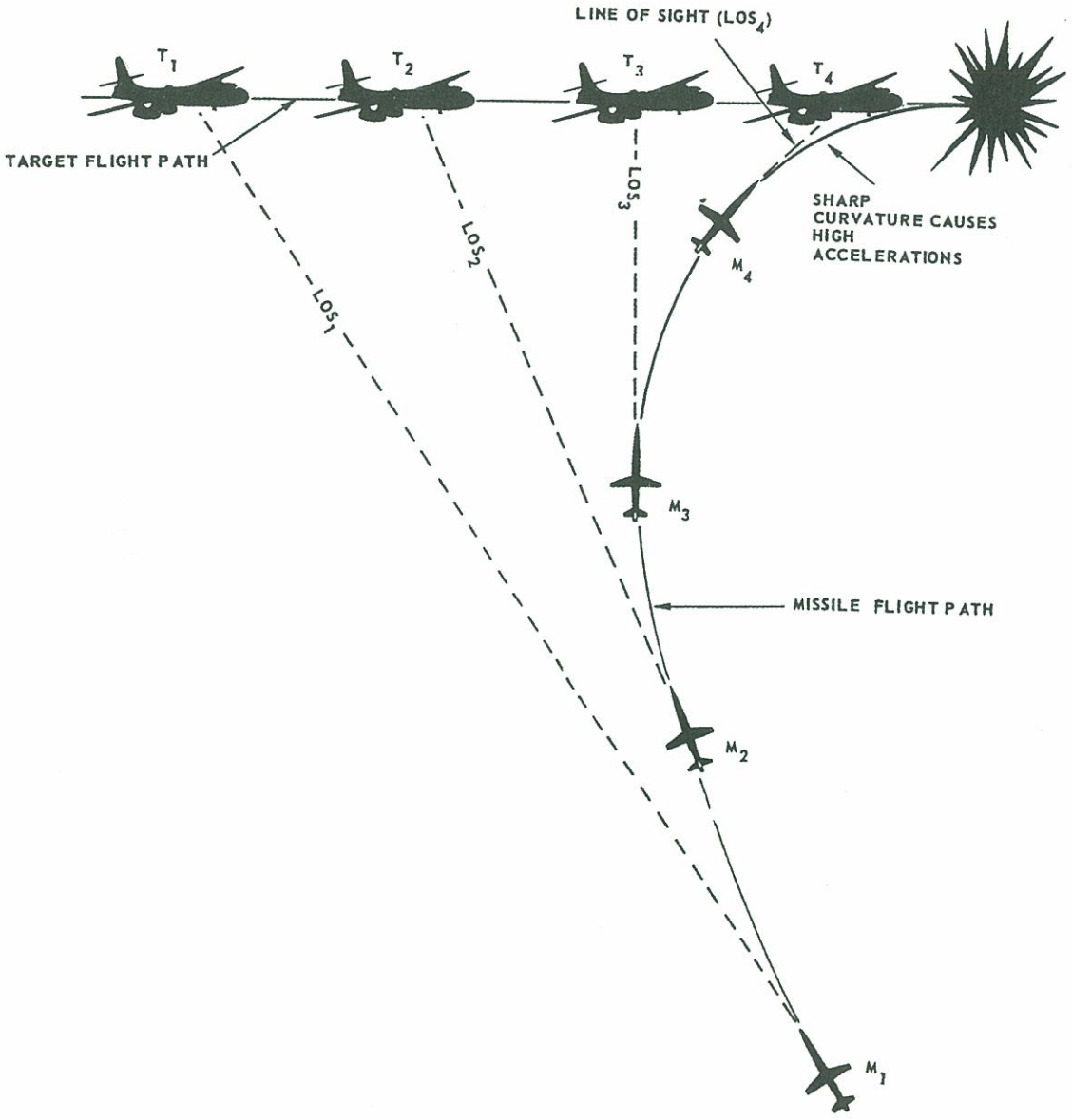
The **trajectory** of a missile is its path from launch to impact or destruct. There are two basic types of missile trajectories: ballistic and aerodynamic. A number of other trajectories are named according to the path traveled, including glide, powered flight, terminal, and standard.

In a **ballistic trajectory**, the missile is acted upon only by gravity and aerodynamic drag after the propulsive force is terminated. An **aerodynamic trajectory** is one in which aerodynamic forces (thrust, drag, weight, and lift) are used to maintain the flight path.

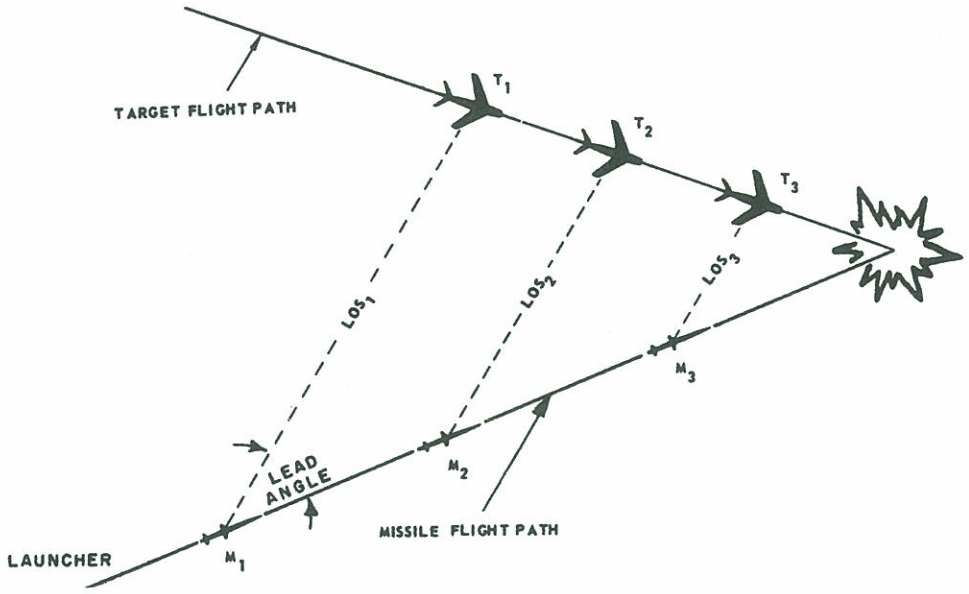
As was mentioned in the previous chapter, gun projectiles have a purely ballistic trajectory. The major part of the trajectory of ballistic missiles is also of this type. ICBMs such as Trident, as well as short-, medium-, and intermediate-range

ballistic missiles, are launched vertically so they can get through the densest part of the atmosphere as quickly as possible. At a certain altitude determined by preset guidance, the missile inclines to a more gradual climb. This powered part of the trajectory, during which the guidance system makes corrections to the flight path to give the missile the proper trajectory to hit the target, is called the *boost phase*. Depending on the type and size of the missile, there may be two or more booster rockets called *stages* that power the missile in this phase of its flight, each of which falls away after exhausting its fuel supply. After final stage booster separation, the missile payload coasts along a curving ballistic free-fall trajectory, called the *mid-course phase*, during which its warhead(s) are released. In the case of longer-range ballistic missiles, this phase occurs largely above the atmosphere, to a maximum height of about 750 miles. In the final *reentry* or *terminal phase*, the warheads descend back down through the atmosphere to their targets.

Aerodynamic guided missile trajectories include many types of curves. The exact nature of the curve is determined by the type of guidance and the nature of the control system used. A missile with a hyperbolic guidance system, for instance, will follow a *hyperbolic* trajectory. The missile will first climb to the



The pursuit homing or zero-bearing missile intercept path followed by most homing and beam-rider missiles.



The lead angle modified pursuit intercept path.

desired altitude and then follow the arc of a hyperbola before diving on its target.

Most homing and beam rider missiles follow a *pursuit curve*. At any given instant the missile is pointed directly toward the target. If such a missile pursues a crossing target, the missile must follow a curved trajectory. In some cases the extreme curvature required by the pursuit course as the missile nears the target may be too sharp for the missile to follow. A highly maneuverable aircraft with a proficient pilot, for example, may be successful in executing radical maneuvers that will "lose" the missile pursuer. American pilots became adept at outmaneuvering Soviet-made SAMs fired from the Hanoi area in North Vietnam during the latter days of the Vietnam War.

Some homing missiles follow a *modified pursuit course*, flying not toward the target but toward an intercept point in front of it. The missile thus develops a *lead angle*, and the curvature of its course is decreased. A refinement of the lead angle course involves a computer, either in the missile or at a control platform, that can use tracking information about the missile and target to calculate a point of intercept that the missile and target will reach at the same instant. The computer compensates for changes in target course and speed, and new points of intercept are continuously calculated and used to update the missile's guidance system.

ASROC weapons follow **combination trajectories**. The ASROC is fired from a ship and boosted into the air by rocket thrust. After rocket burnout, the torpedo goes through the air in a ballistic trajectory until striking the water. After water entry, the torpedo dives to a preset depth and then begins its homing target search. When it detects an echo from the target, it follows a pursuit path to attack it.

A missile's trajectory is, of course, greatly affected by the design of the missile and its guidance system. But just as for a gun projectile, natural external forces also affect the trajectory. These include wind, gravity, centripetal forces, and the Coriolis force. All of these factors must be taken into account with any long-range missile. Modern computers and guidance systems are able to compensate for these effects and keep the missile on a correct course to its target.

Critical Thinking

1. Are naval aircraft designed for a specific weapon system or is a weapon system adapted to fit an airplane? Give evidence to support your answer.
2. Research three current naval aircraft and identify their weapons capabilities.
3. Research and describe some of the possible tactics that could be used by an aircraft seeking to evade radar-guided air-to-air or surface-to-air missiles.

Study Guide Questions

1. What type of weapon has become the main armament on most of today's armed naval aircraft?
2. What are the four basic parts of a guided missile?
3. A. What is the payload of a missile called?
   B. What can it consist of?
4. What are the five types of guidance systems used by most Navy guided missiles?
5. What Navy missile is a part of the nation's strategic nuclear triad?
6. What kinds of missiles have become the main defensive weapon for surface ships and land forces against enemy aircraft and ballistic missiles?
7. What is the purpose of an antiballistic missile?
8. What kind of missiles have become the main weapon used in aerial combat?
9. What meanings do the initial three-letter DOD designations for guided missiles convey?
10. A. What is the Harpoon missile?
    B. What are its principal features and range?
11. A. What is the Tomahawk missile?
    B. What are its capabilities?
12. What were the 3 Ts that provided the surface Navy with its second line of air defense capability from the 1950s through the 1970s?
13. What are the capabilities of the Standard missile versions presently in use?
14. What Navy surface-to-air missile was developed from the Sparrow air-to-air missile?
15. What Navy surface-to-air missile was developed from the Sidewinder heat-seeking air-to-air missile?
16. What are the air-to-ground missiles (AGMs) currently used by Navy aircraft?
17. What is the ASROC?
18. How do homing torpedoes operate?
19. What are the two basic types of missile trajectories?
20. What kind of a trajectory is followed by most ballistic missiles?
21. A. Describe a missile pursuit curve.
    B. How may a pilot evade such missiles?
22. What natural external forces affect a missile's trajectory?

New Vocabulary

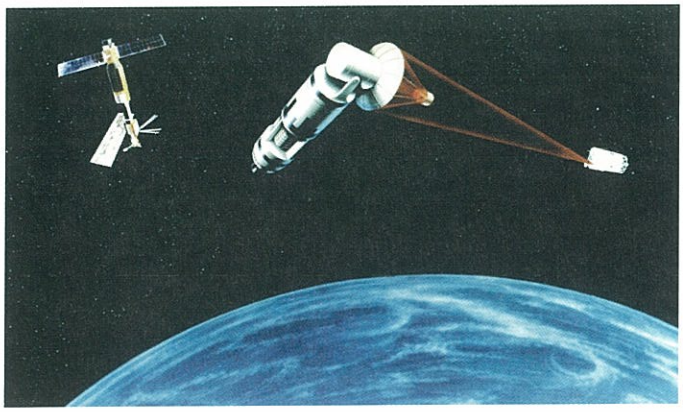
Gatling guns
guidance system
rocket
propulsion system
warhead
homing guidance
semiactive homing
command (missile) guidance
3 Ts
acoustic homing
lead angle
guided missile
smart bomb
airframe
oxidizer
inertial guidance
active homing
passive homing
beam rider guidance
Coriolis force
trajectory
pursuit curve

19

Laser Weapons and Rail Guns

The preceding chapters of this unit presented an overview of the major conventional weapons used on Navy ships, aircraft, and submarines. This chapter describes two of the more futuristic types of weapons currently being developed for naval surface warships: laser weapons and rail guns. Both of these had their genesis in the last years of the Cold War during the Reagan administration in the 1980s, in a program he initiated called the Strategic Defense Initiative, or SDI.

The objective of SDI was to develop a defensive shield against any massive nuclear ICBM attack that might be launched against the United States. It would consist of a combination of ground-based and spaced-based antiballistic missile technology, including long-range antiballistic missiles (ABMs), then being developed; and hypervelocity electromagnetic rail guns, massive chemical lasers, X-ray lasers, and particle-beam weapons, all of which were only in the conceptual stage at that time. The last three of these, and others similar to them, are referred to as **directed energy weapons** because they use projected electromagnetic energy to damage or destroy a target. The ABMs, rail guns, and chemical lasers would be ground based and focused on destroying descending nuclear warheads, while satellite-based X-ray lasers powered by exploding nuclear bombs and particle-beam weapons consisting of streams of highly accelerated atomic particles would target enemy ballistic missiles from space during the boost and mid-course phases of their trajectories.



A contemporary artist's rendering of a generic laser-equipped satellite firing on another as part of the Strategic Defensive Initiative of the 1980s. The then just-proposed International Space Station is shown in the background. *Air Force photo*

Although the contemporary mainstream media derided much of this as "*Star Wars*" science fiction, after the popular motion picture series of the same name, much research effort was nevertheless spent in feasibility studies and early developmental efforts. America's main Cold War adversary at the time, the Soviet Union, strenuously objected to the initiative, claiming that it would seriously destabilize the strategic mutual assured destruction (MAD) doctrine of nuclear parity that had deterred nuclear war since the beginnings of the nuclear arms race in the 1950s. Moreover, some of the space-based aspects of SDI would violate the provisions of the Outer Space Treaty of 1967, which banned the placement of any satellites containing nuclear weapons or other weapons of mass destruction in Earth orbit.

Eventually it became evident that most of the more far-fetched weapons envisioned for use in the SDI program were not within the capabilities of the current technology of that time. That, plus the relaxation of tensions with the Soviets presaging the end of the Cold War the following year, caused the program to be largely abandoned by the end of the Reagan presidency in 1988. Nevertheless, numerous proponents continued advocating for some type of directed energy and rail gun weapons to be developed for use in the U.S. Navy.

Laser Weapons

Following the demise of the SDI program, scientific interest turned toward the development of another type of directed energy-beam weapon that would not use dangerous chemicals—or X-rays or atomic particles—but rather laser light beams in the infrared range generated by solid state technology. Not being composed of either X-rays or charged particles, such beams would not be as susceptible to deflection by the Earth's

magnetic field or dispersion in the atmosphere, especially over relatively short ranges, and automated optical and radar trackers would be capable of keeping the laser beam focused on a target long enough to have the desired destructive effect. If these beams could be radiated with sufficient power, once focused upon a target they could convey enough heat energy to seriously damage or destroy it within a few seconds.

LASER is the acronym for *light amplification through the stimulated emission of radiation.* Lasers work by exciting the atoms, molecules, or ions in a medium such as gases, liquid chemicals, fibers, or diodes until they emit a quantity of light having exactly the same wavelength, often outside the range of visible light. In a **laser weapon**, that light, generated with a powerful concentration of energy, is then focused into a narrow beam by mirrors and directed at a target. The laser beams do their damage by heating the target, quickly and with a lot of conveyed energy. This rapid heating can cause fuel tanks of smaller surface combatants such as gunboats or patrol craft to catch fire or explode, engines to overheat, ammunition to detonate, and other such debilitating effects. Lasers burn the fuselage and control surfaces of aircraft, drones, and missiles, causing them to become aerodynamically unstable and fall out of the sky.

It has been determined that in order to have sufficient power to seriously damage or destroy a missile, aircraft, or small surface combatant, a potent weapons-grade laser beam would have to be radiated at a power of at least about one hundred kilowatts (KW), with several hundred to a thousand kilowatts (one megawatt) being preferable. Since laser weapons only have an efficiency of around 10 percent, this would mean delivering up to ten megawatts of power to the weapon for the duration of each shot, with most of the difference showing up as waste heat that has to be dealt with by some sort of cooling mechanism in the mount.

Even with an associated device that could accumulate and store the required energy over several minutes for each shot, this would severely strain the power-generating capability of most existing Navy warships, which have an average total maximum steady state power-generating capacity of about six megawatts. However, with the possibility that such weapons may become commonplace in the not-to-distant future, in recent years new classes of U.S. Navy warships such as *Zumwalt*-class destroyers and *Gerald Ford*–class carriers now just entering service have been designed with far greater power-generating capability. The *Zumwalt*-class destroyers are being built with gas turbine generators that can produce 78 megawatts of power, and the *Gerald Ford*–class has four 26-megawatt generators capable of generating 104 megawatts, with both of these peak capacities being much more than is required to run all of their existing operating equipment. Thus, both of these new classes of warships would have more than enough additional capacity to easily sustain several laser weapons.

Rather than the hundreds of thousands or even millions of dollars that each medium or long-range surface-to-surface or surface-to-air missile shot can cost, the cost of the fuel required for each shot with a laser beam of suitable strength is only a few dollars. This could be a crucial cost-savings element for the Navy in future years as it strives to develop an affordable defense against increasing numbers of adversaries who may choose to use swarms of small boats, UAVs, and antiship cruise and ballistic missiles (ASBMs) to attack Navy ships. Moreover, a laser beam weapon takes up a relatively small amount of space, in contrast to missiles or gun systems whose rounds must be stored in space-consuming secure magazines within the ship's hull. And as long as the firing ship maintains sufficient power-generating capabilities, it will never run out of ammunition.

Notwithstanding the advantages of laser weapons, however, they have the tactical disadvantage of being useful only for line-of-sight attacks on a target, making missiles a continuing necessity for defending against over-the-horizon air and surface threats. Thus, it is doubtful that laser weapons would ever become the only armament on naval warships.

Laser weapon development programs sponsored by the Office of Naval Research (ONR) continued for the next twenty-five years following the demise of the SDI concept, eventually resulting in several test prototype models of an effective weapon. After thorough testing, the current prototype weapon, designated the LaWS (laser weapons system), was placed in operational status in 2014 on board the converted amphibious transport dock test ship USS *Ponce* (AFSB 15), permanently deployed to the Persian Gulf. The LaWS has a solid state optical fiber laser with a maximum power of about thirty kilowatts. It can be directed either by auxiliary tracking telescopes located

A prototype Navy LaWS laser weapon placed in operational status on the converted amphibious transport dock test ship USS *Ponce* (AFSB 15) in 2014. It has an optical fiber laser with a maximum power of about thirty kilowatts and has brought down test drones at ranges of up to about two miles. *John Williams*

alongside the beam generator in the mount or by the short-range radar system of the Phalanx close-in weapons system. Although somewhat underpowered, in tests this beam has been able to remain focused on airborne target drones and maneuvering small remotely operated surface craft long enough to cause them to burst into flame out to ranges of about two miles, consistent with the range of the Phalanx CIWS gun system. More powerful versions of this weapon currently in development will probably extend the range and destructive capability to ranges of ten miles or more, comparable to the range of the Navy's SeaRAM defensive missiles.

Besides the large power and cooling requirements, another major technical disadvantage of the laser weapon is that atmospheric effects such as water vapor, clouds, fog, dust, and smoke particles can scatter and absorb the energy in the beam, and atmospheric turbulence can defocus it, limiting its ability to damage the target at anything except short ranges. An infrared laser, for example, will lose half of its energy traveling two and a half miles on a clear day, and in less than a mile on a hot, humid day. The more powerful the laser, the more damage it can do in less time at close range, and the better it remains a coherent, damaging beam at longer distances.

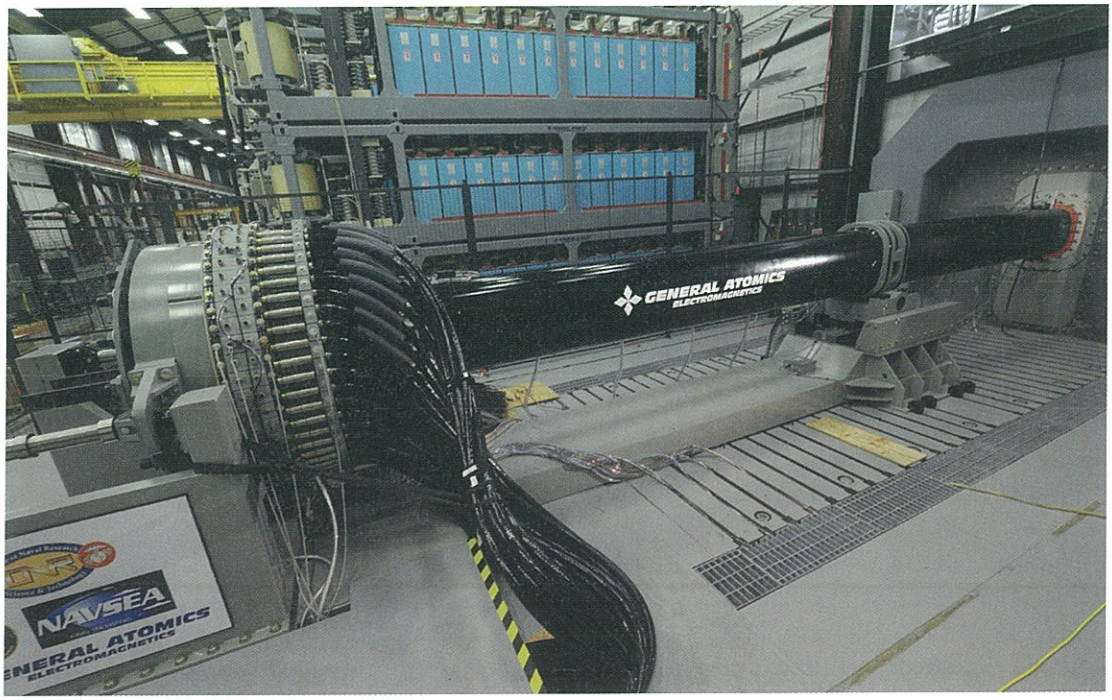
Current plans are to put laser weapons on all new *Gerald Ford*–class carriers and *Zumwalt*-class guided-missile destroyers, and if technologically feasible by then, back-fit them onto all *Arleigh Burke*–class guided-missile destroyers in the early 2020s. A modified lighter-weight version has been proposed for use on the new F-35 Lightning jet fighters as additional air-to-air and air-to-surface weapons.

Another type of directed energy weapon also being investigated is **radio-frequency weapons**. These would utilize bursts or beams of high-power microwaves or other ultra-wide-band electromagnetic radiation capable of disabling electronics or personnel. Although these weapons would require less power than laser beam weapons, they are also more susceptible to random deflection and distortion by the Earth's atmosphere and magnetic field, and would have a much shorter range. With the exception of some vehicle-mounted prototypes, therefore, no other successful large-scale prototypes have been developed to date.

Equipping Navy surface ships with laser weapons could lead to major changes in naval tactics, ship design, and procurement plans for ship-based weapons, bringing about a "game-changer" technological shift for the Navy comparable to the advent of shipboard missiles in the 1950s.

Rail Guns

The SDI program in the 1980s also initiated research into the concept of an electromagnetic **rail gun** that would propel a projectile down a pair of parallel rails at a very high speed. Subsequent R&D efforts in the years since by ONR led to the design and construction of several working prototypes. As the rail gun projectile travels along the rails, a magnetic field created by a large direct current on the order of several million amps or more flowing through the rails for a few milliseconds converts up to fifty megajoules of electrical potential energy into kinetic energy (energy of motion), accelerating the projectile to

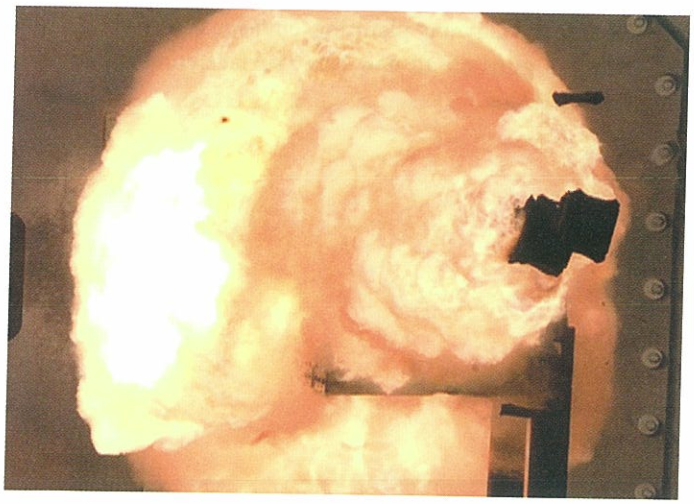


An early prototype rail gun developed by ONR for testing at the Naval Surface Warfare Center (NSWC) at Dahlgren, Virginia.

a very high velocity by the time it reaches the end of the rails. Research with large rail gun prototypes has shown that they can generate muzzle velocities of up to 2,500 meters per second (5,600 mph), enough to enable the projectile to travel well over a hundred nautical miles and penetrate several meters (up to about 20 feet or more) of reinforced concrete. By contrast, the muzzle velocity of a World War II–era battleship's 16-inch gun projectiles was 760 meters per second. Because a rail gun projectile strikes its target at a very high speed, it can penetrate further and deliver as much destructive kinetic energy as the explosive energy of a 5-inch naval gun projectile.

Rail gun projectiles are smaller and much cheaper than most missiles, so many more of them can be carried in a given amount of interior space, and they do not need special storage or handling because they are inert.

Rail guns also have their disadvantages, however. They require significantly more energy per shot than laser weapons, which would strain the power generation capabilities of even the newer Navy ships. Another major disadvantage of a rail gun system is that the friction of the projectiles with the rails during each shot generates huge amounts of waste heat, which like laser weapons' heat must be dissipated before the next shot. The rails are made of special heat-resistant materials, but even with that, thermal erosion of the rails requires that they be changed out at relatively short intervals. This also represents a significant problem, since like the Phalanx CIWS gun system, unguided rail gun rounds will require many shots to be made in very short time intervals to bring down maneuvering supersonic antiship missiles. Also, the projectiles must be strong enough to withstand acceleration forces of up to 100,000 g as well as a large amount of frictional heating because they travel down the rails and through the air at such high velocities.



A plume of superheated plasma produced by a test firing of a thirty-two-megajoule prototype rail gun at NSWC.

Rear Adm. David Hahn, Chief of Naval Research (left), and Capt. Godfrey Weekes, commanding officer of the Naval Surface Warfare Center, hold a hypervelocity rail gun projectile. *Ryan DeShazo*

Notwithstanding these drawbacks, shipboard rail guns are being given much consideration by the Navy, initially for use as antiaircraft weapons against air threats, especially antiship cruise missiles, and for shore bombardment. Because of its high speed, a rail gun projectile can engage a target such as a cruise missile at ranges up to about thirty nautical miles, and do so much faster and farther away from the ship than close-in antiaircraft missiles. The odds of hitting the missile improve dramatically the closer the projectile gets.

The latest prototype electromagnetic rail guns are currently being built for the Navy and tested by General Atomics and BEA Systems. They have been in R&D status for the past ten years. The guns can fire a 25-pound elongated cone-shaped nonexplosive metal projectile from a 32-foot-long barrel containing the rails with a muzzle velocity of about 2,000 meters per second, or about 4,600 miles per hour (Mach 6 in terms of sound speed), to a distance in excess of 100 miles. The projectile is fired inside an aluminum casing that falls away after the projectile leaves the barrel, along with a large, incandescent plume of superheated plasma formed from the ablated surfaces of the rails and casing vaporized during each shot. The projectile is filled with tungsten shrapnel pellets and is fitted with small, stubby fins at the tail end to impart a spin to it as it travels through the air after firing. Each shot requires twenty-five megawatts of power for the duration of the projectile's travel down the rails in the barrel, which results in the generation of about thirty-two megajoules of energy per shot. As with laser weapons, even with an associated energy-accumulation device, this amount of power and energy still represents a significant drain on a ship's generating capability—about a third of the

Unit 6

Modern Naval Warfare

The last several decades have seen major changes in the ways the U.S. Navy brings to bear its people, weaponry, and forces in order to be ready and able to wage war when required for the national defense. Traditionally, there were two broad classifications of such warfare: conventional and unconventional. At one time in the last century it was rather easy to differentiate between the two. **Conventional warfare** was fought between or among two or more clearly defined antagonists, usually sovereign nations, with uniformed military personnel using **conventional weapons**, defined as any weapons not chemical, biological, or nuclear in nature. Anything else was *unconventional warfare*, fought with *unconventional* (mainly nuclear) weapons.

In this century the distinctions between conventional and unconventional warfare have blurred, with the focus in modern times shifted to the type of warfare as opposed to the weapons used. **Unconventional warfare** is now defined by the Department of Defense as "activities to enable a resistance or insurgency to coerce, disrupt, or overthrow a government or occupying power through and with an underground, auxiliary, and guerrilla force in a denied area." Such unconventional warfare is also called **irregular warfare**. As was discussed earlier in this book, in the late 1990s and early 2000s this type of warfare was often referred to as *asymmetric warfare* in order to better differentiate it from the earlier concept. Asymmetric warfare is defined as armed conflict between belligerents of greatly differing military capabilities, in which the weaker adversary (or adversaries) resorts to unconventional tactics such as guerrilla warfare, terrorism, hijackings,

and suicide bombers. Belligerents in such warfare might use mainly conventional weapons, but they might also resort to **unconventional weapons** such as biological or chemical agents, IEDs and barrel bombs, and "dirty bombs" laced with radioactive material. Nowadays, however, the term *asymmetric warfare* has gone out of vogue because by its nature almost all warfare is asymmetric, in that a major tactic in all forms of conflict is to mass power against perceived weaknesses of the opponent. Instead, such warfare is now generally called **special warfare**, in which the targets are not confined solely to military objectives but often include government institutions and leadership in general, as well as the civilian population.

Previous chapters of this book have dealt with many different aspects of what is commonly called conventional or irregular warfare, from strategy and tactics, operations and support functions, and international law governing its conduct to the weapons used by the U.S. Navy to engage in such warfare. In this unit we will complete the discussion by focusing on other major aspects of modern warfare, including cyber warfare; special warfare and counterterrorism; mine warfare; and biological, chemical, and nuclear warfare, traditionally referred to as *special weapons*, or in more recent times, *weapons of mass destruction*.

20

Cyber Warfare

The modern U.S. Navy depends on computer technology for almost every activity in which it engages. However, this dependence carries with it a potential vulnerability to outside efforts to penetrate the Navy's communication and command and control computer networks in order to conduct espionage or to damage or render them ineffective, especially in wartime.

Such attempts to penetrate or impair information networks or computers that are interconnected within them, if done on a large scale by foreign government entities, are called **cyber warfare**. If done by extremists or terrorists in furtherance of their agendas, they are called **cyber terrorism**. Unfortunately, such attempts at disruption are not limited to military information networks and computer systems. Hundreds and often thousands of such attempts are made daily against government, commercial, and private individuals' computers and computer networks as well. Some of the more successful of these attacks to date are described later in this chapter. They have necessitated the development of a whole new discipline called **cyber security** to try to safeguard these computers, their networks, and the information they contain and convey.

Cyber warfare generally involves sophisticated attacks against large military, government, or commercial computer networks and information systems, although smaller systems and individual computers operated by private users may also be attacked. There is currently much discussion and controversy in the United States—most recently sparked by an alleged cyber attack by Russia on the computer systems of the Democratic National Committee and some of its officials in the fall of 2016—as to when such acts of cyber warfare reach a level of severity that constitutes an act of war. Also, given that there are some thirty other countries in the world that have relatively sophisticated capabilities in cyber warfare—and of these, a half dozen or so unfriendly ones with capabilities equal to or perhaps even greater than ours—there is also a great deal of concern and current discussion about what retaliatory measures the United States ought to take to try to deter future cyber warfare attacks by unfriendly nations.

Thus far, such cyber countermeasures have been relatively mild and narrowly targeted against the perpetrators within the countries that launched the attacks. If the United States were to mount stronger cyber counterattacks, the responses by unfriendly nations might not be as restrained. Because of the current vulnerability of much of the U.S. infrastructure to such possible retaliatory cyber-attacks, many U.S. government officials have expressed the opinion that U.S. retaliation for future cyber attacks ought to be more focused on alternative retaliatory measures such as economic and trade sanctions rather than on cyber countermeasures. It remains to be seen what future U.S. policies will be in regard to the conduct of cyber warfare. For now, only the President may authorize cyber countermeasures against foreign countries.

This chapter discusses the concepts of cyber warfare and cyber security in the U.S. Navy in some detail to give you a better idea of how, where, and by whom these endeavors are conducted within it.

Command Relationships

Within the U.S. military, cyberspace operations are under the purview of the U.S. Cyber Command (USCYBERCOM), headquartered at Fort Meade, Maryland. After its formation in 2009 USCYBERCOM was for many years a component command of the unified U.S. Strategic Command, but in August 2017 President Donald Trump elevated it to become one of the ten unified combatant commands of the U.S. national defense command structure (see chapter 6). USCYBERCOM's mission is to plan, coordinate, integrate, synchronize, and conduct activities to direct the operation and defense of DOD information networks, and when directed, to conduct full-spectrum military cyberspace operations in order to ensure freedom of action in cyberspace and deny the same to our adversaries. USCYBERCOM is the centralized command for all U.S. military cyberspace resources, synchronizing all cyber warfare capabilities to defend the military information security environment.

Each of the military services, including the Marine Corps, has a component command within USCYBERCOM that

coordinates all cyber-related activities within that service. The Navy's organization, called the Fleet Cyber Command (FLTCYBERCOM), is also headquartered at Fort Meade. FLTCYBERCOM is an operating force of the U.S. Navy responsible for all of the Navy's cyber warfare programs. Its force provider was designated the Tenth Fleet in 2010, in keeping with the fleet designations within the other geographic commands of the U.S. unified command structure. Operating as the U.S. Tenth Fleet, FLTCYBERCOM provides support to Navy commanders worldwide for information, computer, electronic warfare, and space operations. It also serves as the Navy's cryptologic commander. Like the afloat fleet commands, the Tenth Fleet's forces are organized into task forces, task groups, elements, and units.

Should any military unit such as a ship within the operating forces detect a possible cyber attack attempt upon any of its information systems, the unit reports the specifics to its service's component cyber organization within USCYBERCOM for resolution and guidance as to how to proceed to mitigate any adverse effects.

Cyber Warfare Fundamentals

Cyber warfare is a broad topic encompassing a number of different disciplines. The study of cyber warfare begins with gaining an in-depth understanding of the technical aspects of computer and information system architecture, because it is this architecture that often governs how cyber attacks are initiated and how defenses against them are implemented. A wide variety of other interdisciplinary studies also come into play, including but not limited to law, political science, strategy and tactics, policy, ethics, and the studies of foreign languages and cultures.

Some of the basic principles of computer architecture and the Internet were introduced in *Naval Science 2*, but a much more thorough understanding of computer and network technology and cyber operations is required to become proficient in the field of cyber warfare. Much of this is beyond the scope of the NJROTC program and requires the student interested in this field as a possible future profession to gain the needed expertise in computer science and its applications through higher-level studies in high school, technical schools, or college.

Cyber operations include digital forensics, cyber reconnaissance, cyber security, cyber attack, and cyber defense. *Digital forensics* is concerned with reconstruction of past events of concern that occurred within a computer system using stored log data, surviving memory fragments, and other electronic trace evidence. It is often done as part of a post–cyber attack analysis or a criminal or civil law investigation. *Cyber reconnaissance*, like military reconnaissance of a prospective target, involves gathering information about a targeted computer system or network in order to assess its strengths and weaknesses. Reconnaissance can be done actively using certain scanning tools or passively by simply gathering relevant information. An overview of cyber security, cyber attack, and cyber defense is presented below.

The Cyber Battlefield

The **cyber battlefield** is comprised of the basic components that constitute what is generally called **cyberspace**—the sum total of all the world's computers, servers, and the networks interconnecting them. Familiarity with the cyber battlefield begins with an understanding of digital data, the physical computer, operating systems, and application programs, and extends to the World Wide Web, the Internet, and both wired and wireless networks.

A major subset of the cyber battlefield is the **cyber domain**, which comprises the users; the devices and software with which they interact or interface with information systems; logic used by component devices and software; circuits that provide paths for logic to flow; and the geographic and physical location of the users, circuits, and systems. At different times users may have different roles, or *personas*, in the cyber domain, and may interact with it in different ways at different times. *Interface aspects* of the cyber domain are the hardware devices and software with which users interact to provide input into various components within the cyber domain. Traditionally these included keyboards and computer mice, and today also include touch screens, microphones, and cameras, and may in the future include implants within our bodies. *Logic aspects* consist of the information stored within information systems, and *circuit aspects* are the paths across which data flows between systems or data storage sites. In the cyber domain, *entities* (users, components, or organizations) associated with one aspect can have many simultaneous interactions with other aspects. An interaction, interface, or mode of operation that was safe one day might not be safe another if a vulnerability is discovered by a malevolent actor during the intervening time.

Cyber Security

Protection in the cyber domain centers on the ability to maintain the service for which an information system is intended, despite any attempts to deny this ability. For almost any information system, there are five so-called **pillars of cyber security** that users and system designers strive to protect, and that a hacker tries to attack or circumvent:

- *Confidentiality*: protection of information from disclosure to unauthorized individuals, systems, or entities.
- *Integrity*: protection of information, systems, and servers from unauthorized modification or destruction.

Both of these are *data oriented.*

- *Availability*: timely, reliable access to data and information services by authorized users.

Availability is *service oriented.*

- *Nonrepudiation*: the ability to correlate, with high certainty, a recorded action with its originating individual or entity by disallowing denial of its origination or receipt.
- *Authentication*: the ability to verify the identity of an individual or entity.

Both of the above are *entity oriented.*

There is some degree of overlap among these five pillars, so that a given defensive measure may protect more than one pillar. For the same reason, in many cases a single attack may violate more than one pillar. There is a close relationship between nonrepudiation and authentication, but they are not the same. Authentication is compromised when an attacker has the ability to pose as another individual or system, often by stealing valid authentication credentials. In contrast, nonrepudiation concerns the ability to *prove later, after the fact*, that an action is associated with a specific individual or entity. Very often, log entries or *digital signatures* (unique identifiers for the originator of a digital message or document) of events are used to provide nonrepudiation, so a violation occurs when the logging or signature mechanism is compromised. One example of this is the digital signature a person can place on a document using a *digital certificate*—an attachment to an electronic message used for security purposes. Nonrepudiation establishes that a later analysis of the signed document can show with high certainty that it must have been signed by someone who possessed that digital certificate.

Identifying an event as an attack requires understanding which of the five pillars have been violated and which properties are consequently lost. Some examples of possible attacks and the pillars they violate are as follows:

- Stealing a file: *confidentiality*
- Defacing a web page: *integrity*
- Bringing down a server: *availability*
- Sending a malicious e-mail from someone else's account: *nonrepudiation*
- Stealing log-in credentials: *authentication*

There is always an inherent conflict between the services an information system provides and security. An information system with no way for data to flow in or out is very secure, but it is unable to provide a service. The more services that are provided or allowed, the more ways there are to get in and out of the system that need securing. Thus, for each service, its value must be weighed against the security implications of providing or allowing it. The associated *risk* is weighed against the *benefits*, and a decision is made.

Cyber Attacks

"Security" for an information system means its ongoing ability to provide its services while maintaining the properties constituting the pillars of cyber security. Thus, a **cyber attack** is basically defined as an action that violates one of the pillars. There are unlimited possibilities. For example, an attacker driven by monetary gains might sell credit card information obtained with privileged access on the black market. Or an attacker motivated by political gains might expose private embarrassing information about a political opponent to hurt the opponent's popular image.

In general, if a mal-doer wants to attack a system in some way, he or she needs to violate at least one pillar. In order to do so, he or she needs to defeat the security tools that are being used to protect the pillars.

There are three basic phases of a cyber attack:

- *Reconnaissance.* In this phase the goal is to identify weak points of the targeted system. The attacker finds out the information he or she needs to get into the system: what traffic the firewall lets through, what *hosts* (computers or other devices) are in the network, what services they have running, and the like.
- *Infiltration and maneuver.* In this phase the goal is to gain control of a host on the target's network. This is typically done by gaining remote access as an administrator on that host. The attacker thus gains the access needed to achieve his or her goal. This may often involve multiple steps.

A Navy cryptologic technician helps a high school student at the Naval Air Station Pensacola, Florida, who is participating in an annual Cyber Thon event that provides high school and college students an opportunity to gain experience in cyber defense procedures. *Taylor Jackson*

- *Exfiltration and maintaining access.* In this final phase the goal is to achieve the intended objective within the compromised system and then get back out, leaving no trace of the trespass. The attacker takes an action that violates one or more pillars of cyber security and then takes whatever steps are necessary to cover his or her tracks. The attacker may either terminate the connection, if no further access is required, or create a virtual backdoor into the system for future access to the target.

A cyber attack is not very different from a military attack. A cyber attacker will dedicate a significant amount of time to observing and probing the target computer system to find weaknesses in its defense. Any weakness found may lead to infiltration of the target network.

Below are some examples of successful cyber attacks that have occurred in the recent past and the pillars of cyber security that were violated:

- *Confidentiality.* In December 2013 national retailer Target Inc. reported the theft of records for 40 million credit and debit cards used at its stores. Not long after the breach, the card data was being sold at underground forums to thieves. The credit card data was supposed to be confidential, but *confidentiality* of the data was not preserved.
- *Integrity.* In 2010 the Stuxnet computer worm developed jointly by U.S. and Israeli intelligence agencies was used to infiltrate the computer systems controlling Iran's nuclear enrichment centrifuges. The Stuxnet code modified the programmable logic controller (PLC) software, causing the centrifuges to spin out of control while giving the console operators only normal indications. The *integrity* of the PLC software was violated in this attack.
- *Availability.* In 2008 computer systems supporting banks, media, communications, transportation, and other infrastructure in the nation of Georgia experienced a widespread denial-of-service attack originating from Russia. At the time, a dispute had flared up between Georgia and Russia over control of areas along the Georgia-Russia border. The *availability* of critical systems through Georgia's (entire country) connection to the Internet was greatly diminished.
- *Nonrepudiation.* Although there are few publicized examples of nonrepudiation violations, or "repudiation attacks," the following are some general examples:
  - Unauthorized manipulation of e-commerce transaction logs (making it hard or impossible to later prove a company performed an action, such as an equipment purchase or a stock market trade).
  - Unauthorized manipulation of administrator access logs on any computer (making it hard or impossible to later prove who was logged on, and when).
- *Authentication.* In 2011 RSA, an American Internet security company, acknowledged that its proprietary authentication system, employed by some defense contractors and other high-security industries, was compromised. The attackers were able to log into systems at Lockheed Martin and other companies using the stolen credentials of legitimate users.

In addition to those used as examples above, several other large-scale and widely publicized successful cyber attacks have been perpetrated against entities in the United States in recent years. Three of the worst of these to date occurred in 2011, 2015, and 2016. In April 2011, in a cyber attack later attributed to North Korea, the Sony PlayStation system was infiltrated, gaining access to more than 77 million user accounts. User names, passwords, home addresses, and some 12 million credit card numbers were all compromised. In April 2015, malware was discovered in the computer systems of the federal government's monolithic Office of Personnel Management, which gave the perpetrator, since identified as China, access to all the agency's servers. By the time the malware was identified and removed, some 18 million files containing the detailed 127-page security clearance questionnaires of every applicant for a federal job during the prior decade had been compromised, along with the complete personnel files of some 4.2 million federal employees. In the fall of 2016, in the midst of the then ongoing presidential election campaign cycle, the internal e-mail files of the Democratic National Committee and several of its key officials were hacked, and later released by Julian Assange's WikiLeaks organization. Subsequent investigation by the CIA, DHS, and NSA determined that the perpetrator was Russia, and that the compromised material was hacked in an attempt to influence the outcome of the election. Many additional similar but smaller-scale incidents have occurred before, during, and after these three, and continue today, affecting both national security and the personal privacy rights of millions of U.S. citizens.

It is widely acknowledged that such attacks constitute a serious threat to national security, and a recent head of USCYBERCOM has called them the greatest threat currently faced by the U.S. military.

The President must personally approve any offensive cyber attack, such as the Stuxnet worm incident in 2010, launched against any foreign entity by any agency of the U.S. government.

Methods of Attack

There are a number of ways and means an attacker might use to conduct cyber attacks. One of the simplest methods is the *semantic attack*, the dissemination of incorrect or misleading information that leads the system being targeted to take incorrect or harmful actions in response. Other more sinister methods, called *syntactic attacks*, involve the injection of malicious coding into a system via some form of **malware** (malicious software). The malware alters or destroys a computer system's

Vice Adm. Walter Carter, superintendent of the U.S. Naval Academy, observes a team of midshipmen participating in an annual cyber defense competitive exercise hosted by the National Security Agency. Naval Academy cyber teams customarily rank among the top competitors in this annual multiday competition. *Tyler Caswell*

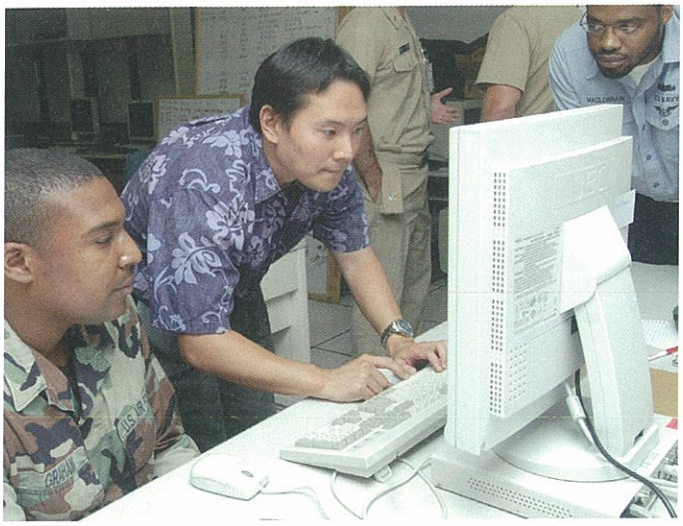
programming and/or other software from within—often without any awareness by the user until it is too late—by means of viruses, worms, or Trojan horses. All three of these are likely to attack an individual computer or network via such vectors (paths of entry) as e-mail attachments, web browsers, chat clients, remote software, and updates.

Viruses are self-replicating programs that can hide in unlikely locations in the memory of a host computer system and attach themselves to targeted programs or files in order to execute their code and reproduce themselves. Most often they will attach to executable type files and cannot run unless the file is executed. A virus cannot spread past its initial host without some unintentional assistance from human action. Once enabled, a virus might corrupt or delete data on a computer, or even the whole hard drive, without any knowledge on the part of the user. More sophisticated viruses can change their digital footprint each time they reproduce, making them very difficult to track down, isolate, and remove.

Worms are self-replicating, self-propagating programs that use networking mechanisms to spread themselves without any help from a user. Worms typically scan the surrounding network, exploit specific vulnerabilities in the host operating systems or services via an open port (software communications interface), and then transfer themselves to the new host.

Trojan horses are named for the famous wooden horse in which the attacking Greeks gained entrance to Troy during the Trojan War. In the computer world, a Trojan horse is a program that appears to have a useful function but also has a hidden and potentially malicious function that evades security mechanisms and performs unknown and unwanted activity. In contrast to viruses and worms, Trojans do not replicate themselves or send themselves to other hosts. "Trojan" actually refers to the mechanism by which the malware is delivered, not to the malware itself. Once malware is delivered via a Trojan, it might be used to gain access to other hosts, but not usually via the same Trojan mechanism.

Once it infects a computer, malware can have many harmful effects. Files could be deleted or sent back to the attacker; the host computer could become a *zombie*—a computer under the control of the attacker—that might be used to send spam or participate in a denial-of-service attack. Collections of zombies with a single master are often called *botnets*. The infected computer might become a springboard for a further attack on the system of which it is a part; or it could act as a key-logger and capture what is typed on the computer keyboard, or even turn on the computer's webcam unbeknownst to the user. **Spyware** is a type of malware that installs on a computer and enables the attacker to gather information useful for identity theft or a user's activities in the digital realm. **Adware** is a malware package that automatically plays, displays, or downloads unwanted advertisements. It may also change settings on a computer, such as the browser homepage.



An instructor at the Space and Naval Warfare (SPAWAR) Systems Center in San Diego, California, demonstrates to an Air Force staff sergeant and Navy information systems petty officer how to monitor the activity of a computer network in order to defend against intrusions such as viruses and probes with sweeps and scans of the system. *Michael Lantron*

Defeating Cyber Attacks: Cyber Defense

While there are many companies that market antivirus software protection for individual computers that protects them against many forms of cyber attack, large-scale information systems require much more elaborate protection. In addition to antivirus software installed on each device within the network, there is usually a dedicated IT security staff that monitors the network 24/7 using a variety of sophisticated intrusion detection devices and software.

The fundamental reality that makes securing an information system so difficult is that an attacker only has to find one vulnerability to exploit in order to start an attack, whereas a defender must guard against an attack on each and every service or user. A large system such as a corporate network or IT infrastructure consists of many hosts and users, and provides many services, and any of these could become avenues for successful attacks. That does not mean that defense of such a system against cyber attack is hopeless, but it does mean that securing a system is a difficult task and is an ongoing process, not a one-time undertaking.

Risk for an information system is related not only to the system's exploitable vulnerabilities but also to the impact of successful attacks. System designers try to reduce the vulnerabilities of their information systems, of course, but trying to design a system with no vulnerabilities is unrealistic with current technology. Instead, it makes sense to acknowledge the risks and try to minimize the impact of any successful attack. Three principles— least privilege, defense in depth, and vigilance—should be considered in the design of an information system to not only help reduce the risk of successful attacks, but also to reduce the impact of any successful one.

Least Privilege

Give users and programs the access privileges they need, and no more. This commonsense idea has far-ranging consequences. For example, if a network needs to provide only web and name-resolution services to users/hosts outside its network, then the designer should employ a firewall that blocks inbound connections to other than appropriate ports. If a file or collection of files is needed only by a specific user or by a particular network service, then that file or files should be accessible only to the user that needs them or to the server processes that require them. Operating system file permissions are a natural way to limit access like this. But this principle should also guide decisions on what information such as that in databases and web applications goes on network drives, as opposed to a host's local drive, and what goes on "shared" drives.

Defense in Depth

If a system has a single firewall protecting everything that needs to be secure and that firewall fails and is breached, all is lost. If, on the other hand, there are concentric rings of firewalls, breaching a single one gains only a limited amount of access. Castle builders understood this principle and designed their castles with moats and outer walls, inner walls, and keeps (fortified towers within a castle). The same principle applies to information systems regarding access to resources.

Vigilance

Following the principles of least privilege and defense in depth is likely to slow attackers down. They may successfully exploit a vulnerability and gain some access, but they will need to find another vulnerability and another way to exploit it before they can overcome the next barrier. A vigilant operator may well recognize the intrusion and be able to deny the attackers further access to the system before they get to the asset they most wanted to attack. Many kinds of events get logged by information systems. Administrators need to continually monitor these log files in order to recognize an attack. Programs called *intrusion detection systems* can be used to assist this effort by automatically combing log files looking for unauthorized attempts to enter the system.

Cyber Defense in the Navy

Defending against a cyber warfare attack threat on Navy information networks ashore or afloat is similar to defending a battle force at sea against an incoming attack by physical enemy

forces. As in the case with battle force defense, there are three defensive phases. Analogous to the long-range surveillance of the outer reaches of a physical battlespace with various types of search platforms, within cyberspace the first defensive phase involves continuous scanning of Navy information networks by agencies such as USCYBERCOM, the National Security Agency (NSA), and the Defense Information Systems Agency (DISA). When the sensors used by these agencies detect a potential cyber activity threat, they distribute an alert within USCYBERCOM, NSA, and DISA, as well as each of the component cyber commands of each of the military services. The threat may originate from Internet protocol addresses within nation-states and criminal enterprises, hackers, or even terrorists. Specially trained operators use detailed cyber forensics to fully define the threat, but often only after an intrusion has occurred. Detailed analysis of sensor data combined with the cyber forensics eventually allows the network defenders to determine who the adversary is, the locations from which the threats are originating, and the specific tactics being employed.

During the second phase of cyber defense, analogous to taking an incoming threat under fire at intermediate ranges in defense of a battle force, teams are dispatched from the appropriate agencies described above to investigate, identify, and understand the extent of any compromise that may have occurred in order to take appropriate defensive action. This can range from blocking adversary access to full isolation of the affected network segments.

Finally comes the third phase of cyber defense, analogous to close-in defense against an enemy that has managed to penetrate to within weapons firing range of the main body of a battle force. In a cyber attack, this corresponds to an attacker having gained access, whether undetected or not, to an individual network at the local level. At this stage the attacker is now within "cyber weapons range" and can gain additional intelligence; steal information; or, in extreme cases, execute attacks that can degrade or render unusable a specific network, system, or host. The ability to share information across the physical battlespace may be in jeopardy. At this point, cyberspace warriors such as Navy Tenth Fleet component commanders conduct "close-in" support and damage control measures such as rerouting network data paths, executing preplanned reconstitutions, or blocking further potential adversarial actions to prevent future compromise.

All the foregoing phases of cyber defense against a cyber attack are essentially reactive in nature. In the future, cyber warfare "rules of engagement" (ROE) may be formulated that will allow Navy and other U.S. service entities that have been attacked in the manner described above to institute at least some form of appropriate immediate proactive offensive cyber retaliation against the perpetrators of such attacks, in the same way that a ship commanding officer or force commander can take reasonable offensive measures against a physical attacker. For now though, as stated above, only the President can authorize such retaliatory attacks.

Critical Thinking

1. Research the qualifications necessary to gain employment in either the private or government sector in the field of cyber security. List five college-level institutions that currently offer curricula in the cyber security/cyber warfare area of studies and the qualifications a high school graduate should have to successfully apply for them.
2. Investigate what cyber security measures are installed on your home computer, or alternatively another PC or laptop computer to which you have access. Identify how the user is informed about any malware or computer viruses that might be discovered on that computer and what measures can be taken to remove the threat and minimize the chances of any reinfection.
3. Choose any recent large-scale successful cyber attack in the United States and describe it, including who was responsible, the methods used, and the outcomes and consequences.

Study Guide Questions

1. What is the difference between cyber terrorism and cyber warfare?
2. What is the concern about the use of cyber countermeasures by the United States in retaliation for cyber attacks by foreign government entities?
3. What are the responsibilities of the U.S. Cyber Command?
4. What are the responsibilities of the Navy's Fleet Cyber Command/Tenth Fleet?
5. Besides computer science, what other interdisciplinary studies come into play in cyber warfare?
6. What is included within *cyber operations*?
7. A. What is the *cyber battlefield*?
   B. What does the *cyber domain* encompass?
8. What are the five pillars of cyber security?
9. What are the three basic phases of a cyber attack?
10. What three significant cyber attacks on U.S. computer systems were successfully carried out by foreign countries in the mid-2010s?
11. What are the three means of syntactic cyber attacks?
12. A. What is a computer virus?
    B. What is a computer worm?
    C. What is a Trojan horse in the computer world?
13. A. What is spyware?
    B. What is adware?
14. What is the fundamental reality that makes defense of an information system difficult?
15. What are the three principles that should be considered in the design of an information system to help reduce the risk of successful attacks?
16. How is defense of a Navy information network against cyber attack analogous to the defense of a battle force against an enemy attack at sea?

New Vocabulary

cyber security
digital forensics
cyber battlefield
entity (in computer science)
authentication
exfiltrate
virus (computer)
Trojan horse (computer)
botnet
adware
cyber operations
cyber reconnaissance
cyber domain
nonrepudiation
cyber attack
malware
worm (computer)
zombie (computer)
spyware
networking port

21

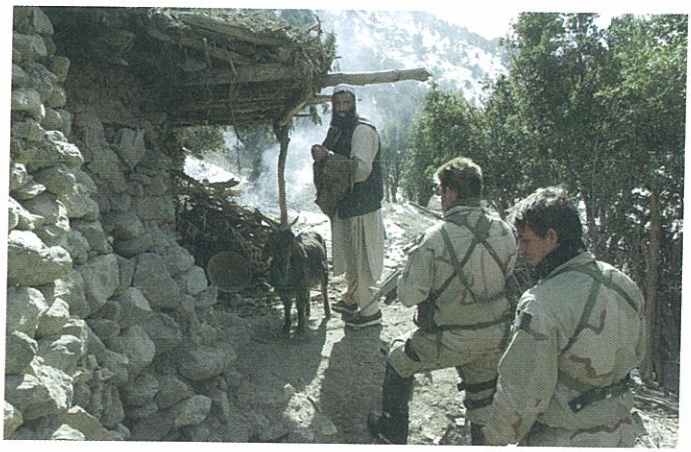
Special Warfare

Special warfare is a type of unconventional or irregular warfare defined by the Department of Defense as "the execution of activities that involve a combination of lethal and nonlethal actions taken by a specially trained and educated force that has a deep understanding of cultures and foreign language[s], proficiency in small-unit tactics, and the ability to build and fight alongside indigenous combat formations in a permissive, uncertain, or hostile environment." It "represents special operations forces (SOF) conducting combinations of unconventional warfare, *foreign internal defense* [measures undertaken to assist a foreign government to resist irregular warfare threats], and/or counterinsurgency through and with indigenous forces or personnel."

Special warfare operations are characterized by the following six features:

- Their goal is stabilizing or destabilizing the targeted regime.
- Local (indigenous) partners provide the main effort.
- U.S. forces maintain a small (or no) footprint (long-term presence) in the country.
- They are typically of long duration and may require extensive preparatory work measured in months or years.
- They require intensive interagency cooperation, in which DOD may be subordinate to the Department of State or CIA.
- They employ "political warfare" (the use of political means and diplomacy to compel an opponent to do the will of the United States) methods to mobilize, neutralize, or integrate individuals or groups within a partner nation from the tactical to strategic levels.

In carrying out their special warfare missions, special operations forces may engage in some or all of the following activities at various times: direct action in the country being targeted or assisted, strategic reconnaissance, unconventional warfare, foreign internal defense, civil affairs, military information support operations, counterterrorism, humanitarian assistance, theater search and rescue, and other activities as may be directed by the President or the Secretary of Defense.



Navy SEALs search for al Qaeda and Taliban operatives while conducting a mission in the Jaji Mountains in Afghanistan in support of Operation Enduring Freedom. *Tim Turner*

Navy SEALs jump from a C-130 aircraft during a training exercise. *Anthony Harding*

U.S. Special Operations Forces

In the U.S. Navy, unconventional special warfare is most often the task of Navy SEALS, the well-known sea, air, and land Sailors and Marines who go through an extremely demanding and extensive special warfare training program. They are assisted in their missions by highly trained special warfare combatant-craft crew (SWCC) who operate the craft used to convey SEAL team personnel on their missions in and around rivers and coastal regions of the world. In addition to assisting SEAL teams on special warfare and special operations missions, SWCC operatives also conduct direct action and special reconnaissance missions of their own, including collection of data about enemy military installations and shipping traffic, and assisting other military and civilian law enforcement agencies.

Other Navy SOF personnel include explosive ordnance disposal (EOD) technicians trained to render safe all kinds of ordnance, including IEDs and nuclear, biological, and chemical weapons, and also demolish natural and manmade underwater obstacles; and Navy divers and aviation rescue swimmers.

In addition to the Navy, the U.S. Marine Corps and the other U.S. armed services also have specially trained SOF personnel. The Marines maintain a Marine Raider Regiment consisting of three battalions of troops who train, advise, and assist friendly nation naval and other military forces to support their governments' internal security and stability, and a Marine Intelligence Battalion that provides intelligence support at all operational levels in order to support Marine SOF training and operations worldwide.

The U.S. Army has a number of SOF organizations, including the Army Rangers, the premier Army light infantry, whose mission is to plan and conduct special operations missions worldwide in support of U.S. policy and objectives. Headquartered at Fort Benning, Georgia, each Ranger battalion

Two special operations river craft operated by special warfare combatant-craft crewmen from Special Boat Team 22 on a training mission at the John Stennis Space Center in Mississippi. *Nathan Laird*

Two U.S. Army Special Forces soldiers conduct a reconnaissance patrol with French commandos during a combined exercise in Djibouti on the Horn of Africa. *Army photo by Adam Schnell*

can deploy anywhere in the world on eighteen hours' notice. U.S. Army Special Forces (the Green Berets) perform unconventional warfare, foreign internal defense, special reconnaissance, direct action, and counterterrorism. The premier Army special operations unit is the Delta Force, composed of selected members of the Rangers and the Special Forces. Delta Force has the capability to conduct a wide variety of special operations missions but specializes in counterterrorism and hostage rescue operations. Like Navy SEALs, Delta Force personnel must complete a rigid selection and training process, after which they conduct clandestine and covert special operations worldwide.

The Air Force Special Operations Command, with headquarters at Hurlburt Field in the Florida panhandle, conducts global special operations missions ranging from precision application of firepower via airstrikes or close air support to infiltration, exfiltration, and resupply and refueling of SOF operational elements of all services. The personnel within that command are sometimes referred to as Air Commandos.

The U.S. Special Operations Command (USSOCOM or SOCOM) is the unified combatant command charged with overseeing the various special operations component commands of the Navy, Marine Corps, Army, and Air Force described above. It is a functional command, headquartered at MacDill Air Force Base in Tampa, Florida, and was formed from the old U.S. Readiness Command in 1987. The Joint Special Operations Command (JSOC) is a component command of USSOCOM charged with planning and conducting special operations exercises and training, and developing SOF tactics. The two main counterterrorist units of the JSOC and USSOCOM are the Army Delta Force and the Navy's Special Warfare Development Group, better known as SEAL Team Six of the raid on Osama bin Laden fame. The Navy's counterpart to the

Delta Force, SEAL Team Six is composed of select SEAL team members who train especially for counterterrorism and hostage rescue missions.

Notable U.S. Special Warfare Operations

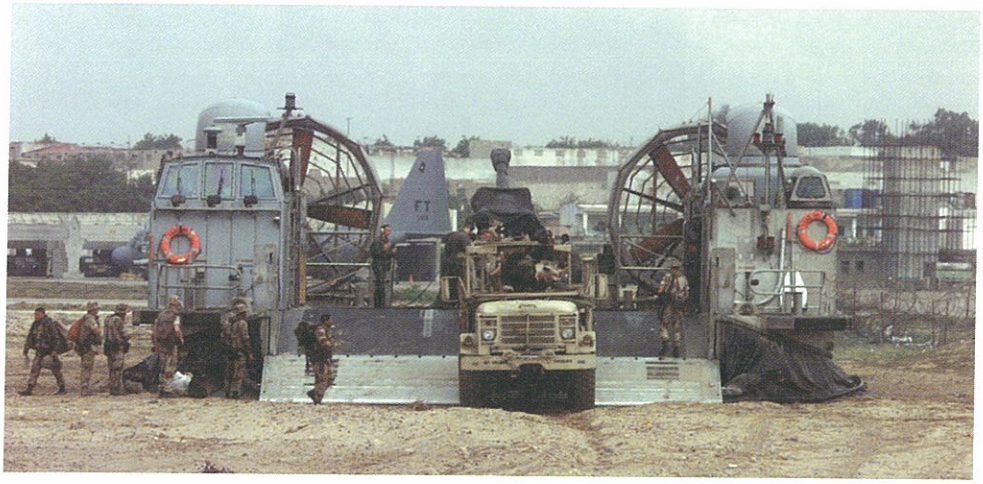
The first tactical operation to be conducted under the new USSOCOM in the fall of 1987 was Operation Earnest Will, which concerned keeping the oil tanker routes of the Persian Gulf open for free transit during the later stages of the Iran-Iraq War. Navy SEALS boarded, searched, and destroyed Iranian oil drilling platforms that were harboring Iranian navy boats that had been laying mines in the Gulf and that had attacked tankers with missiles. The next spring, after the U.S. frigate *Samuel B. Roberts* hit a mine and nearly sank, U.S. forces in retaliation attacked two Iranian frigates and set fire to another oil platform. Thereafter, Iranian attacks on neutral ships dropped drastically. On 18 July, Iran accepted the UN ceasefire, and on 20 August 1988, the Iran-Iraq War ended.

In 1992 USSOCOM became involved in Somalia as part of UN-sponsored efforts to relieve an ongoing famine there, which later that fall morphed into U.S. Operation Restore Hope. Air Force C-141 Starlifter and C-130 Hercules cargo aircraft delivered food and relief supplies to Somali airstrips. Army Special Forces personnel accompanied many relief flights into the airstrips throughout southern Somalia to assess the area. They were the first U.S. soldiers in Somalia, arriving before the U.S. forces who supported the expanded relief operations of Restore Hope. In October 1993 a joint U.S. SOF task force with the mission to capture rebel leader Mohamed Farrah Aidid had two of their MH-60 Blackhawk assault helicopters shot down in Mogadishu. Nineteen Army SOF and other soldiers were killed during the ensuing recovery operations, as were more than five hundred Somali rebel fighters. The action was later immortalized in the 2001 hit movie *Blackhawk Down*.

At the launch of the Iraq War in 2003, dozens of twelve-member SOF teams infiltrated southern and western Iraq to hunt for Scud missiles and pinpoint bombing targets. Scores of Navy SEALs seized oil terminals and pumping stations on the southern coast. Air Force combat controllers flew combat missions in MC-130H special mission aircraft and established desert airstrips to begin the flow of soldiers and supplies deep into Iraq. During the war USSOCOM forces killed or captured hundreds of insurgents and al Qaeda terrorists, and since the U.S. withdrawal in 2011, U.S. SOFs have conducted many foreign internal defense missions training the Iraqi security forces.

U.S. special operations forces played a major and continuing role in the war in Afghanistan. In the initial stages of the war in 2001–2, USSOCOM forces linked up with CIA paramilitary officers to defeat the Taliban without the need for large-scale conventional forces, since acclaimed as one of the biggest successes of the global war on terrorism. These units later linked up several times during the war and engaged in several furious battles with the enemy. One such battle took place in March 2002 during Operation Anaconda, a mission to neutralize a Taliban and al Qaeda stronghold dug deep into the Shahi-Kot Valley and Arma Mountains of eastern Afghanistan. The operation, one of the heaviest and bloodiest fights in the war, involved special operations forces from all four services and the CIA. A major battle was fought on an Afghan mountaintop called Takur Ghar. Navy SEALs, Army Rangers, Air Force combat controllers, and pararescuemen fought entrenched al Qaeda fighters atop the 10,000-foot (3,000-meter) mountain. The seventeen-hour battle was the most intense firefight involving American special operators since the "Black Hawk Down" incident in Mogadishu, Somalia, in 1993. The Americans suffered seven dead and four wounded, with the enemy suffering an estimated two hundred killed and an unknown number wounded.

One of the more storied SOF incidents involving Navy SEALs in the new millennium was the liberation of Capt.



Marine SOF troops and equipment disembark from an LCAC from the USS *Mount Rushmore* (LSD 47) at the airport in Mogadishu, Somalia, during Operation Restore Hope in 1993.
Terry Mitchell

Navy SEAL Senior Chief Petty Officer Edward Byers on duty in Afghanistan during Operation Enduring Freedom. He was awarded the Congressional Medal of Honor for his actions during a 2012 hostage rescue operation there.

Senior Chief Edward Byers receives the Medal of Honor, the nation's highest military honor, from President Barack Obama during a ceremony at the White House in February 2016. *Oscar Sosa*

Richard Phillips of the containership *Maersk Alabama* from Somali pirates off the coast of Somalia in 2009. After his capture when the pirates seized his ship, a team of Navy SEALs boarded an escorting Navy destroyer and liberated Phillips by shooting two of his captors in a commandeered lifeboat being towed to port by the destroyer. The incident was later the subject of the 2013 film *Captain Phillips*.

The most famous SOF action involving Navy SEALs in recent years was, of course, the killing of the al Qaeda leader Osama bin Laden by members of SEAL Team Six in Pakistan in 2011. After nearly a decade of futile efforts to hunt him down, the CIA and JSOC finally located bin Laden at a compound in Abbottabad, Pakistan, in the spring of 2011. The night of 1 May, two Army SOF helicopters with twenty SEALs from SEAL Team Six embarked landed at the compound and stormed it, killing bin Laden in his third-floor bedroom, thus bringing to justice the most infamous terrorist leader of that time.

Current U.S. SOF Operations

As the global irregular war on terror and violent extremism has continued to expand since 2000, so also has the number of U.S. forces engaged in SOF operations. In 2000 al Qaeda had an estimated total membership of 200–1,000 individuals. There are now currently eleven recognized al Qaeda affiliates operating in Pakistan, five in Afghanistan, and others in Mali and Tunisia, Libya and Morocco, Nigeria and Somalia, Lebanon and Yemen, and many other countries. Altogether it is estimated that there are at present at least some forty extremist groups operating throughout Africa, the Middle East, and the Far East. In 2001 there were about 33,000 personnel engaged in SOF operations in the armed forces of the United States. Today the estimated total is some 70,000. Special operations liaison officers (SOLOs) are currently stationed in fourteen key U.S. embassies worldwide to advise the special forces of various allied nations, with the number expected to increase to forty by 2019.

Between 2011 and 2014 U.S. special operations forces deployed to more than 150 countries, and in 2015, the latest year for which figures are available, to more than 100 in the first several months. American SOF personnel continue to play an important role in Afghanistan as advisors to Afghan special forces troops, and are active in Iraq and Syria as advisors and trainers of the indigenous forces there fighting against DAESH (ISIS/IL). They continue to engage in special operations in the war against extremists and terrorists in many countries throughout the globe, not only in the Middle Eastern territory controlled by DAESH, but also in such trouble spots as east, central, and western Africa; Pakistan, Yemen, and Lebanon; and across Europe and the Far East. They are also active in training indigenous forces to combat the illegal drug trade throughout Central and South America.

Army Green Berets help train Honduran TIGRES commandos, a counternarcotics and special police force that conducts SOF operations in Honduras. *Army photo by Thomas Cieslak*

Critical Thinking

1. Research the training program undergone by recruits for the Navy SEAL program, including where the training takes place, how long it lasts, its major focus, and the qualifications for Navy personnel who apply for the program.
2. Expand on what you think will be the future trends in special warfare and special operations forces, including the threats likely to be faced and the circumstances under which this type of warfare might be undertaken in the future.

Study Guide Questions

1. What is DOD's definition of special warfare?
2. What characterizes special warfare operations?
3. What is the primary special warfare force within the U.S. Navy?
4. What is the Marine Corps's special warfare organization?
5. What is the premier special operations force within the U.S. Army?
6. What is the U.S. unified combatant command in charge of special warfare within DOD?
7. What is the Joint Special Operations Command (JSOC)?
8. What was the role of U.S. SOF personnel in the early days of the U.S. invasion of Iraq in 2003?
9. What is the title of SOF officers assigned as liaisons within U.S. embassies?
10. What is the role of U.S. SOFs in Afghanistan, Syria, and Iraq, and in other countries throughout the world?

New Vocabulary

foreign internal defense
USSOCOM/SOCOM
SOLO
political warfare
JSOC

22

Mine Warfare

A **mine** as used in naval warfare is a weapon containing a charge of explosive in a watertight casing that is floating on, moored in, or planted under a waterway for the purpose of blowing up an enemy vessel that strikes it or passes close by. Mine warfare may be divided into defensive and offensive mining, and mine countermeasures. *Defensive mining* is done to protect a nation's own harbors and shorelines. *Offensive mining* may be used to bottle up enemy harbors; to render their shipping routes dangerous or impossible to use; and to make the enemy divert ships, equipment, and personnel to minesweeping chores. By spreading minefields over as wide an area as possible, and by using several different types of mines, the problem of removing, or *sweeping*, them is made formidable, and safe shipping routes become more and more difficult to maintain. Offensive minefields also force enemy shipping to go through areas where it may be more readily attacked.

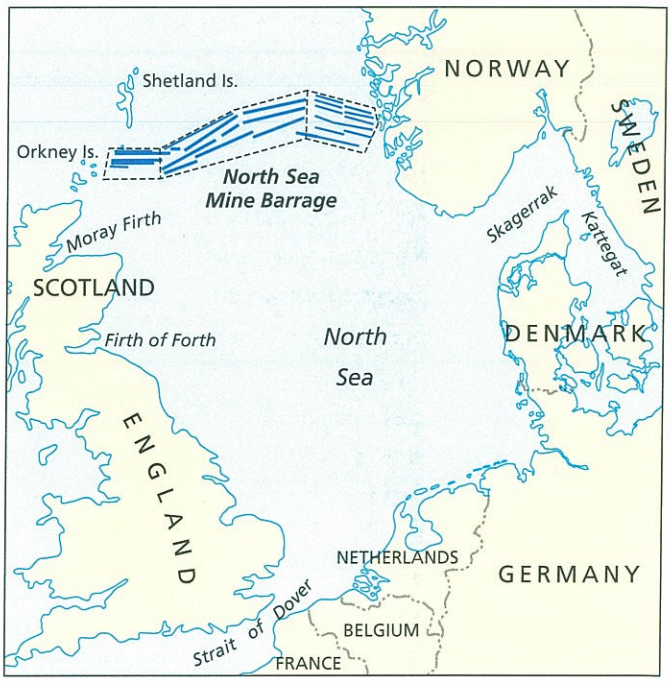
Mine countermeasures constitute all methods of countering an enemy's mines. These measures include self-protection for ships as well as hunting and sweeping mines.

Evolution of Mine Warfare

During the American Revolution, David Bushnell attempted to break the British blockade of the Delaware River at Philadelphia with floating kegs filled with gunpowder and equipped with contact-firing devices. An unfortunate current caused the kegs to go astray, and red tape in Congress prevented additional expenditures on the concept. In the early nineteenth century, Robert Fulton, well known as the inventor of the steamship, contributed to a slowly developing concept in naval warfare by demonstrating that an underwater explosion could sink a ship.

By the time of the Civil War, "torpedoes" (contemporary term for mines) moored in harbors and rivers were considered a prime naval weapon, especially by the Confederates, who used them to defend against the much larger Union Navy.

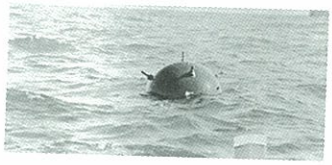
Adm. David G. Farragut's attack at Mobile Bay in 1864 remains one of the more dramatic episodes in the history of mine warfare. The Confederates had planted some two hundred mines to force Union ships into a channel covered by shore batteries, an early use of a mining tactic that later became standard. When the Union monitor *Tecumseh* hit a submerged mine, blew up, and sank, the Confederate batteries opened fire. Progress into the harbor became confused, and the Union force seemed in danger of defeat. At this crucial point, however, Admiral Farragut exhorted his force to proceed with his famous order: "Damn the torpedoes—full speed ahead!" taking a calculated risk that no additional mines would explode because of saltwater deterioration. He was right, and the battle was won. With a more reliable mine, the Confederates might have frustrated the Union attempt to close the last major Southern port, won



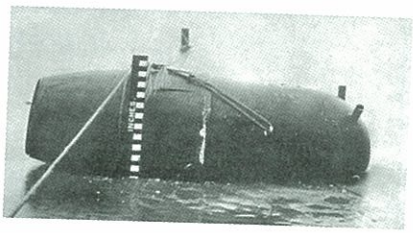
Navy map showing the North Sea mine barrage planted by the United States and Britain during World War I. U.S. mines were sown in the center area, mostly British mines in the right-hand area, and a combination of both in the left-hand area.

a major naval victory, and prolonged the war. Thus was dramatized the problem of mine deterioration, a baffler that modern science has not yet entirely solved.

Mines were considered only a defensive weapon until the Russo-Japanese War of 1904–5. The Japanese sowed offensive minefields across entrances to Russian harbors and then enticed the Russian fleet out with a show of inferior forces; the mines sank six ships. The Russians mined defensively with even more success, sinking nine Japanese ships. After the war, free-floating mines that had broken loose from their wartime moorings sank several ships of other nations, giving rise to the 1907 Hague Convention concerning floating mines. The convention sought to restrict the use of floating mines unless they could self-deactivate after a time.



A spherical German contact mine of the type used extensively by both the Axis and Allied navies during World Wars I and II. Note the contact horns protruding from the top. *Imperial War Museum*



Contemporary photo of the up-to-then secret German influence mine recovered by the British in a mud bank in November 1939. *Imperial War Museum*

International law, however, imposes few other restrictions on mine warfare. Moored or bottom mines need not be made to deactivate automatically after a prescribed time.

Offensive mining was used extensively in World War I. The Allies laid a huge barrage (formidable barrier) of mines in the North Sea between northern Scotland and the Norwegian coast. It was designed to keep German U-boats confined in the North Sea and allow the Allies to use Atlantic shipping routes in comparative safety. American minelayers planted some 57,000 of these mines, and the British planted more than 13,000. They were the anchored contact type, spherical and studded with "horns" (protruding contact detonators). There is no definitive information as to the success of this field in sinking U-boats, but that it kept them bottled up to a considerable extent is certain. Postwar statistics revealed that mines sank more ships than did torpedoes and gunfire combined.

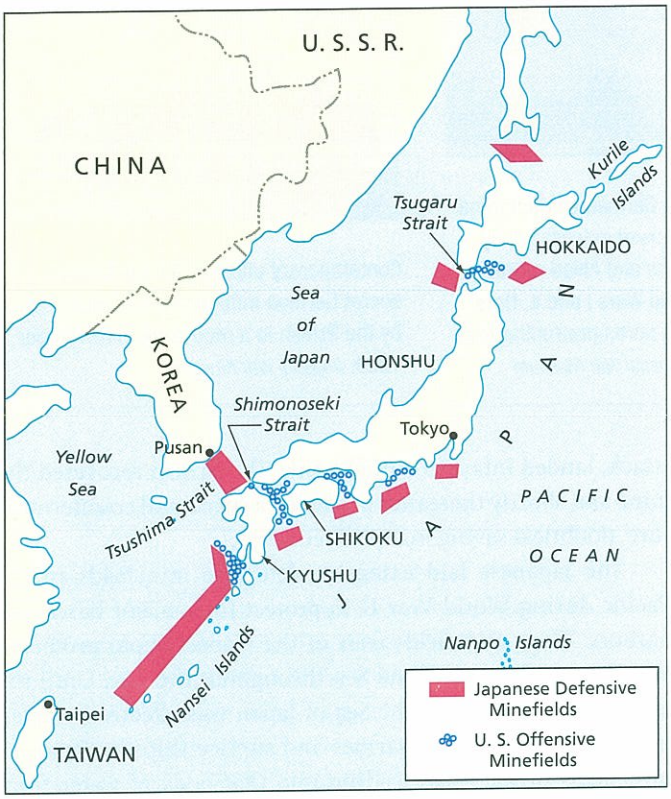
Mine warfare in World War II featured offensive and defensive minelaying by both Axis and Allied powers. Offensively, submarines and aircraft were used to plant mines for the first time. Defensive mining was carried out mainly by conventional types of surface minelayers, and mine clearance was done primarily by surface craft equipped with special minesweeping gear. Countermeasures included novel devices for protection and detection. Most of these mines were of the moored or floating type, but as noted below, the Germans also developed a bottom-laid influence mine early in the war. In addition to their use in coastal waters and rivers, these were sometimes dropped by the Luftwaffe against land targets.

In the opening months of the war, German submarines and aircraft sowed extensive minefields off the English and Scottish coasts. A number of British ships were sunk by this mine barrage, which was especially heavy in the Thames estuary. In the fall of 1939, however, the Germans lost an important secret weapon just recently developed—a bottom influence mine designed to be triggered by the magnetic field of a passing steel-hulled ship. The mine, dropped by an airplane under attack, landed intact in a mud bank. The British recovered the mine and shortly thereafter produced a successful countermeasure, doubtless saving many Allied ships.

The Japanese laid extensive defensive minefields in the Pacific during World War II to protect their major bases and harbors. Their minefields west of the Nansei Shoto protected shipping in the East China Sea throughout the war. Until the last months of the war, the Sea of Japan was effectively sealed off from American submarines and surface ships by Japanese minefields in the strait leading into that body of water from the Pacific. Both the Americans and the Japanese laid offensive fields to destroy or divert enemy shipping.

Mines were used during the Korean and Vietnam Wars as well. Communist forces floated mines down rivers into harbors and out to sea, and several Allied ships were sunk by mines during the former conflict. The Vietcong also used improvised controlled mines in the rivers of South Vietnam that they would detonate from shore whenever a suitable target came within range. Later, drifting mines caused damage to ships of

A German World War II influence mine developed early in the war. In addition to their use at sea, these were sometimes dropped by the Luftwaffe against land targets. *Imperial War Museum*



Minelaying in Japanese waters was extensive during World War II. This map shows positions of both U.S. and Japanese minefields in the Shimonoseki Strait and the Sea of Japan.

several nations in the Persian Gulf during the Iran-Iraq War in the 1980s, and to several U.S. warships during Operation Desert Storm in 1991.

Mine Classification

Mines are classified according to the method of planting (surface, aircraft, or submarine), the final planted position (moored, bottom, or drifting), the mode of operation (controlled or automatic), and the detonating or actuation mechanism (contact or influence).

Method of Planting

Mines can be planted by surface craft when secrecy is not of prime importance. High-speed minelayers can carry many mines and can lay a large minefield in a relatively short time. Presently, however, the U.S. Navy has no minelayers in commissioned service.

Planting mines by submarine can be accomplished with great secrecy and at great distances from home ports. Once the minefield has been laid, however, friendly submarines cannot navigate in the area during the armed life of the planted mines.

A modern Navy Mark 65 Quickstrike mine designed to be air-dropped from an aircraft is being loaded on board a Navy P-3 Orion ASW patrol aircraft. Unlike the other two air-dropped mines in the Navy inventory that are essentially converted 500- and 1,000-pound bombs, the Mark 65 is a 2,000-pound mine with a thin-walled casing rather than a bomb body. *Shannon Smith*

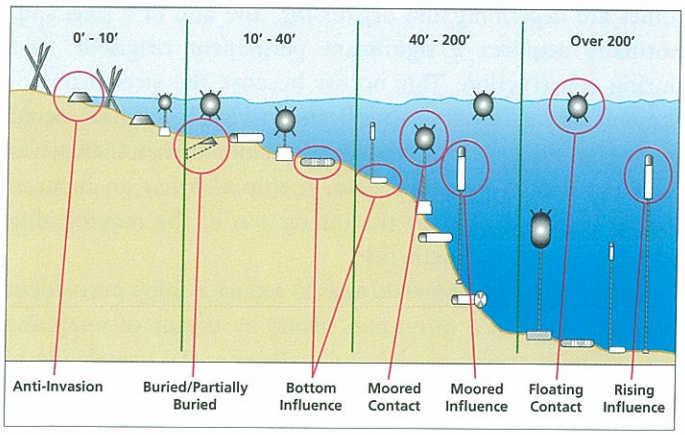
At present the Navy has only one model of submarine-launched mine, the Mark 67, essentially a converted obsolescent Mark 37 torpedo. There is currently a joint venture with the Australian Navy to develop a replacement based on the current Mark 48 torpedo, to be called the Improved Submarine Launched Mobile Mine (SLMM). It would retain the wire guidance of the Mark 48 torpedo, thus allowing the mine to be guided into place during its emplacement, and would have two warheads that could be planted in separate locations.

Aircraft-planted mines can be carried and released like bombs or torpedoes. A parachute is attached to the mine to slow its descent; the parachute separates from the mine case and sinks on impact with the water. Aircraft can carry mines into enemy-held areas, and the field can be replenished without danger from previously planted mines. There is little secrecy in planting aerial mines, though night-flying planes can be used to some extent. Aircraft can mine coastal and shallow waters that no other platform could possibly mine. This type of mining can be very effective for blockading enemy shipping lanes and harbors.

The Navy currently has three models of air-dropped mines, known as the Quickstrike series. Two are basically converted 500- and 1,000-pound bombs designated the Mark 62 and Mark 63; the third is a thin-walled conventional 2,000-pound mine designated the Mark 65.

Planted Position

Moored mines have a buoyant case containing the explosive charge. A mooring cable attached to an anchor keeps the mine on or near the surface or at a predetermined depth. Because the



The various types of mines that can be used in various water depths.

depth of the mine can be controlled by the length of its mooring cable, the mines can be deployed in shallow water against small craft, or in deeper water against larger surface ships and submarines. The main disadvantage is that they may be cleared with comparative ease by mechanical sweeping gear. The classic moored mine is the large, black sphere studded with horns containing contact detonators, used throughout much of the last century and still a mainstay today.

Bottom mines were developed to make sweeping them more difficult and dangerous. They can be planted by any type of craft, and can either lie on the bottom or burrow into it. Costly high-tech minesweeping gear is required to detect and remove them, neither of those tasks being easy. Their major limitation is that they cannot be planted in water depths greater than 30 fathoms (180 feet) unless intended as antisubmarine weapons.

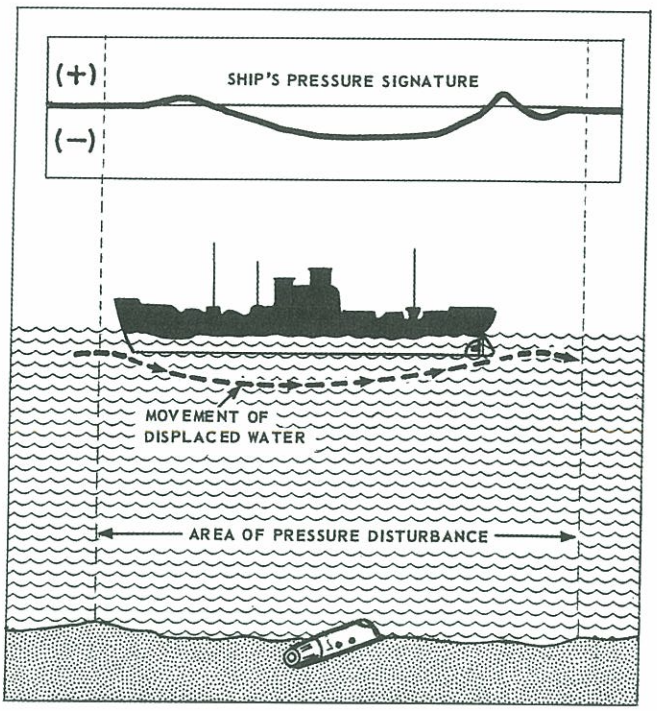
Drifting mines are not actually planted, in the true sense. Often, however, a drifting mine is a moored mine that has broken loose from its mooring cable and has become a hazard to all international navigation, neutral and belligerent alike.

Mode of Operation

Controlled mines are no longer used by the U.S. Navy, but the Vietcong used many varieties of them in rivers during the Vietnam War. They are manually detonated by a person on shore when an enemy vessel is near the mine. Most mines today are designed to detonate either from contact or automatically when a firing mechanism detects a ship passing over it.

Method of Actuation

Actual contact of a ship with a mine or its detonator is required to detonate a **contact mine**. As noted above, the most common contact mine is a moored mine equipped with lead horns encasing glass tubes containing an electrolyte. When a horn



A pressure mine is detonated by the change in water pressure caused by a ship passing over it. The movement of displaced water as the ship passes is called the ship's pressure signature. This type of mine is the most difficult to sweep.

is struck and bent, the glass tube is broken and the electrolyte flows into a battery cell, generating enough current to detonate the mine. Another type closes an "inertia switch," which completes an electric circuit.

There are three basic types of **influence mines**: magnetic, acoustic, and pressure. Influence mines are normally of the bottom type. The *magnetic mine* is triggered by the target ship's magnetic field. When a ship passes overhead, the firing circuit is actuated and the mine detonates. The *acoustic mine* is triggered by the noise produced by a passing ship's propellers, machinery, or hull vibrations. The firing mechanism can be set to react only to specific sounds so it will not be actuated by any normal sea sounds. The *pressure mine* is triggered by the change in water pressure caused by a ship passing over the mine. It is the most difficult of the three basic influence types to sweep.

A **combination mine**, detonated by the simultaneous actuation of two or all three of the foregoing types of influence firing mechanisms, is more effective because it is less susceptible to activation by false targets and is harder to sweep. In order for such a mine to detonate, for example, the pressure influence of a ship may have to close a switch at the same time as its magnetic field influences a coil. The U.S. arsenal contains mines detonated by simultaneous actuation of all three mechanisms. Such mines are almost impossible to sweep.

A Navy Mark 60 CAPTOR mine being loaded on an Air Force B-52 during a joint Air Force/Navy minelaying exercise. The casing contains a Mark 46 torpedo. *Air Force photo by Russ Pollanen*

In addition to the combination of various actuating mechanisms, "counters" have been installed in some combination mines to further increase the difficulty of sweeping them. These are designed to cause the mine to remain inert until the actuation process has occurred a preset number of times. Some mines of this type may in addition have timers that delay any actuation until a set amount of time has passed. Both of these features are intended to give the enemy a false sense of security by setting up the mines for activation after minesweeping operations have been "successfully concluded." Some types of moored mines can rest on the bottom for a set length of time after being laid before rising to the length of their cable, thus defeating any prior minesweeping efforts.

Perhaps the most unusual "mine" in the Navy arsenal is not really a mine at all. Called the **CAPTOR** (encapsulated torpedo), it consists of an acoustic homing torpedo moored to the bottom with about 300 meters (about 980 feet) of cable. Primarily a USW weapon, the torpedo, upon identifying a submarine's acoustic signature, is automatically released to home in on and destroy the submarine. It is one of the Navy's primary antisubmarine weapons.

Mine Countermeasures

Mine countermeasures (MCM) include all actions taken to protect friendly shipping against mines. The three major types of MCM are ship treatment against magnetic and acoustic mines, mine hunting, and minesweeping.

Deperming and Degaussing

The two principal methods of treating a steel-hulled ship to decrease the magnetic effects that actuate magnetic influence mines are *deperming* and *degaussing*. The hull of a steel ship normally acquires a significant permanent magnetic field during construction. This occurs because the steel plates of the hull are constantly being heated, riveted, and hammered during building, causing the iron molecules to align themselves with the Earth's magnetic field. A ship also has an induced magnetic field caused by the interaction of the moving ship with the Earth's magnetic field.

The purpose of **deperming** is to reduce a ship's permanent magnetic field to a minimum. Done by means of wrapping the hull with energized electrical coils after the completion of construction, this process is essentially a large-scale version of demagnetizing a magnet.

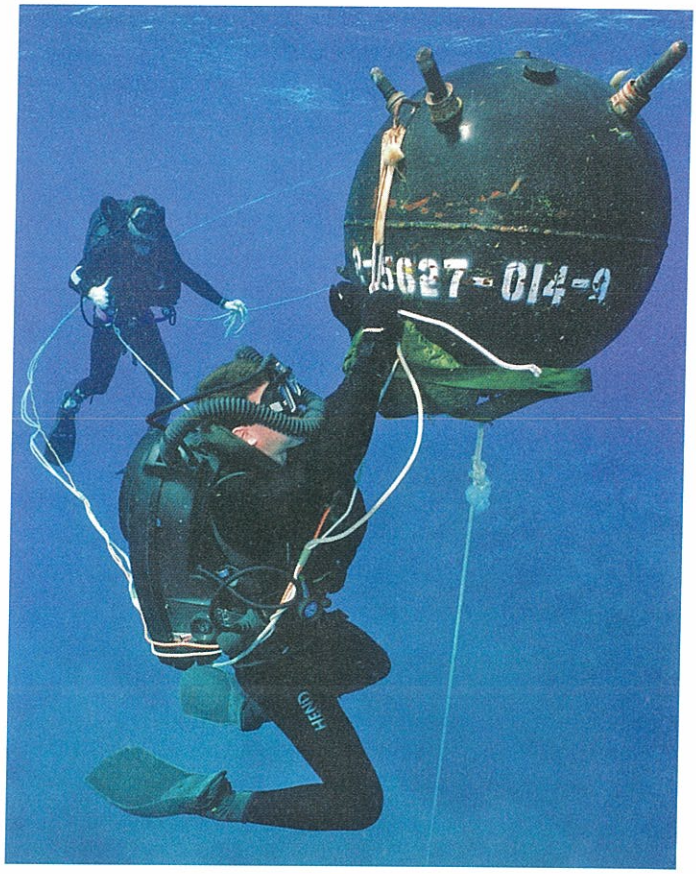
Degaussing was developed by the British during World War II to defeat the aforementioned German influence mine. It neutralizes the strength of both the induced and the permanent magnetic fields of a ship by means of large electrical coils installed within the hull of the ship parallel to the waterline. Basically, a variable direct current is sent through the coils to produce a magnetic field in exact opposition to that generated by the ship itself as it maneuvers, thus tending to nullify any magnetic effects.

Though these measures can greatly reduce the magnetic signature of a steel-hulled ship, some residual magnetic field is always generated by all steel vessels. Consequently, minesweeper hulls are built of wood, fiberglass, aluminum, or other nonmagnetic materials. The Navy's new littoral combat ships (LCSs) are made of aluminum in part to facilitate their projected mine countermeasures role.

Acoustic Countermeasures

Very little can be done to protect a ship from acoustic mines. Most underwater noise generated by ships is caused by the movement of the screw blades with respect to the water. This effect is called *cavitation* because it is caused by bubbles of water vapor that form and collapse at sonic or subsonic frequencies around the tips of the blades. Some noise also is produced by water flowing over rough surfaces and sharp edges on the hull, and by machinery inside the ship. Beyond the *Albacore* hull design of nuclear submarines, it appears that little more can be done to change substantially the acoustic characteristics associated with a ship's hull. As will be explained in more detail in chapter 1 of the Naval Skills section of this textbook, a significant reduction in cavitation noise effects has been achieved in newer submarines by the use of cylindrical shrouds around their propellers and by the use of pump-jet propulsion, a form of water jet. The LCSs also use water-jet propulsion, in part to reduce their acoustic signatures at slow speeds. Most ships, however, can reduce underwater ship noise only by slowing their speed, using special noise-reducing mountings for essential machinery, and shutting down nonvital machinery.

A demolition charge simulating a mine blows up near the *Avenger*-class mine countermeasures ship USS *Scout* (MCM 8) during a training exercise near the Strait of Hormuz. *Joshua Kelsey*



A Navy explosive ordnance disposal (EOD) diver attaches an inert satchel charge to a training mine during exercises in waters off Naval Base Guantánamo Bay, Cuba.

Mine Hunting and Minesweeping

Mine hunting is the methodical employment of sensor and neutralization systems in the air, on the water surface, or underwater to locate and dispose of individual mines when sweeping is not feasible or desirable, or to verify the presence or absence of mines in a given area. **Minesweeping** is the technique of clearing a minefield using mechanical, explosive, or influence sweep equipment. Mechanical sweeping removes or otherwise neutralizes mines; explosive sweeping induces mines to detonate or blows them up or seriously damages them; and influence sweeping produces either the acoustic or the magnetic influence—or both—required to cause them to detonate.

At present, the Navy's primary surface ship mine-hunting and minesweeping force is the *Avenger* class of MCM ships built during the 1980s and 1990s. Fourteen of these were originally built, but three of them have been retired and decommissioned in recent years. The others are homeported overseas at Sasebo, Japan, and Manama, Bahrain. They are made of wood sheathed in fiberglass and can find, classify, and sweep and destroy moored and bottom mines. They have both conventional mine countermeasures gear and newer devices such as remotely operated and autonomous underwater vehicles to seek out and destroy mines. Minesweeping helicopters were developed in the 1970s and have been extensively used as sweepers in most mine-clearing operations conducted by the U.S. Navy in the years since.

Mine Hunting

Mine hunting involves searching an area with mine detection gear to locate mines, verifying their presence or absence, and then sometimes individually removing or destroying them, either before, in conjunction with, or after a larger minesweeping operation. In the past mine hunting was done mainly by divers who were part of an underwater demolition team (UDT), and later by underwater explosive ordnance disposal (EOD) teams.

Today, most Navy mine hunting is done using highly sensitive sonars like those in the *Avenger*-class MCM ships in conjunction with unmanned underwater vehicles (UUVs) that can operate without a human crew. These include both **autonomous underwater vehicles** (AUVs) that can operate completely independently without any control by external operators and **remote operating vehicles** (ROVs) operated via control cables by operators on the surface. The AUVs can be programmed to search for mines automatically after being launched by a mine-hunter vessel. They resemble long torpedoes, are fitted with sensitive sonars and electronic mine detection gear, and follow preprogrammed search tracks beneath the water. They have self-contained guidance systems that use a combination of GPS and inertial navigation systems (INSs) to determine their position. In the future mine hunting may also be done by semi-autonomous unmanned surface vehicles (USVs) streaming

Crewmembers of a mine countermeasures ship recover a mine neutralization vehicle (MNV), a type of UUV used to seek and destroy mines. *Abraham Essenmacher*

A Navy USV tows a sonar system during a mine countermeasures exercise. The boat is being piloted by operators several miles away. *Ken Rose*

A Reliant AUV is recovered after a test mission. Developed by the Acoustic Division of the Naval Research Lab, the Reliant can be equipped with a variety of "swapable" sensors and payloads and can operate autonomously underwater for long periods. In 2013 a Reliant AUV completed a totally autonomous 315-mile 109-hour test mission from Boston Harbor to New York Harbor, communicating every 12.5 hours via an onboard satellite communications system. It is outfitted with a low-frequency broadband sonar system for seeking bottom mines and a fiber-optic gyro-based inertial navigation system and Doppler velocity log for precise navigation when submerged. Commercial versions were used to assist in the search for the vanished Malaysian Flight 370 in the Indian Ocean in 2014.

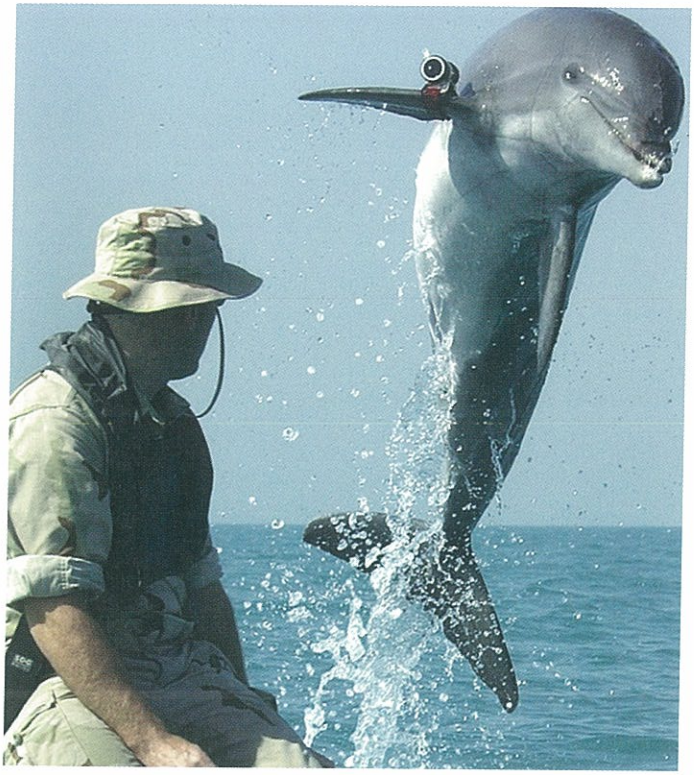
These antishipping mines disguised as oil drums were discovered and seized on an Iraqi barge in 2003 by a Navy visit and search team during Operation Iraqi Freedom. Note the detonating horns on the tops of the mines. *Richard Moore*

sonar gear, operated either by the *Avenger*-class MCM ships or by LCSs as part of their mine countermeasures package.

AUVs similar to those used by the Navy were extensively employed in the as yet unsuccessful hunt for the remains of Malaysian Airlines Flight 370, thought to have been intentionally crashed into the Indian Ocean in March 2014.

For many years there has been an ongoing effort to use trained dolphins to search for mines and enemy swimmers as part of the Navy Marine Mammals Program. They work with human handlers in much the same way as police dogs do on land. Dolphins from the program were used in the Persian Gulf in Operations Desert Storm and Iraqi Freedom and performed well. There are currently some seventy-five dolphins in the program at Navy bases on the Gulf and West Coasts, but the program may be discontinued if autonomous UUVs are eventually shown to compare favorably with a dolphin's ability to hunt for and locate undersea mines.

Once found, mines can be individually destroyed by such means as EOD divers and ROVs fitted with explosive devices or



A Navy Marine Mammal Program dolphin named Kdog doing mine-hunting work in the Persian Gulf during Operation Iraqi Freedom. Navy dolphins were credited with helping to clear more than a hundred antiship mines during the operation.

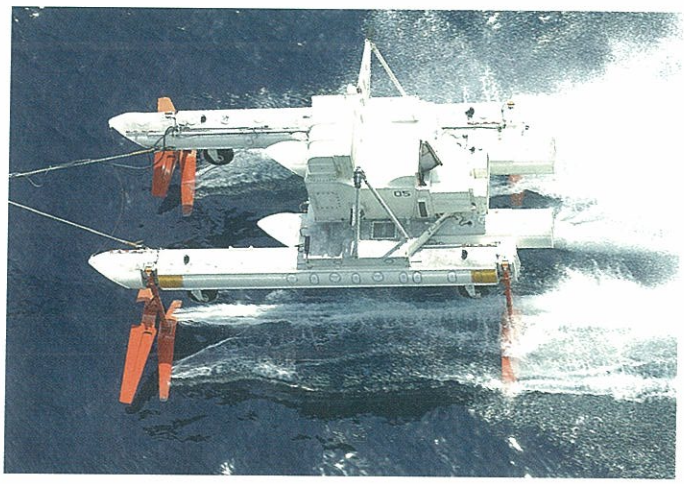
swept as discussed below using minesweeping gear deployed by mine countermeasures helicopters or ships, or by USVs to be operated by LCSs.

Minesweeping

For many years the conventional procedure for clearing a suspected minefield has been to first sweep it with sleds containing electronic decoys towed by mine countermeasures helicopters such as the MH-60S Seahawk, then complete the process by sweeping any remaining moored or bottom mines with minesweeping gear streamed from surface craft such as the *Avenger*-class MCMs. The main emphasis of mine countermeasures in the Navy today, however, is rapidly shifting to the use of innovative new technology such as cable-connected ROVs and other partially or completely autonomous unmanned underwater and surface vehicles. These greatly reduce the exposure of both Navy personnel and the ships and aircraft they operate to the hazards of clearing mine-infested waters.

The main platforms that will employ the new mine countermeasures equipment are the new littoral combat ships now being built and coming into service at the rate of about

An MH-53E Sea Dragon tows an MK-105 Magnetic Influence Minesweeping System minesweep. *Steven Weber*



A close-up view of the MK-105 Magnetic Influence Minesweeping System sled. The 8,000-pound sled is towed at high speed by an MCM helicopter and mimics the sound and magnetic signature of a ship.

four per year. The LCSs are designed to be able to counter a wide range of surface, submarine, and mine threats in littoral sea areas worldwide by having the ability to be outfitted with any one of several interchangeable mission-oriented combinations of appropriate equipment, weapons, and associated crew cadres, depending on the mission assigned. The various combinations are referred to as *packages* or *modules*. The prototype LCS mine countermeasures module is currently undergoing operational testing and evaluation at this writing. The modules will include USVs equipped with side-scanning sonar and others that can tow a sonar array or deploy sweeping gear; UUVs called Knifefish that hunt for and destroy bottom-type mines; and an embarked MH-60S Seahawk USW helicopter equipped

The LCS USS *Freedom* (LCS 1) and its MH-60S Seahawk helicopter.

with both an **airborne laser mine detection system** (ALMDS) and an **airborne mine neutralization system** (AMNS). The ALMDS detects floating mines and moored mines close to the water surface with its lasers; the AMNS, called the Archerfish, is an aerodynamic dispenser pod hung beneath the helicopter containing four miniature torpedo-shaped camera- and sonar-equipped ROVs that can be lowered into the water and controlled from the helicopter via thin fiber-optic cables. Each carries a shaped charge that can be detonated to destroy any mine encountered. The mine countermeasures module is designed to enable an LCS equipped with it to perform both mine hunting, including detection, bypassing, and disabling mines as appropriate; and minesweeping, using both mechanical and electrical/electronic sweeping gear.

About twenty of a currently planned eventual total of twenty-eight LCSs have thus far been built and commissioned. Under current Navy planning, when sufficient numbers of LCSs equipped with mine countermeasures modules become available sometime over the next decade, the remaining *Avenger*-class minesweepers will be retired.

An Archerfish pod on an MH-60S Seahawk USW helicopter. *BSA Systems*

Mine Warfare

Of all the aspects of mine warfare, none is more significant than the profound psychological effect of the mine on an enemy. Almost invariably the danger of mines is judged to be much greater than the actual physical threat. Because a minefield is hidden, unknown in extent, and difficult to assess, there is a usual tendency to overestimate the threat. It is not the calculation of the minefield's effectiveness by the minelayer but the enemy's estimate of the threat that is important.

In addition to the tactical effects of mine warfare, there is no question that the use or threat of use of mines has had a strong effect on political and military strategy. Mines possess a number of unique qualities that make them very significant in strategic planning.

Mines are versatile. They can do direct damage to military units, but they can also attack the enemy's economy. Ships carry the large bulk of international trade goods, and they are vulnerable to attack and total loss. Mines can destroy a nation's merchant marine. They can increase damage to enemy

forces by restricting their area of operations, thereby making their ships more susceptible to attack.

Mines are passive weapons. They wait for the target to come to them. This has a number of advantages. The mine maintains its vigilance for a considerable amount of time, without continued commitment of forces. The enemy is faced with a choice between confronting the minefield and accepting a blockade situation.

Mines are selective weapons. They can be set to be detonated only by a very specific size or class of target, and can also be selective in depth or range. Mines are flexible in duration and times of activation. They can be rendered harmless during selected time intervals or after a set time duration. They can also, in effect, change the geography of the battlespace by making certain areas impassable to ships. An area that has been declared dangerous because of mines is usually treated with great respect and avoided as though it were land.

The use of mines may aid significantly in gaining a victory over an enemy country. An effective mine blockade can destroy the enemy's economy, cause food shortages, enable conservation of friendly attacking forces, psychologically destroy the enemy's morale and will to resist, and prevent sortie of enemy forces from their harbors.

Other potential strategic advantages of mine warfare that might accrue to a belligerent using it effectively are the following:

- The enemy is forced to engage in mine countermeasures, tying up personnel and resources at little cost to the minelayer.
- Shipping is delayed and cargo-handling facilities at ports on both ends of a supply line are disrupted, even if no ship is sunk.
- Both ship and shore crews faced with confronting a minefield are demoralized.
- Mines achieve cost-effective potential physical, political, and psychological damage to the enemy.
- The potential for mine blockade without direct harm to the local populace can be a useful weapon to force settlement of disputes without actual combat, or to constrain a limited war.

Critical Thinking

1. Research the ways in which modern mines might be laid by both open and covert means in order to effectively blockade an enemy port.
2. Describe why and how a credible threat of a minefield can be as effective in controlling enemy shipping and diverting enemy mine-clearing assets as an actual minefield.

Study Guide Questions

1. What are the three principal aspects of mine warfare?
2. How is defensive mining used?
3. How is offensive mining used?
4. Where was the first American attempt at mine warfare in the Revolutionary War carried out?
5. A. What was the famous Civil War sea battle in 1864 in which mines played a crucial part?
   B. Who was the Union naval commander, and what was his famous directive?
6. Following the Russo-Japanese War, why was there an attempt to place international restrictions on floating mines?
7. What was the most extensive Allied mining effort in World War I?
8. A. What two new offensive minelaying methods were employed during World War II?
   B. Where were the extensive minefields sowed by German submarines and aircraft?
9. What secret German mine was captured early in World War II, enabling the British to develop countermeasures against this major German weapon?
10. Where were Japanese defensive mining operations conducted in the Pacific during World War II?
11. What are the categories by which mines are classified?
12. A. How are moored mines kept at predetermined depths so they may be used against either small craft or major vessels?
    B. What is their main disadvantage?
13. A. Why were bottom mines developed?
    B. What is their major limitation?
14. A. What are the three basic types of influence mines?
    B. What is a fourth type that complicates sweeping?
15. In addition to combinations of various actuating mechanisms, what other device has been installed in combination mines to further increase the difficulty of sweeping them?
16. A. What are mine countermeasures?
    B. What are the three major types of mine countermeasures?
17. What are the two principal methods of treating a ship's steel hull to decrease magnetic effects that actuate magnetic mines?
18. A. What is currently the Navy's primary mine countermeasures surface craft?
    B. What other type of platform developed in the 1970s has been extensively used for minesweeping in the years since?
19. How is most mine hunting done in the U.S. Navy today?
20. What marine mammal has been used by the Navy to hunt for mines?
21. A. What has been the conventional procedure for clearing minefields?
    B. What is the emphasis in mine countermeasures in the U.S. Navy today?
22. A. What will soon be the main Navy mine countermeasures platforms?
    B. How will they be equipped for this mission?
23. What is the most significant impact of mine warfare on an enemy?
24. What are three unique qualities that make mines significant in strategic planning?
25. How can mines be used to gain victory over an enemy country?
26. What are other potential strategic advantages of mine warfare?

New Vocabulary

mine
bottom mines
contact mine
magnetic mine
pressure mine
CAPTOR mine
degaussing
minesweeping
mine countermeasures
actuation method
influence mine
acoustic mine
combination mine
deperming
mine hunting
ROV

23

Chemical, Biological, and Nuclear Warfare

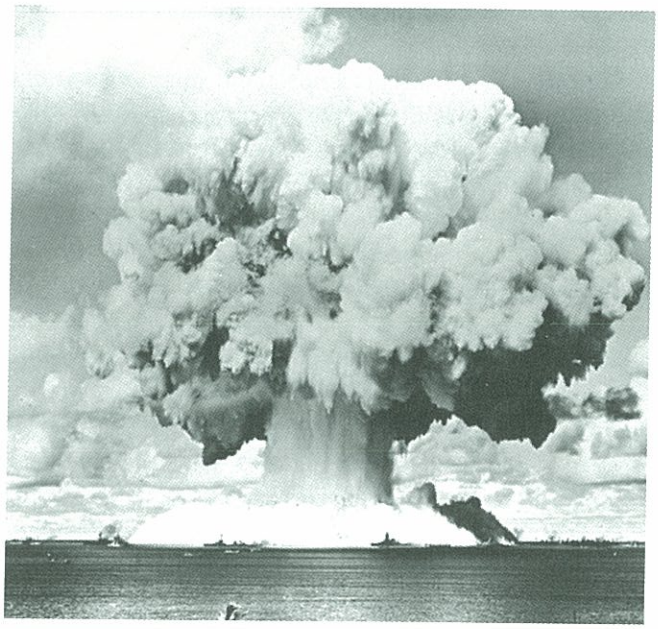
The previous chapters of this unit, and prior units of this book, have discussed various types of weapons and weapon systems with which the naval forces of the United States and other countries of the world are equipped. Most of these weapons depend for their effectiveness on the delivery of some type of high-explosive warhead or explosive device, such as guns, mines, and most bombs, rockets, and missiles. Such weapons are collectively called *conventional weapons*. In addition to these, there are other potentially far more devastating types of weapons in the arsenals of many of today's military forces. These are referred to as **CBR weapons** (chemical, biological, and radiological or nuclear), or sometimes *special weapons* or *weapons of mass destruction* (WMD), to differentiate them from conventional weapons. They can inflict massive destruction over a large area and mass casualties among a population.

Although they are often thought of along with nuclear weapons as being relatively new concepts, in actuality chemical and biological warfare have been used in war for many centuries. Even in ancient times it was a common practice to disrupt an enemy's food-production capability by spreading salt on their agricultural fields or to contaminate an enemy's water supply by dumping dead animals or vegetation into it. More lethal chemical weapons such as mustard (blister) gas were developed and used in the trench warfare of World War I, and the use of smoke of various kinds to mask movements at sea was a common tactic until well after the advent of radar in the mid-1940s.

The widespread use of chemical and biological warfare in World War II and in more recent conflicts since has been held in check for the most part by threats of retaliation and international accords limiting their use, but many rogue nations, and probably some terrorist organizations as well, still have some of these kinds of weapons. Their use by unprincipled leaders against civilians and weaker foes unable to retaliate has been documented several times in recent decades, the most recent instance being Syrian president Bashar al-Assad's use of nerve and chlorine gas against civilian opposition in the Syrian civil war.

The age of nuclear weapons began in 1945 with the use of the atomic bomb against the Japanese cities Hiroshima and Nagasaki in the closing days of World War II, followed by the development of the hydrogen bomb shortly thereafter. The end of the war ushered in the Cold War, a fifty-year-long era of nuclear confrontation and stalemate between the Soviet Union and the United States and their respective major power allies that did not end until the dissolution of the USSR in the early 1990s.

Much progress has been made since then with disarmament negotiations and international accords among the current-era world powers and many other nations that have done much to limit the spread and diminish the stockpiles of CBR weapons. Nevertheless, the threat of potential use of these weapons, especially by rogue nations and terrorists, still



An expanding shock wave and surge of radioactive material sweeps out over and above target ships moored at a mid-Pacific test site at Bikini Atoll in 1946.

persists. Thus, the United States and its allies must continue to maintain strong deterrent capabilities to try to discourage any aggressive use of CBR weapons of mass destruction.

The following sections summarize current capabilities in CBR warfare and some of the damage control measures that could be taken in the event of their use in any future conflict.

Chemical Warfare

Chemical warfare (CW) is the military use of any chemical to harass or cause casualties among an enemy's military forces or its civilian population. CW **agents** are poisonous chemical compounds or substances that can cause death, injury, or irritating effects. They may be gases, vapors, powders, or liquids, and include screening smokes and incendiaries. Though they can be deadly, CW agents are often unstable and difficult to produce and store, and can be dispersed and rendered ineffective by weather and sunlight.

CW agents such as nerve gas can be difficult to detect, and many are lethal in very small concentrations. Upwind dispersal of them could contaminate a large area with devastating results. Combatants sometimes use chemical smoke screens to hide their own ships or forces or to confuse enemy forces. The smokes can be combined with other chemical agents as well. Incendiaries—chemical compounds that burn with terrific heat—may be dropped by aircraft, fired in shells, or used with flamethrowers. They include napalm, jellied gasoline, and thermite and magnesium bombs. But the most dangerous CW threat is the use of casualty and harassing agents against troops or civilian populations.

CW gases cause various kinds and degrees of severity of bodily damage, depending on the type of agent used. The most common types of CW agents are nerve gases, blister gases, blood gases, choking gases, psycho gases, and vomiting and tear gases. A protective gas mask can protect the eyes and lungs against many of these agents, and specially treated garments will protect the skin.

Nerve gases are the most deadly of the CW agents. They were developed by the Germans in World War II but never used in that war. Entering the body through the nose, skin, or mouth, they are quick killers. Protection against nerve gases depends on speed in detection, masking, and self-aid or first aid. Many analysts believe these are the most probable CW agents to be used in the future. There were recorded uses of nerve and possibly blister gases by Saddam Hussein against Iranian forces during their protracted war of attrition in the 1980s, and more recently nerve and chlorine gas by Syria's Bashar al-Assad against people in that country in 2013 and 2017 in the ongoing civil warfare there.

Blister gases cause blisters on the skin. A type of blister gas called mustard gas was used extensively in World War I and caused many casualties on both sides. Whether in liquid or vapor form, blister gases cause painful burns and blisters on the skin and can damage the eyes even more seriously. If breathed into the lungs, blister gases will inflame the throat, windpipe, and lungs, often resulting in pneumonia and death.

Blood gases directly affect heart action and interfere with the absorption of oxygen by the body. The body tissues suffocate and die. A mild exposure will produce headache, dizziness, and nausea, followed by recovery within a few hours. Heavy exposure will cause a speedy death. These gases have not been successfully used in war because they are very light and dissipate quickly. They would probably not be used by themselves.

Choking gases (lung irritants) act on the respiratory system and are often fatal. Chlorine and phosgene are two common types. Phosgene was used in World War I and caused casualties second only to mustard gas. These gases cause the lungs to fill with liquid, causing death due to lack of oxygen.

Psycho gases produce a mentally confused state that includes hallucinations, anger, and inability to sleep. They may also cause physical symptoms such as dizziness, blurred vision, fainting spells, and severe muscle weakness. These gases make people completely ineffective, but they do not kill. Their effects last from eight hours to four days. According to some analysts, psycho gases could also be widely used in future wars.

Vomiting gases and **tear gases** produce unpleasant symptoms, but usually for only a short time. They are not intended to cause death. They are used to control riots, to force people out of buildings or caves, or to capture enemy forces without serious injury. They are often used in training exercises. Because these gases are vapors, protective gas masks give complete protection if used quickly and correctly. Mixture of these agents with more lethal gases is possible, however. The vomiting or tear gas would cause victims to remove their protective gas masks, whereupon they would then be susceptible to fatal exposure to the nerve agent. If that were done, many casualties could quickly occur.

All of these chemical warfare agents can be delivered via gun projectiles, missiles, airdropped munitions, and aircraft spray tanks.

Biological Warfare

Biological warfare (BW) is the use of living organisms (bacteria, spores, or fungi) or toxins (powerful biologic poisons) to reduce the ability of an enemy to wage war by destroying or contaminating food or water supplies, or by spreading epidemic disease. A BW attack could be launched by an aerosol spray (foglike droplets) released into air currents, by infectious agents (germs) contaminating food or water supplies or causing animal- or insect-borne diseases, or by a powder containing spores that people might ingest. Biological agents can be released by aircraft, bombs, and missiles, and also by enemy

agents or terrorists. Like certain chemical agents, it takes only a very small amount of many BW agents to do serious harm.

An extended laboratory testing process is necessary to detect BW agents, which are very difficult to identify. Many people could become casualties by the time the agent is identified. Once identified, however, diseases caused by most BW agents can be successfully treated. Most BW agents die or lose their effectiveness after a few days of exposure to sunlight and ordinary weather conditions. Food and clothing suspected of being contaminated should be discarded or burned, and water boiled before use. Canned goods are normally considered safe to use.

Vaccines are available against many potential BW agents such as anthrax and plague, and can be administered to military personnel and civilians in danger of being exposed to this kind of attack. Several kinds of antibiotics are effective in treating the effects of many kinds of BW agents after exposure.

Nuclear Warfare

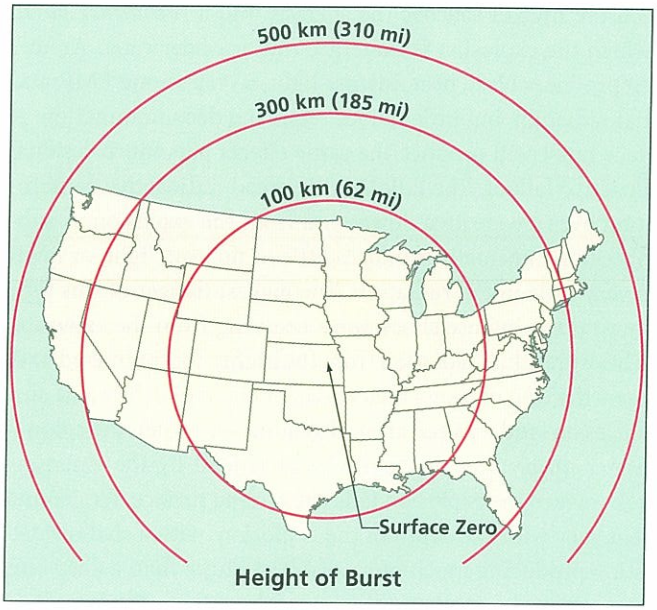
Nuclear warfare involves primarily the use of weapons or devices that use nuclear fission or fusion to produce their explosive effects, but can also include "**dirty bombs**"—IEDs containing radioactive waste materials dispersed by conventional explosives. The former are included in the definition of weapons of mass destruction, but the latter is sometimes called a weapon of mass *disruption* because its use would probably not result in mass casualties.

Insofar as nuclear warfare (or nuclear power) is concerned, *nuclear fission* involves the use of some form of uranium or plutonium that can undergo splitting, or *fission*, of its atomic nuclei under certain circumstances; *nuclear fusion* involves the combination of hydrogen nuclei to form helium. Both processes release massive amounts of thermal energy if they occur as detonations in which trillions of nuclei are either split or combined within an extremely short time. Fission weapons are often called **atomic bombs**, and fusion weapons are called **thermonuclear weapons** or **hydrogen bombs**. Fusion weapons are thousands of times more powerful than fission weapons. The amount of energy nuclear weapons release, called the *yield*, is specified in terms of the energy that would be released by the detonation of an equivalent amount of high explosives. Fission weapons are measured in *kilotons* (KT—thousands of tons of TNT), and fusion weapons in *megatons* (MT—millions of tons of TNT).

When a nuclear weapon in the form of a bomb or missile warhead detonates, a tremendous shock wave is released along with intense pulses of light, heat, electromagnetic energy, and nuclear radiation. These effects, though devastating, last only a few seconds. Subsequent **radioactive fallout** from this kind of attack can continue for days, however, and spread over large areas if carried by wind or water currents.

The shock wave, or blast, from a nuclear detonation, just as with any explosion, can smash ships, level buildings, and cause casualties for miles. The light pulse can blind anyone within miles. The thermonuclear heat, called *thermal radiation*, is so intense that any metal near **ground zero** (the site of the explosion) may melt, and flammable objects will burst into flames. Soft body tissue of anyone unfortunate enough to be near ground zero will vaporize, and serious burns to exposed skin can occur as far as twenty-five miles away.

The **electromagnetic pulse** (EMP)—the burst of electromagnetic energy released by a nuclear detonation—varies with the altitude of the detonation and its yield, and potentially extends at least to the horizon as seen by the weapon, depending on its size. Since any wire or metallic or electronic component can function as an antenna with respect to an oncoming electromagnetic pulse, an EMP generated by a nuclear detonation of sufficient yield could damage electronic systems many miles away, regardless of whether or not they were powered up at the time. A 100-kiloton or larger explosion at an altitude of 40 kilometers (about 25 miles) over the United States would generate an EMP that could damage electronics within a radius of about 710 kilometers (about 440 miles), and one exploded at an altitude of 100 kilometers (about 60 miles), damage within a radius of about 1,120 kilometers (about 700 miles). The explosion of a 1-megaton weapon would extend the radius of damage much further, possibly over the entire United States if the explosion took place at an altitude above about 500 kilometers (about 300 miles). The most severe effects would occur to the south of



Potential radii of EMP (electromagnetic pulse) damage from the high-altitude explosion of a one-megaton nuclear weapon at various heights above the United States. *Atomicarchive*

ground zero because of interaction with the Earth's magnetic field. The damaging effects of an EMP from the same weapons detonated at ground level, however, would extend to a radius of only about fifteen miles or less. An EMP could potentially be far more debilitating to our technology-dependent population than all the other effects of a nuclear weapon detonation.

The *initial nuclear radiation*, or first radiation, cannot be seen or felt, but it can be as deadly as any of the other effects. This radiation is made up of alpha particles (like a helium nucleus) and beta particles (high-energy electrons), high-speed neutrons, and energetic gamma rays. All these particles and rays are lethal to human tissue and can result in severe injury, sickness, or death, depending on the exposure. Alpha particles can be stopped by a sheet of paper; beta particles can be stopped by a thin sheet of aluminum. The others are much more difficult to stop with anything less than heavy lead shielding or some other dense substance.

Residual radiation, or *nuclear fallout*, consists of radioactive particulate materials produced by the explosion, plus airborne dust, dirt, and water vapor contaminated with alpha and beta particles. It may be deposited for days over a large area by wind and weather. This fallout can be detected and measured by special instruments called **radiacs** (Geiger counters), which measure the radiation emitted by radioactive materials. If it is present in hazardous concentrations, the area must be decontaminated (washed clean) before unprotected personnel can enter.

There are three types of nuclear bursts: an *airburst*, in which the fireball does not touch the Earth; a *surface burst*, in which the fireball touches the surface; and a *subsurface burst*, in which the explosion is underground or underwater. An airburst produces blast, heat, intense light, a very strong EMP, and initial radiation, but little fallout requiring decontamination. A surface burst will produce the same effects plus much residual radioactive fallout. The fallout will spread radioactive contamination over a wide area downwind from the explosion. A subsurface burst normally produces little or no heat, light, or EMP, and very little initial radiation. The biggest danger of this type of burst is the intense shock wave resulting from the explosion and heavy residual radiation from the highly contaminated **base surge**—the wall of heavy mist at sea, or cloud of debris and dust particles on land, created around ground zero when the column of water droplets or dirt particles generated by the emerging shock wave of the explosion falls back to the surface. Its size and extent vary with the depth of the explosion, with a shallow detonation producing much more of a base surge than a deep one. Like a surface burst, the radioactive fallout from the large base surge resulting from a relatively shallow detonation can spread over a wide area downwind from the site of the explosion.

In the case of radioactive material dispersed by a conventional explosive in a dirty bomb, there will be shock and heat damage in close proximity, as with all such detonations, but the most troublesome effect is the radioactive waste material that could be spread for some distance. Anyone or anything near the site of such an attack can be contaminated with this material. Though normally the contamination would not be intense enough to cause immediate injury or death to personnel surviving the initial blast, the site itself may be unusable for a long time thereafter until complete decontamination can be accomplished, if ever.

Effects of Radiation Exposure

The physiological (body function) effects of nuclear radiation on people depend on the intensity of the radiation and the time of exposure. The amount of radiation received is called the *dosage* and is measured by wearable devices called **dosimeters**. The effects of radiation exposure are most severe on soft tissues in the body. They can vary from short-term weakness, fatigue, and nausea to burns, hair loss, immune system deficiencies, sterility, long-term genetic defects, skin lesions, leukemia and other cancers, and mental impairment, to severe sickness, delirium, and death within days or weeks, depending on the dosage received and the time interval over which it occurs. Moreover, the effects of radiation dosage are *cumulative*, meaning that even small exposures repeated often over time can have the same effects as a large dose received all at once.

Radiation dosage is measured either in SI units called *sieverts* (Sv) or, in the United States, in equivalent units called *rems* or *roentgens*. One Sv = 100 rem. A person who spent a day in a high-altitude city like Denver, Colorado, would receive about 1 millirem (.002 rem); a potentially fatal dose of radiation would be 400–450 rem (4–5 Sv). In the past, radiation dosage was commonly measured by film badge dosimeters, but now solid state dosimeters like the one shown here are used.
Stephane Allimann

When a CBR attack is anticipated, a ship will activate the water washdown system in order to wet all exposed surfaces to make the decontamination process after the attack easier. Here, a rainbow forms as a crewmember checks out the system on the amphibious assault ship USS *Boxer* (LHD 4). *Rudy Pulach*

CBR Damage Control

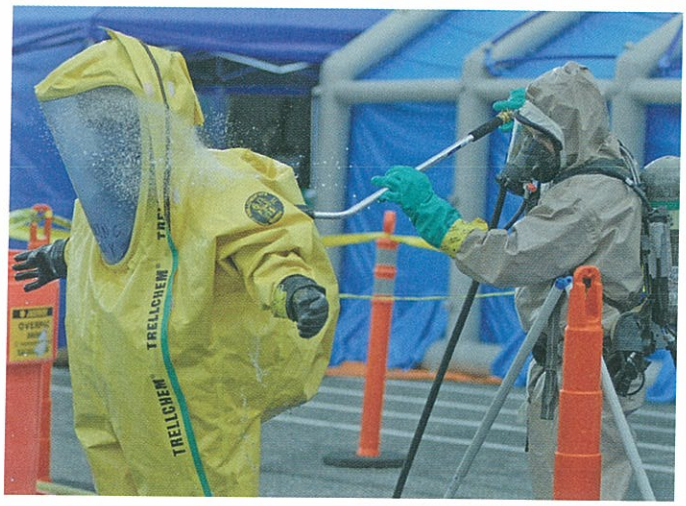
The crew of a naval ship can do much to minimize the damage and casualties that might result from an attack with CBR weapons, except when a ship is at or near ground zero. Tests have shown that ships not receiving direct effects of such attacks have a very good chance of survival with relatively few casualties and with weapons systems still operable.

Before an attack, ships normally would be at general quarters, so the ship should be pretty well "buttoned up." Water washdown systems that spray saltwater through sprinkler heads are turned on to wet all topside surfaces, so most contaminants will tend to wash overboard. All nonvital openings of the ship are closed, and nonessential circle WILLIAM ventilation fittings are shut to maintain as complete a gas-tight envelope as possible. Protective gas masks are distributed to personnel who must breathe outside air. Topside personnel in exposed positions wear protective clothing as well as masks.

Crewmembers wearing full protective gear conduct a topside contamination survey during a CBR warfare training exercise. *John Becman*

After the attack, trained personnel conduct surveys both topside and below deck throughout the ship using radiacs or other specialized equipment to determine the extent and location of contamination. **Decontamination** (removal or neutralization of the dangerous substances) is then done in three phases. The first two, called *tactical decontamination*, take place immediately, at sea. They reduce contamination so the ship can carry out its mission without exposing the crew to dangerous levels of radiation or other contaminants.

Phase one is *gross decontamination* by saltwater washdown, done with fire hoses by crewmembers wearing protective gear.



A CBR decontamination team member practices decontamination procedures with a teammate during a CBR drill. *Nardelito Gervacio*

It will eliminate 98 percent of the contamination if the surface was wet before the attack and washdown begins while it is still wet. If the surface has dried, only half of the contamination will be removed.

The second phase is *detailed decontamination* conducted by repair party personnel and others of the ship's crew topside. They use a steam lance or hose, scrub brushes with detergents, scrapers, and flame torches to try to remove any remaining concentrations of contamination (called **hot spots**) and wash it overboard.

The final phase of decontamination would normally be conducted at advanced bases by repair ships and tenders using flame burning, acid dips, and sandblasting.

Decontamination of personnel is done with fire hoses, sprayers, or jury-rigged topside showers. All contaminated clothing and protective gear is discarded. Personnel scrub thoroughly with soap and water and dress out with uncontaminated clothing.

Critical Thinking

1. In the 2002 movie *Sum of All Fears*, terrorists detonated a small nuclear device in Baltimore, Maryland. Research the likely effects of the explosion of a ten-kiloton nuclear device in or near a city the size of Baltimore in the United States. What would be the lethal radius of such a device, and how might the citizens of the place prepare to defend themselves against the effects of such a blast if some advance warning was received?
2. Research why an effective one-time large-scale chemical or biological attack would be very difficult to effectively plan and carry out under most circumstances.
3. Research some of the modern devices that could be used to give warning of an attack by chemical weapons. What are some of the countermeasures that can be used against such an attack by troops on the ground and ships at sea?

Study Guide Questions

1. What are conventional weapons?
2. What are special weapons, or weapons of mass destruction?
3. What are some examples of the use of chemical and biological warfare in ancient times?
4. What has tended to keep the use of chemical and biological agents in check in modern warfare?
5. What events began the age of nuclear warfare in the closing days of World War II?
6. Who poses the greatest threat to use CBR weapons today?
7. What is chemical warfare?
8. A. What are chemical warfare agents?
   B. What substances may they include?
   C. What are the most common types of CW agents?
9. What is biological warfare?
10. What does nuclear warfare involve?
11. What are the units in which yields of nuclear weapons are measured?
12. What are the effects from the detonation of a nuclear bomb or warhead?
13. What widespread destructive electromagnetic effect potentially results from a high-altitude airburst of a nuclear weapon?
14. What is nuclear fallout?
15. What are the three types of nuclear bursts?
16. What would be the most persistent effect of the detonation of a dirty bomb?
17. What are the physiological effects of nuclear radiation on people?
18. What are the three phases of shipboard CBR decontamination?

New Vocabulary

conventional weapons
CBR weapons
CW, BW agents
blister gas
choking gas
tear gas
nuclear warfare
nuclear fusion
thermonuclear weapon
yield (nuclear weapon)
megatons
shock wave
ground zero
radiac
"dirty bomb"
water washdown system
decontamination
special weapons
chemical warfare (CW)
nerve gas
blood gas
psycho gas
biological warfare (BW)
nuclear fission
atomic bomb
hydrogen bomb
kilotons
radioactive fallout
thermal radiation
electromagnetic pulse (EMP)
base surge
dosimeter
circle WILLIAM fittings
hot spots (radiation)

Unit 7

Shipboard Organization and Watchstanding

A naval ship's crew is made up of the officers and enlisted personnel necessary to fight the ship. The crew is organized in a manner best suited to meet combat needs, and that allows it to operate efficiently in peacetime but adapt quickly to meet wartime needs. Whether in time of peace or war, each crewmember has an important job. The chapters in this unit discuss the way ships' personnel are organized in the U.S. Navy and the watchstanding procedures on Navy ships.

24

Shipboard Organization

All Navy ships have both an administrative organization and a battle organization that govern how the crew goes about doing its job in both peacetime and wartime. Both are built around a hierarchy called the **chain of command**, which extends from the commanding officer through the executive officer and other ship's officers to every member of the crew. The administrative organization is the means by which the day-to-day routine of the ship and administration of the crew are carried out, and the battle organization is how the ship is manned during general quarters, the highest condition of readiness, to maximize the ability to fight the ship. In order to perform their duties effectively and efficiently, all crewmembers must know where they fit within each organization and what authority, duties, and responsibilities are associated with their jobs, called **billets** in the Navy. As a general rule, authority is normally delegated to the lowest level possible within the ship's organization for each function performed, commensurate with the subordinate's assigned responsibility and capabilities.

The ship's administrative and battle organization is detailed in such shipboard directives as the *Ship's Organization and Regulations Manual* (*SORM*), *Battle Organization Manual* (also known as the *Battle Bill*), and the *Watch, Quarter, and Stations Bill*. The latter is maintained by the ship's commanding officer and specifies by name and billet number each enlisted crewmember's berthing and locker assignments, as well as his or her assignments to various ship's bills, battle stations, and various duties and watches within each department in both peacetime and wartime.

Ship's bills contained in the *SORM* set forth for each type of ship how almost every routine and emergency evolution is to be performed, and by whom. There are administrative bills such as the berthing and locker bill, the formation and parade bill, and the security watch and antiterrorism bill; operational bills such as the cold weather bill, darken ship bill, flight operations bill, and the sea and anchor detail bill; emergency bills such as the aircraft crash and rescue bill, man overboard bill, and for nuclear-powered ships, the nuclear reactor plant casualty bill; and many others.

This rest of this chapter presents a general overview of the administrative organization and chain of command on board U.S. Navy surface combatant ships, ending with a brief summary of a typical combatant battle organization. Submarines have a similar organization; however, their officers and enlisted crew are all designated submariners, and their organization and duties are specifically tailored to the type of submarine to which they are assigned. Much of the material in this chapter pertains to submarines as well, but there are significant differences because of their unique nature.

Commanding Officer

Every commissioned ship in the Navy operates under the authority of an officer ordered to command it. Regardless of rank, he or she is called "captain." The **commanding officer** (CO) is the line officer in actual command of a ship.

The CO is totally responsible for the command. His or her authority is also total, within the limits set by law and *Navy Regulations* and the reporting senior. Subordinates in the chain of command may be delegated authority to manage the details of running the ship, but delegation of authority in no way relieves the CO of overall responsibility for the safety and operation of the command.

The CO strives to keep the command ready for war service. He or she is assisted by the **executive officer** (XO), who has charge of administration and training of the ship. The CO gives directions to the XO, who then works with the ship's department heads to conduct training, exercises, and drills to keep the crew ready.

With the assistance of the XO and the department heads, the CO maintains the ship's *Watch, Quarter, and Stations Bill*, which specifies the billet, berthing, duty, and watch assignments for each enlisted crewmember.

A main responsibility of the CO is the safety of the ship. This means, among other things, proper handling and stowage of ammunition, making sure the ship is watertight, careful navigation, posting of proper lookouts, and safe maneuvering and navigation. Since the CO cannot handle all these matters

The CO of a guided-missile destroyer (right) greets visitors from the Chinese navy. *Matthew White*

personally, he or she depends on the assistance of good subordinate officers. For example, the navigator must know the ship's position at all times, but the CO is still responsible for the safe navigation of the ship.

During combat, the CO's battle station is that station from which he or she can best fight the ship. In the event of the loss of the ship, the CO waits until all personnel are off the ship before leaving.

The CO supervises everyone under his or her command. He or she must direct the investigation of conduct offenses and assign punishments under the Uniform Code of Military Justice. The CO, in turn, is held responsible for his or her command by higher authority.

The welfare, morale, and living conditions of the crew are a CO's constant concern. He or she must strive to promote a positive climate within the command and ensure that unlawful discrimination based on sex or sexual orientation is absent. The CO must ensure that all personnel are assigned jobs, educational opportunities, and special programs based on merit, fitness, and capability, and that awards and recognition are fairly given.

Executive Officer

The **executive officer,** often called "the exec" or "XO," is the line officer next in rank to the CO. He or she is the direct representative of the CO. The XO is responsible for all matters relating to personnel, the ship's daily routine, and discipline on the ship. All orders issued by the XO have the same force as if issued by the CO.

The executive officer is responsible for coordination of all departments; assignment of personnel and upkeep of their records; preparation and maintenance of ship's organization bills and orders; supervision and coordination of work, exercises, training, and education; supervision of loading and berthing plans; supervision of ship's correspondence; and navigation (smaller ships only).

With the help of department heads, the XO coordinates all ship's work. This includes all significant activities, drills, and exercises; policing of the ship through the master-at-arms force; and inspections of the ship. The XO is responsible for the cleanliness, good order, and military appearance of the ship and crew.

The XO supervises the department heads in the performance of their duties and is in charge of the instruction of junior officers. The XO is responsible for the entries made in the crew's service records. He or she investigates matters involving conduct and discipline of the crew, normally through the executive assistants.

He or she supervises whenever all hands are called for any particular activity, exercise, or evolution, except during combat. When the ship is cleared for action, the XO inspects it, receives reports from the various departments, and reports to the CO the condition of the ship. If the CO is incapacitated or killed, the XO becomes the acting CO. For this reason, the XO's battle station is located some distance from the captain's. In modern surface combatant ships other than aircraft carriers, the CO usually is in the combat information center (CIC) on older ships, or in the ship's mission center (SMC) on new *Zumwalt*-class DDG 1000 ships; and the XO is on the bridge. On aircraft carriers the XO will be in the combat direction center (CDC), and the CO is normally on the bridge.

Navigator

The **navigator** is responsible to the CO for the safe navigation and piloting of the ship. In small ships, navigation is a **collateral duty** (a duty assigned and performed in addition to a primary duty) of the XO. Large ships usually have a separate navigator and a navigation department.

The navigator keeps the CO, XO, and officer of the deck (OOD) advised on the ship's location and maintains a position plot by celestial, visual, electronic, or other navigational means. He or she must study all charts and other sources of information before entering piloting waters (relatively shallow coastal or intracoastal waters) and give careful attention to the course of the ship and the depth of water when approaching land or shoals (places where the sea bottom is near or on the surface). In emergency situations the navigator is permitted to relieve the OOD as authorized in writing by the CO.

The navigator conducts navigation training of personnel such as junior officers, boat coxswains, and boat officers; and also trains quarterdeck personnel in procedures for honors and ceremonies, and all junior officers in Navy etiquette.

The navigator's staff maintains records of all observations concerning navigation of the ship. They obtain and add corrections and updates to all navigational charts, sailing directions, light lists, and other navigation publications.

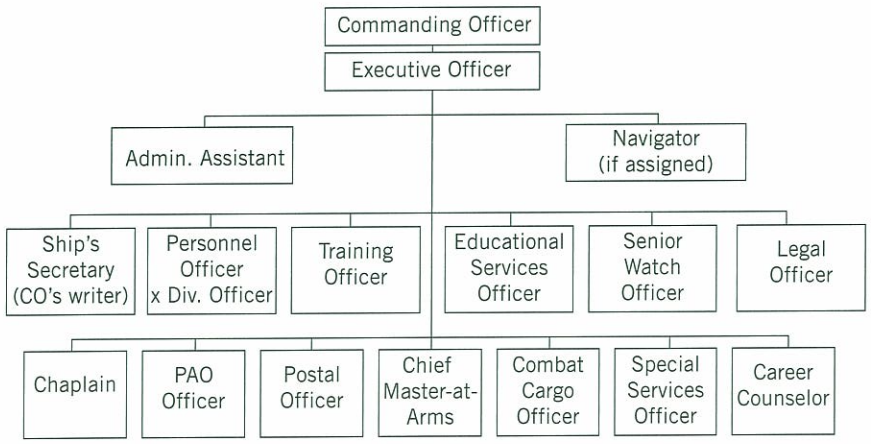
The navigator is responsible for the operation and care of all navigational equipment and for making daily inspections of the Deck Log for accuracy and proper content. It is also his or her responsibility to advise the CO and engineering officer of any deficiencies in the ship's steering system, and to monitor the progress of any necessary repairs to it. In general, the navigator is in charge of maintenance and upkeep for the bridge, pilothouse, chart room, and bridge wings.

Command Master Chief

The **command master chief**, normally the senior enlisted chief petty officer on board, serves as the principal enlisted advisor to the CO on the formulation and implementation of policies pertaining to morale, welfare, job satisfaction, discipline, and utilization and training of all enlisted personnel. The command master chief reports directly to the CO and works closely with the XO.

Equal Opportunity Advisor

To assist and advise the CO in matters pertaining to equal opportunity for all members of the crew, there is an **equal opportunity advisor** (EOA) assigned to each ship. He or she is a senior petty of junior officer with at least four years of service, reports directly to the CO, and serves as the primary advisor and subject matter expert on equal opportunity matters within the command.



The XO's assistants in a typical large amphibious ship. An aircraft carrier may have several additional assistants unique to carriers, and in smaller ships many of these tasks may be assigned as collateral duties.

Executive Assistants

As many as twenty staff officers and senior enlisted personnel work as **executive assistants** directly under the XO, depending on the size of the ship. In smaller ships several of these duties are assigned to one person as primary duties or as collateral duties. On an aircraft carrier these assistants are grouped into a separate department with its own department head. Some of the more important of these assistants, and their basic duties, are as follows.

The *administrative assistant* (AA) helps the XO in details of administration and serves as the administrative division officer. He or she assists the XO with all aspects of the ship's correspondence, directives, and reports.

The *command career counselor* (CCC) is the ship's enlisted career information program manager. He or she is responsible for providing each enlisted crewmember with a sufficient quantity and quality of career information to make sound career decisions. The CCC reports directly to the CO on all matters concerning command's career information program, and to the XO for administrative matters.

The *chief master-at-arms* (CMAA), normally one of the more senior petty officers on board, is responsible for enforcing regulations and keeping good order and discipline. He or she is in charge of supervising most working parties and is responsible for the security and welfare of any prisoners in the ship's brig. The CMAA may have several assistant petty officer *masters-at-arms* (MAAs) to help carry out these duties.

The *combat cargo officer* in amphibious ships has charge of the loading and unloading of troops; the billeting and messing of troops; and the loading, stowage, and unloading of cargo.

The *safety officer* is responsible for the implementation of a comprehensive safety program based on objectives established by the CO, promoting maximum cooperation on safety measures throughout the command, ensuring wide distribution of safety information, monitoring the timely submission of required safety reports, and maintaining appropriate safety records and statistics. He or she reports to the CO on safety and occupational health matters, and to the XO on administrative matters, and manages the Navy Safety and Occupational Health (SOH) program on the ship. On larger ships such as aircraft carriers he or she is a department head in charge of the safety department and reports to the XO for administrative matters.

The *security manager* is responsible to the CO for management of the command's information and personnel security programs. He or she develops and monitors these programs, ensures protection of classified information,

and maintains liaison with the command's public affairs officer to ensure security review of press releases and nonofficial speeches. He or she reports to the CO on security matters and to the XO for administrative purposes.

The *information assurance manager* (IAM) is responsible for ensuring adequate security of all of the ship's information technology systems.

The *personnel officer* assigns enlisted personnel according to the ship's bills. He or she is responsible for all enlisted service records.

Larger ships may have a public affairs officer, legal officer, and chaplain.

The *public affairs officer* (PAO) carries out the public affairs program of the ship. He or she keeps the CO and XO informed on public relations matters and prepares articles and photography for release to the news media (newspapers, radio, and TV).

The *legal officer* advises the CO and XO on matters concerning discipline and administration of justice. He or she often serves as an investigator for the XO on disciplinary charges.

The *chaplain* is responsible for religious activities of the command. The chaplain ministers to the spiritual needs of ship's personnel and often helps with personal counseling.

Department Heads

Most of a warship's crew is divided up into various **departments**, each of which may have one or more **divisions** within it. Each department on small to mid-sized ships is headed by a mid-grade officer called the **department head**, usually a full lieutenant (O-3), and divisions are administered by more junior division officers (O-2 or below) who report to the department head. On large amphibious ships and aircraft carriers, department heads may be lieutenant commanders and commanders (O-4 and O-5). Except for **staff departments** (medical, dental, supply), the department head is normally a line officer eligible for command at sea. In aircraft carriers, many of the departments, and especially the operations and air departments, are headed by naval aviators.

Depending on the size and type of the ship, it may have anywhere from about a half-dozen to twenty or so departments, as shown in the table on the next page. All department heads have equal status. They are the representatives of the CO for all matters related to their departments. They report to the XO for administrative matters and directly to the CO on matters in their departments affecting overall readiness of the ship, while also keeping the XO informed of such reports.

The department heads' duties cover a broad area. They assign, organize, and train their personnel. They are members of the XO's training board. They are responsible for the proper use and care of departmental equipment as well as the cleanliness and upkeep of spaces assigned to them.

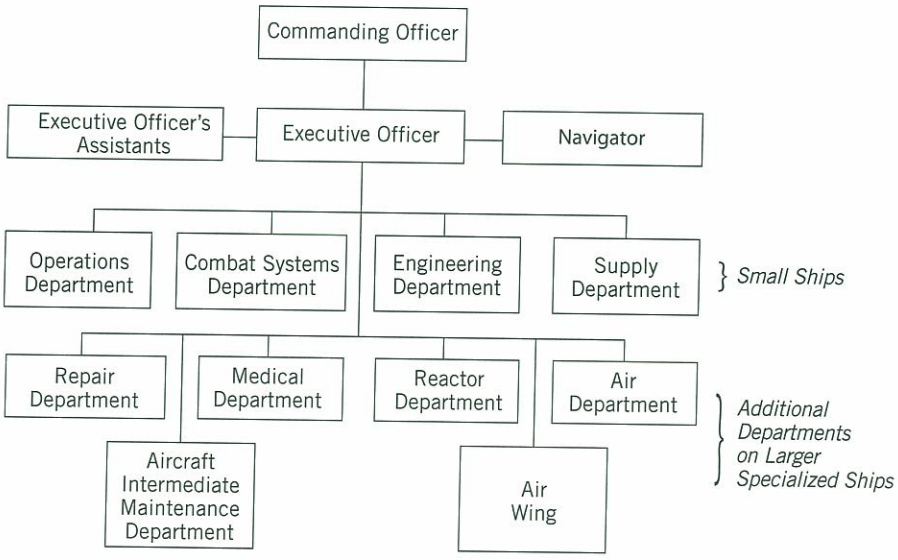
The following sections briefly describe the responsibilities of many of the department heads most commonly found on surface warships.

Operations Officer

The **operations officer** collects, evaluates, and disseminates combat and operational information wherever needed in the command. He or she also is responsible for operations of the ship and assigned airborne aircraft.

Under the operations officer, the operations department is responsible for:

- The conduct of surface and air searches
- The execution of antiair warfare (AAW), antisurface warfare (ASUW), ASW, EW, strike warfare (STW), and intelligence/cryptologic operations as directed, including the maintenance/dissemination of intelligence data, except on those platforms where any of the above functions and responsibilities are assigned to another officer
- The control of assigned aircraft when airborne, except when this control is assigned to another authority or is under the land-launch control of the air officer



A typical shipboard organization chart for a surface combatant. Aircraft carriers may have several additional departments.

- The management and maintenance of battle group command and control systems and associated equipment in support of an embarked flag officer
- The preparation of operation plans and orders
- The maintenance and repair of all electronic equipment except as assigned to another department
- The collection, interpretation, display, and dissemination of meteorological and oceanographic information
- In units not having a communications department, the functions prescribed for that department
- In units not having a weapons or deck department, the functions prescribed for the latter department

An operations specialist monitors air contacts in the CIC of the guided-missile cruiser USS *Lake Champlain* (CG 57). *Greg Messier*

Communications Officer

In most ships the **communications officer** is a division officer in the operations department. On larger ships such as aircraft carriers and amphibious command ships, he or she is a department head. The communications officer is responsible for visual and electronic communications and all the communications equipment. He or she is also responsible for the routing of all messages in the ship. He or she must be familiar with all tactical and communications publications. He or she is in charge of communications watch and signals staff, conducting their training, and supervising their watchstanding.

The communications officer supervises cryptographic (encoded communications) operations and looks after the security of crypto publications and equipment.

SHIP TYPE		LCC	LHA/LHD	LPD	LSD	LCS	CVN	CG	DDG	FFG	MCM	PC	SSN	SSBN	SSGN
DEPARTMENTS	MAINTENANCE MANAGEMENT						✔								
	RELIGIOUS PROGRAMS						✔								
	LEGAL						✔								
	DENTAL	✔	✔	✔	✔		✔								
	MEDICAL	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔
	SUPPLY	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔
	SAFETY		✔				✔								
	ENGINEERING	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	COMMUNICATIONS/INFO SYSTEMS	✔	✔				✔								
	AIMD		✔				✔								
	AIR		✔	✔		✔	✔	✔	✔	✔					
	COMBAT SYSTEMS		✔			✔		✔	✔	✔			✔	✔	✔
	DECK	✔	✔	✔	✔		✔				✔	✔			
	WEAPONS						✔		✔						
	OPERATIONS	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔
	NAVIGATION	✔	✔	✔	✔	✔	✔	✔					✔	✔	✔
	MEDIA		✔				✔								
	EXECUTIVE/ADMINISTRATION	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

The standard departments on board various types of surface warships and submarines in the U.S. Navy.

Combat Systems Officer, First Lieutenant, and Weapons Officer

Depending on the type and size of ship, Navy surface combatant ships can have one or more of the following departments, as indicated in the table opposite: a combat systems department headed by a **combat systems officer**; a deck department headed by the **first lieutenant**; and a weapons department headed by a **weapons officer**. In general, ships that are mainly concerned with ordnance, such as destroyers and cruisers, have a combat systems department and officer; all amphibious ships have a deck department headed by the first lieutenant; and LHAs and LHDs have both. Aircraft carriers have a deck department headed by the first lieutenant and a weapons department headed by a weapons officer.

Aviation units in a ship without an air department are assigned to the combat systems department; they make up the aviation division. These units retain their own basic organization even when so assigned. An embarked Marine Corps detachment may be assigned to the combat systems or deck department also, unless it is of sufficient size to be a separate department.

The *combat systems officer* is responsible for the operation and maintenance of the ship's combat systems, including armament, magazine spaces, search and detection equipment, command and control equipment, and fire-control equipment.

The *first lieutenant* is in charge of all deck seamanship evolutions and repair and care of the ship's exterior, and has oversight over the paint, sail, and boatswain's lockers. This officer is in charge of lifeboats and rafts, life jackets, and other survival equipment. He or she sees that all gear about the weather decks is properly secured. The first lieutenant is in charge of any cargo loading and unloading operations, including during ship-to-ship underway replenishment operations. The ship's boatswain (the senior boatswain's mate on board) reports to the first lieutenant. On ships that do not have a separate deck department, the first lieutenant is a division officer who reports to the combat systems officer.

The *weapons officer* supervises the operation care, maintenance, and inspection of the ship's armament and fire-control equipment, including guns, gun directors, missile batteries, fire-control systems, ASW weapons control system, and associated sonar systems. On ships having a combat systems department, the weapons officer serves as a division officer under the combat systems officer, and on ships having only a deck department, he or she serves under the first lieutenant.

Engineering Officer

Operation and maintenance of the ship's machinery are assigned to the engineering department. Damage control and certain types of repair are also handled by the divisions that make up the department: auxiliaries, repair, boiler, main propulsion, and electrical.

The **engineering officer**, sometimes called the *chief engineer* or *engineer officer*, is the head of the engineering department. He or she is responsible for the operation, care, and maintenance of all propulsion and auxiliary machinery, electrical-power generators, switchboards, and wiring. Engineering personnel operate the ship's engines, power, light, telephone, ventilation, heat, refrigeration, compressed air, and water systems. The engineering officer is in charge of the stowage, care, and use of fuels and lubricants. He or she maintains the engineering log, engineer's bell book, and other engineering records.

The *damage control assistant* works under the engineering officer to maintain the ship's damage control organization,

The first lieutenant (foreground) of the aircraft carrier USS *Carl Vinson* (CVN 70) supervises an anchoring evolution. *Travis Alston*

A machinist's mate mans a throttle in the engineering control room on the amphibious assault ship USS *Bonhomme Richard* (LPH 6) as the ship's chief engineer looks on. *Betsy Knapper*

including the control of ship's stability, list, and trim, and the ship's damage control equipment. He or she is responsible for training ship's personnel in damage control, including defensive measures against chemical, biological, and nuclear weapons.

A *main propulsion assistant* assists the engineering officer in all duties pertaining to the maintenance and operation of the ship's propulsion and auxiliary machinery.

Reactor Officer

Nuclear-powered aircraft carriers and submarines have a reactor department headed by a **reactor officer,** whose job is the operation, care, maintenance, and safety of the installed reactor plants and their associated auxiliaries.

The reactor officer is a technical assistant to the CO on matters of reactor safety. He or she supervises disposal of radioactive wastes from the ship's reactor plants, is responsible for the operation of the main engines, and maintains the engineer's bell book.

Air Officer

On ships that have an air department, the head of that department is the **air officer**—better known on board ship as the "air boss"—who directs aircraft launch, recovery, and handling operations, including visual traffic control related to these functions. His or her department is responsible for crash salvage operations and aircraft firefighting; the operation, daily inspection, and care of aircraft handling equipment (including elevators, tractors, tow bars, and firefighting vehicles); maintenance and operation of catapults, arresting gear, and visual landing aids; and the care, stowage, and issue of aviation fuels and lubricants. The title usually is **aviation officer** in the case of a helicopter detachment on a nonaviation-type ship such as a littoral combat ship.

The air boss (air officer) of the aircraft carrier USS *John C. Stennis* (CVN 74) explains the coordination of aircraft movement to visiting dignitary former governor Sarah Palin of Alaska from the primary flight control bridge (PriFly) overlooking the flight deck. PriFly tracks aircraft within five miles from the ship as they touch-and-go, land on, or maneuver about the flight deck, similar to the control tower of an airport. *Kenneth Abbate*

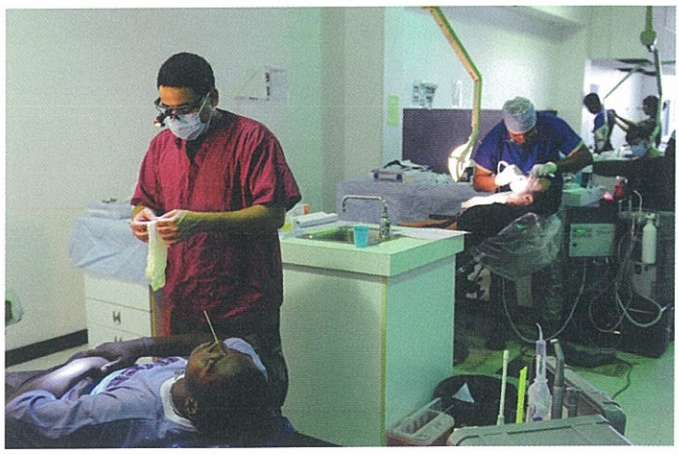
Supply Officer

The **supply officer** heads the supply department. He or she is a staff corps officer responsible for ordering, receiving, storing, issuing, shipping, selling, transferring, accounting for, and maintaining all stores and spare parts in the command. He or she is in charge of the equipment in the supply department such as forklift trucks, computers, ice cream machines, and vending machines.

He or she is in charge of the general mess and all food preparation in the command; manages all the ship's services—laundry, barber shop, tailor shop, ship's store, snack bar, and so on—and supervises the personnel who take care of the officers' staterooms, wardroom, and food preparation. He or she is in charge of disbursing pay and maintaining the pay records of all personnel in the command.

Medical and Dental Officers

Larger amphibious ships and aircraft carriers have a medical department headed by the **medical officer**, the senior officer of the Medical Corps serving on board. He or she is directly responsible for the health of personnel of the command. The medical officer advises the CO in all matters affecting health of



A Navy dentist ministers to a patient on board the amphibious assault ship USS *Kearsarge* (LHD 3). *Jilleanne Buda*

personnel on board. These ships also have a dental department headed by the **dental officer**, the senior officer of the Dental Corps serving on board, who is responsible for the dental care and oral health of ship's personnel. The dental officer and subordinates may be called upon to help the sick and wounded in cases of emergency.

Additional Department Heads on Aircraft Carriers, LHAs, and LHDs

When a carrier air wing (or Marine air group, in the case of LHAs and LHDs) embarks for a deployment on an aircraft carrier, LHA, or LHD, the commander of the air wing or air group, called the **air group commander** or **CAG** (a holdover from past times when a carrier's aircraft were called its air group) acts as a department head as well and reports as such to the XO. The CAG directs tactical training of the air wing or group, coordinates and supervises all activities of the embarked squadrons and detachments, and sees to the material readiness of the wing or group as a whole. The CAG works with the ship's operations officer in operational matters concerning employment, scheduling, training, and tactical air operations, and with the ship's air officer in matters concerning air department functions.

These ships also have a safety officer with a separate department, an intelligence officer, an air operations officer, an aircraft intermediate maintenance officer, and a media officer who head departments associated with each of these titles and duties.

Division Officers

The various departments of a ship are composed of **divisions**. The division is the basic unit of personnel on board ship. The number of divisions in a department varies depending upon the size and function of the ship. A division may be very small or as large as a hundred members or more, such as a deck division on an aircraft carrier.

Each division is headed by a junior officer called a **division officer**. This may be an ensign or lieutenant (junior grade) on smaller ships, or possibly a lieutenant on large ones. Division officers are responsible to their department heads for the administration of all personnel within their divisions. The division officer is the first commissioned officer in the chain of command over enlisted personnel. He or she is a guide, leader, counselor, and supervisor, and often the only officer whom division personnel regularly see every day. He or she must show a very personal type of leadership, always finding time for personal contact with assigned personnel.

The assignment as division officer is often a young officer's first really important assignment, his or her first chance to practice leadership skills. A division officer sets the pace and the example for the division. Almost every duty performed gets instant attention. He or she must issue clear instructions and give orders in such a way that the morale and spirit of the division are maintained.

Capt. Sara Joyner (right), commander of Carrier Air Wing 3, arrives on the flight deck of the aircraft carrier USS *Harry S. Truman* (CVN 75) supporting Operation Enduring Freedom in the Fifth Fleet area of responsibility.
Karl Anderson

Running the training program is one of the most important jobs of a division officer. Because of the rapid personnel changes in today's Navy, it is a continuous job.

Battle Organization

Every ship has a *Battle Organization Manual*, often referred to as the *Battle Bill*, as well as a *Watch, Quarter, and Station Bill* based on this and other ship's bills. The *Watch, Quarter, and Station Bill*, maintained as an administrative responsibility by the CO, details among other things the departmental watch and duty assignments for each crewmember under all battle readiness conditions based on the *Battle Bill* (see the next chapter for a description of the various shipboard readiness conditions).

When a ship is cruising in wartime under condition III (the wartime underway cruising readiness condition), it is partially ready for battle, and the battle organization is partly implemented. A three-section underway watch is normally stood on the bridge and engineering spaces, weapons stations are partially manned, and all ship's sensors (radar and sonar) are brought on line. Most personnel on watch have the same duty stations that they would have during general quarters.

If combat operations become imminent or the ship is attacked, readiness condition I (the highest readiness condition) is set, and general quarters (GQ) is called away, with all hands manning their battle stations. The CO goes to the station from which he or she can best direct the fighting of the ship, which on most modern ships with the exception of

Two cryptologic technicians track a target of interest in the electronic warfare section of the combat direction center of the aircraft carrier USS *Dwight D. Eisenhower* (CVN 69). *Joshua Murray*

aircraft carriers is the CIC or SMC, and the XO goes to the bridge. On aircraft carriers the CO is normally on the bridge and the XO is either in the CDC or in the secondary conning station near the bow. Department heads report to their departmental control stations, and junior officers and enlisted personnel report to their assigned departmental battle stations throughout the ship.

During GQ, pertinent information of all kinds flows quickly and continuously between the CO, XO, and senior officers and key enlisted personnel in charge of all ship control stations, weapons control stations, electronic surveillance systems, and operations centers via internal computer communications systems, sound-powered phones, intercoms, and ship's telephones. In battle conditions the CO directs the maneuvering of the ship, the firing of the ship's weapons, the launching of any aircraft, and all other combat action by communicating orders directly to those in charge of all the various battle stations. The ship's damage control organization is fully manned by the damage control assistant and designated departmental damage control personnel throughout the ship. They stand ready to control any damage sustained by enemy action and to effect emergency repairs to keep the ship in the best fighting condition possible. More about the damage control organization will be presented in chapter 2 of the Naval Skills section of this book.

Critical Thinking

1. Research the organizational structure of a large private company and compare and contrast it with the shipboard organization described in this chapter.
2. Compare the organizational structure of your school district headquarters with the organizational structure of a naval ship. What are the key differences?

Study Guide Questions

1. What two kinds of shipboard organization on a Navy ship govern how the crew goes about doing its job in both peacetime and wartime?
2. What is the chain of command in a naval ship?
3. How is authority normally delegated within a ship's organization?
4. What shipboard directives detail a Navy ship's administrative and battle organization?
5. What kinds of information does a ship's *Watch, Quarter, and Station Bill* contain?
6. What do ship's bills set forth?
7. Who has overall responsibility for the safety and operation of a naval ship?
8. What are the main responsibilities of the executive officer (XO)?
9. Why are the battle stations of the CO and XO separated?
10. What is the basic responsibility of the ship's navigator?
11. What is a collateral duty?
12. A. What are the responsibilities of the command master chief?
    B. To whom does he or she report?
13. A. What are the responsibilities of the equal opportunity advisor?
    B. To whom does he or she report?
14. To whom do the executive assistants report?
15. What is the chief master-at-arms, and what are his or her responsibilities?
16. A. What are the responsibilities of the safety officer?
    B. To whom does he or she report?
    C. On which ships is he or she a department head in charge of a safety department?
17. A. What are the basic duties of department heads?
    B. To whom do they report?
18. What are the basic responsibilities of the operations officer?
19. What is the primary responsibility of the communications officer?
20. A. What types of ships have a combat systems department headed by a combat systems officer?
    B. What types of ships have a first lieutenant in charge of a deck department?
    C. What types of ships have a weapons officer in charge of a weapons department?
21. What are the basic responsibilities of a ship's first lieutenant?
22. What is the basic responsibility of the engineering officer?
23. What kinds of ships have a reactor department and a reactor officer?
24. What are the responsibilities of a ship's air officer?
25. What are the duties of the supply officer?
26. What is the informal title of an air wing commander on an aircraft carrier?
27. A. What organization is the basic unit of personnel on board a naval ship?
    B. What is the title of the senior officer of this unit?
28. What shipboard bills contain the ship's battle organization?
29. What is the difference between the way orders from the CO are conveyed via the administrative chain of command in peacetime conditions and via the ship's battle organization during general quarters?

New Vocabulary

chain of command
combat information center (CIC)
combat direction center (CDC)
equal opportunity career counselor
divisions (ships)
combat systems
reactor
billet
ship's mission center (SMC)
collateral duties
master-at-arms (MAA)
departments (ships)
staff department
first lieutenant
CAG

25

Watches

A naval ship, submarine, or shore station can never be left to run itself. While at sea, shipboard equipment such as the main engines, freshwater evaporators, and electrical generators must be kept running, and various control stations such as the bridge and main engine control must be manned twenty-four hours a day, seven days a week (24/7). The crewmembers who man all these stations 24/7 to keep a ship or submarine operating and safe are said to be *standing watch*, and they are referred to as *watchstanders*. In port, most machinery and electronic equipment is shut down, but even so, watchstanders must be posted and other duty personnel must be assigned to keep the vessel secure and to provide needed services both during the working day and after hours, as well as on weekends and holidays. Likewise, shore stations must have sufficient watchstanders on duty at all times both in and out of uniform to keep vital facilities running and the stations secure.

Watch in the Navy is a word with several meanings. It may refer to the *location* of the person on watch (e.g., the bridge watch on a ship or communications watch ashore) or to his or her *watch section* (e.g., port or starboard, first or second), which is composed of all personnel on watch at a given time. It may also refer to the *time period* (04–08, 08–12, etc.) of the watch, or to the *individual* on watch during that time, such as the lookout watch. Watches take precedence over all normal duties and jobs that a person must routinely do on board ship or a shore station.

As was mentioned in the last chapter, the commanding officer is administratively responsible for maintaining a *Watch, Quarter, and Station Bill* for all personnel in each division of a naval vessel or facility of a shore station. This is based on the ship's or shore station's *Battle Organization Manual* (*Battle Bill*) and the *Organization and Regulations Manual.* The bill shows each person's name, rate, and billet number; the battle station; the duty section assignment; the watch assignments, if any; the station or duty in the event of an emergency such as fire, collision, or man overboard; and cleaning station. For watches that are not the responsibility of a single department, such as the bridge or quarterdeck watch on a ship, the ship's department heads assign the required number of personnel, and the senior watch officer makes up and publishes the watch bill in the plan of the day. Other watches within departments, such as main engineering control or the radio room, are assigned by the department heads concerned.

Persons in the Medical Corps, the Dental Corps, and the Chaplain Corps may be given watch and duty assignments only within their functional areas. All other personnel on a naval vessel or uniformed service members on a naval shore station may be assigned any watches and duties commensurate with their rank or rate, expertise, experience, and qualifications.

General Orders to the Sentry

The specific duties of a watch vary with each watch assignment, of course, but there are certain general precepts of conduct that are applicable to all watches stood by Navy personnel. Over time these have become embodied in what is known as the ***eleven general orders of the sentry***, which are as follows:

1. To take charge of my assigned post and all government property in view.
2. To guard my post in a military manner, keeping always on the alert, and observing everything that takes place within sight or hearing.
3. To report all violations of orders I am instructed to enforce.
4. To repeat all calls from posts more distant from the guard house than my own.
5. To quit my post only when properly relieved.
6. To receive, obey, and pass on to the sentry who relieves me, all orders from the commanding officer, command duty officer, officer of the deck, and officers and petty officers of the watch.
7. To talk to no one except in the line of duty.
8. To give the alarm in case of fire or disorder.
9. To call the officer of the deck in any case not covered by instructions.

10. To salute all officers and all colors and standards not cased.
11. To be especially watchful at night and, during the time for challenging, to challenge all persons on or near my post and to allow no one to pass without proper authority.

Although some of these general orders apply more to guard duties stood ashore than to watches on a naval vessel at sea, the general orders as a whole are nevertheless valuable guidelines of conduct for all watchstanders and are required knowledge for all new Navy recruits.

Readiness Conditions

In addition to the type of vessel and size of its crew, the number of watchstanders on station on board a particular naval vessel at any given time in port or at sea is governed in large part by the **readiness condition** under which it is operating. These conditions correspond to a vessel's degree of readiness to operate under circumstances ranging from routine in-port maintenance and upkeep during peacetime to battle conditions at sea in wartime. For surface ships there are five such conditions of readiness, ranging from V to I in inverse order of readiness for battle. Submarines because of their nature typically operate under only a couple of these, and shore stations make appropriate modifications based on the type of facilities they host.

Conditions IV and V are set during normal peacetime operations at sea and in port respectively. No weapons systems are manned, and a minimal number of watches are stationed, consistent with maintaining the safe operation of the ship.

Condition III is set at sea and in port during wartime and in peacetime during times of heightened stress or tension requiring increased readiness and alertness. A limited number of weapons systems are manned for prolonged periods, consistent with the need to conduct or repel any imminent attack that might occur before the ship could sound general quarters and go to full battle stations. To facilitate going to general quarters, inasmuch as possible, watch stations assigned to personnel under condition III are the same ones they would man during general quarters under readiness condition I.

Condition II is a special readiness condition applicable to gunfire support ships for situations such as extended periods of shore bombardment.

Condition I is the **general quarters** condition in which all ship control, weapons systems, sensors, damage control, engineering stations, and other battle stations are fully and continuously manned, either for battle or in the event of a serious shipboard emergency such as fire or flooding. Engineering systems are configured for maximum flexibility and survivability. If the ship remains at GQ for an extended time, a modification to condition I (condition 1E) may be set to allow designated personnel to obtain and distribute battle rations at their action stations, or on board amphibious ships, to free enough personnel from their GQ stations to carry out the ship's mission in amphibious assault operations (condition 1A). Most personnel will remain on their battle stations for the duration, eating battle rations and napping at slack times as best they can. If the threat of imminent combat diminishes, the ship may return to condition III for normal wartime steaming to allow time for the crew to obtain some rest and attend to their personal needs before higher-tempo operations resume.

A master helmsman outfitted in protective battle gear mans the helm on the bridge of a destroyer during a condition I general quarters drill while on deployment in the Mediterranean Sea. *Amanda Gray*

The remaining sections of this chapter deal primarily with watch procedures on board Navy surface warships because they are the primary training and initial duty assignments that most NJROTC cadets may one day receive if they opt to pursue service in the Navy. Though the basic principles are the same, the watch organization on board submarines is different in many respects because of their nature and will not be covered in detail herein. Further information about life and watchstanding on board Navy submarines and shore stations is readily available on the Internet.

Watchstanding Procedures

Traditional shipboard watches in peacetime conditions of readiness both in port and at sea are normally four hours long beginning each day at midnight, except for two 1600–1800 and 1800–2000 **dogwatches** in the early evening. These divided, or "dogged," watches allow watchstanders to eat their evening meal, and the watches to rotate so crewmembers are not standing the same watch every day. An alternative watch schedule used on a number of ships today features four five-hour-long watches from 0200 until 2200, then a mid-watch lasting from 2200 to 0200 the next day that may be split into two dogwatches if circumstances require. This schedule facilitates meals for watchstanders and eliminates the two early evening dogwatches. On submarines, the standard when underway is an eighteen-hour cycle, with six hours on watch, six hours for ship's work, and six hours for eating, sleeping, and rest and relaxation. Watch schedules in port may be more similar to those on surface combatants, depending on the circumstances and readiness condition set.

During readiness condition II and on occasion conditions III and IV at sea, a ship may go to "**port and starboard**" watches consisting of six hours on, six hours off when increased manning is necessary for some reason, such as conducting extended shore bombardment missions, extended flight operations, or "holding down" an unidentified submarine contact.

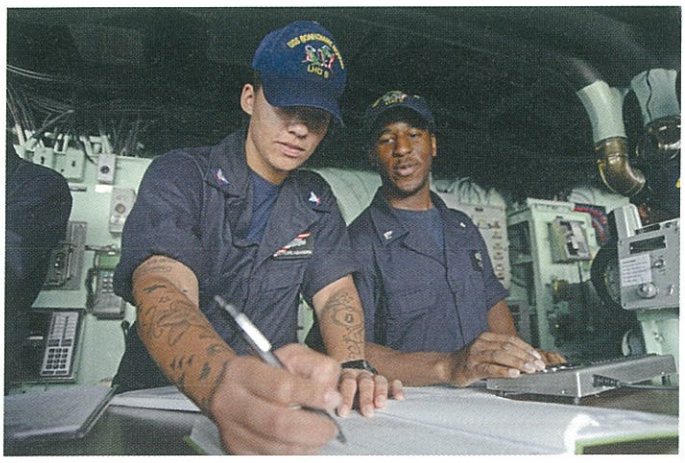
Because watches ashore are usually less demanding and not so frequently stood, shore station watches are normally eight or twelve hours long.

Relieving the Watch

Watches must be relieved on time. "On time" does not mean the relief shows up at the exact minute the watch changes, but rather about fifteen minutes before the nominal start time of the watch. This is both a courtesy and a practical procedure. This period allows time for the relief to review any logs that may be kept at that station, receive pertinent information and instructions that may need to be passed on from the off-going watchstander, and, at night, to read any night orders that might be on hand. In the case of night watches topside, this preparation time is also necessary for the reliever's eyes to adjust for night vision.

When the relief feels that he or she is ready to assume the watch, the relief says to the person to be relieved, "I am ready to relieve you." The off-going watchstander replies, "I am ready to be relieved." Permission to relieve the watch is then requested from the officer or petty officer in charge of that watch station, if present. After permission is granted and the relief understands everything and is ready to assume the watch, he or she says, "I relieve you," and the person being relieved states, "I stand relieved."

On watch stations where a log is kept, the off-going person completes and signs off on any entries made during his or her watch before departing. After that, the new person is responsible for the watch, and the change of watchstanders is reported to the senior officer or petty officer in charge of that watch station. When underway on a surface ship, if the ship's captain is on the bridge, the oncoming watch officer in charge of the bridge watch, called the **officer of the deck** (OOD), advises the captain that he or she has assumed the watch, and then the new OOD and JOOD (junior officer of the deck) announce to all bridge watchstanders that they have the deck and/or the conn (responsibility of giving rudder and engine orders) as appropriate. The responsibilities of the OOD and other topside watchstanders are discussed further below.



A quartermaster of the watch makes entries in a ship's Deck Log at the conclusion of a bridge watch while his relief looks on. *Sarah Villegas*

Shipboard Watch Routine

All personnel on watch at a given time constitute a *watch section*. There might also be specialized duty personnel from various departments such as supply and medical assigned to handle associated needs in their areas. A watch section with assigned duty personnel might be compared in many ways to a "shift" in an industrial manufacturing plant on land that operates 24/7.

Underway during routine peacetime operations in readiness condition IV, smaller ships usually have three numbered rotating watch sections; larger ships may have four or five. In readiness condition III, the standard is three watch sections. As mentioned above, sometimes when involved in very demanding operations under either of these conditions or when conducting shore bombardment in condition II, ships may go to to two "port and starboard" underway watch sections, each standing watch six hours on and six hours off, so that roughly one-half the crew is always up on duty at any given time.

In port, with the ship moored or at anchor and much of the ship's equipment shut down (secured), not as many watchstanders are required. The ship's crew is therefore divided into several rotating **in-port duty sections**, traditionally from four to six while in U.S. ports and naval bases during peacetime, and three while deployed overseas. If there are three duty sections, each section has duty every third day; four, every fourth day; and so on. Each person in a duty section must remain on board throughout the twenty-four-hour period his or her section is on duty, called a **duty day**.

Under normal condition V peacetime circumstances in port in both U.S. and most foreign ports, there are usually at least four rotating *watch sections* for most duty personnel each duty day, sometimes more on larger ships. Engineering department duty personnel may have fewer, depending on how much equipment is operating, and specialized duty personnel from such departments as supply and medical are usually not assigned to a watch section. During wartime in U.S. ports under readiness condition III, duty days are normally increased to one day in three or fewer, with three watch sections each duty day. In foreign ports, such condition III duty days and watches may both be port and starboard, with only reduced liberty hours, if any, for those not in that day's duty section.

In recent years, some alternative condition V in-port duty section assignments/duty day rotations have been implemented on some ships to try to provide the crew with more extensive blocks of scheduled time off for personal and family time, but that is the exception rather than the rule given the demands of the service in modern times.

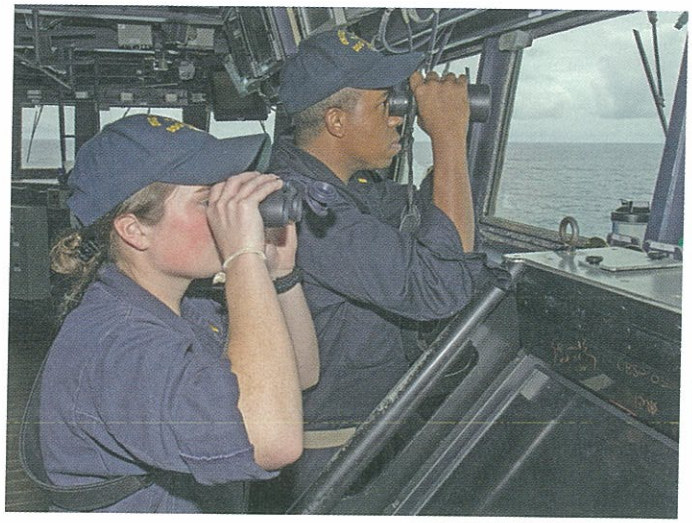
During routine conditions both at sea and in port, those persons not on watch during the working day normally perform ship's work, drills, and other activities as directed by their superiors; after working hours they can rest, participate in recreational activities, or, in port, go on liberty if not in that day's duty section.

Command Duty Officer (CDO)

To provide continuity throughout each duty day in port, most ships appoint a senior officer eligible for command at sea to act as **command duty officer** each day when the ship is in port. This officer represents the CO when he or she is off the ship or otherwise unavailable and is in charge of that day's duty section and all watchstanders. The CDO makes sure all events in the XO's **plan of the day** (POD—a daily published bulletin of planned events and deck watch assignments) for the ship are carried out. Some ships designate a CDO for duty when the ship is under way as well.

Officer of the Deck (OOD)

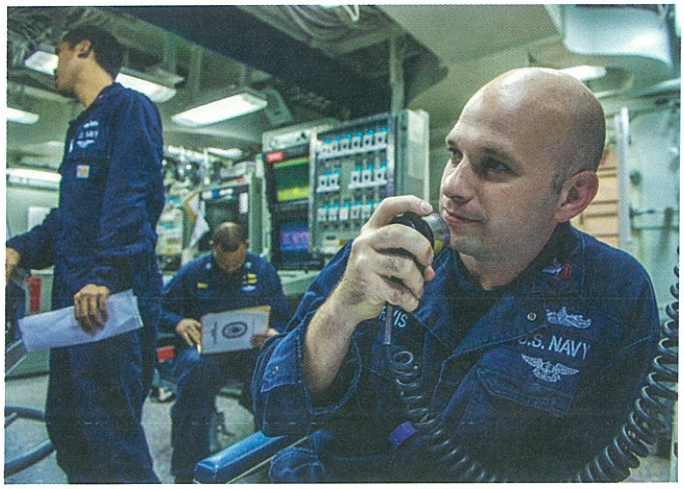
The OOD is the watch officer in charge of the routine ship's operations at any given time, both at sea and in port. He or she must have good knowledge of the policies of the CO, XO, and CDO and must make decisions. When underway, on a surface ship the OOD stands watch on the bridge. On a submarine, when surfaced the OOD stands watch atop the conning tower, and when submerged, in the control room beneath. When in port, the OOD stands watch on the quarterdeck. The safety and well-being of the ship or submarine at any given time depend to a large extent on the OOD.



Two Navy ensigns stand watch as OOD and JOOD on the bridge of a destroyer as the ship makes a transit of the South China Sea. *Will Gaskill*

When a surface ship is underway, the OOD on the bridge may be assisted by another officer called the *junior officer of the deck* (JOOD), and on some larger ships such as an aircraft carrier, by a third officer called the *junior officer of the watch* (JOOW). Normally all of these will be commissioned officers, but on some smaller ships, warrant officers or senior enlisted petty officers may stand these watches. The OOD has the authority to give ship-handling orders to ship control watchstanders such as the helmsman and lee helmsman, if one is assigned. This is called "having the conn." Or the OOD may delegate this authority to the JOOD or JOOW in order to train them for future OOD responsibilities.

The OOD is assisted by several other watch officers and enlisted watchstanders on duty throughout the ship. The operations/communications department has watch officers and/or enlisted watch personnel on duty at all times on the signal bridge, radio room, and CIC/SMC/CDC while underway, and some watches in these spaces in port. The engineering department has a number of enlisted watches in its engineering spaces: reactor compartments, engine rooms, generators, auxiliaries, and so on, as the ship's facilities require; and an engineering watch officer on duty at the main engineering control center of larger ships at all times when underway. Ships equipped with



Underway engineering department watchstanders in the main engineering control room of a guided-missile destroyer on patrol in the western Pacific. *Declan Barnes*

sonars will have watchstanders manning that equipment at all times while underway.

Every ship's department will have either watchstanders or duty personnel assigned to handle the responsibilities of the department at all times both underway and in port. For example, the supply department has duty personnel assigned to handle spare parts requests day and night, and there is always a duty medical corpsman. In addition, if cruising in potentially dangerous circumstances in wartime condition III, various weapons stations will be manned by watchstanders 24/7, and on aircraft carriers and amphibious ships having fighter aircraft, at least two duty combat air patrol (CAP) aircraft and their pilots will always be ready for launch on the flight deck if CAP aircraft are not already airborne.

Tactical Action Officer (TAO)

Because a combat threat to a ship can materialize rapidly, and the CO and XO cannot be available at a moment's notice at all times, a watch officer called the **tactical action officer** is stationed in the CIC/SMC/CDCs of Navy surface warships having offensive or defensive weapons capabilities whenever the ship's combat systems are manned. When stationed, the TAO is responsible for the smooth and efficient operation of his or her watch center, including the collection, display, and dissemination of tactical and other operationally significant data. When authorized by the commanding officer, the TAO can direct the employment of weapons and direct the OOD to maneuver as required to fight or defend the ship under emergency conditions, until the CO or XO can arrive on station.

When a TAO is not on duty, the CIC/SMC/CDC watch team is normally headed up by a more junior commissioned watch officer.

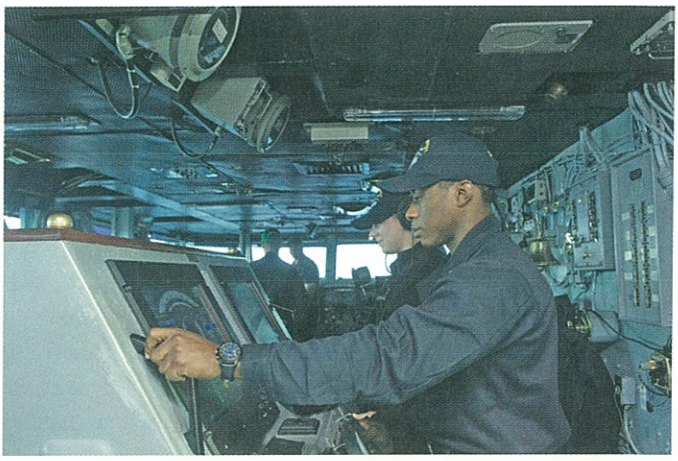
Enlisted Topside Watches Under Way

There are two basic types of enlisted watches in a topside underway watch section: **deck watches** and **navigational watches**. The makeup of a standard traditional enlisted underway watch section is described below. On newer ships outfitted with high-tech ship control and navigation systems, several of these watch assignments may be eliminated or combined.

Boatswain's Mate of the Watch (BMOW)

The BMOW is the petty officer in charge of the topside deck watch. The BMOW is the main enlisted assistant to the OOD.

A tactical action officer (TAO) stands watch in the CDC of the aircraft carrier USS *Harry S. Truman* (CVN 75) while the ship is on deployment. *Christopher Stoltz*



Two boatswain's mates stand watch as helmsman and lee helmsman on the bridge of the aircraft carrier USS *Dwight D. Eisenhower* (CVN 69). *Neo Greene*

He or she sees that all deck watch stations are manned and that all in the off-going watch are relieved. He or she must see that all watchstanders are instructed and trained in their duties. He or she must be a qualified helmsman.

In addition to the BMOW, the principal underway deck watchstanders include the helmsman, the lee helmsman, the messenger, the bridge sound-powered telephone talkers, lookouts, and, when stationed, the lifeboat watch.

Helmsman

The steering wheel of a ship is called the *helm*, and the watchstander who mans it is called the *helmsman*. The helmsman must be fully qualified to steer the ship. He or she steers courses ordered by the conning officer giving orders to the helm.

Lee Helmsman

The person who stands watch at the engine-order telegraph or *lee helm* alongside the wheel on the bridge of ships so equipped is called the *lee helmsman*. This person rings up the conning officer's orders to the engine room on the telegraph and sees that all bells are answered correctly. He or she should be a qualified helmsman. The helm and lee helm watches often alternate when on watch in order to spell each other and to keep alert. On ships with automatic propulsion control systems, the helm and lee helm are in the same console, and both are operated by the same watchstander.

Messenger

The messenger stands watch on the bridge and delivers messages, answers telephones, and carries out other duties assigned by the OOD.

Bridge Sound-Powered Telephone Talkers

A number of bridge sound-powered telephone circuits connecting the bridge with vital stations must always be operating when the ship is underway. Bridge talkers relay messages over these circuits between the OOD and all stations on the circuit.

Lookouts

Lookouts stationed on the ship's superstructure report aircraft sightings and all surface sightings of ships, craft, obstructions, and so on. They report on the condition of the ship's navigational lights every half-hour at night. The after lookout is stationed on the fantail with a lifebuoy close at hand in the event of a man overboard. Additional lookouts may be posted during periods of fog or low visibility. Each lookout will have a sound-powered telephone set to relay all sightings to the bridge.

Lifeboat Watch

Lifeboat watches enable expeditious recovery of any person who may fall into the water either by carelessness or because of some mishap during operations. Ships conducting air operations, on plane guard detail behind an aircraft carrier, or engaged in other potentially hazardous operations such as underway replenishment muster a duty lifeboat crew for each watch so the ship can launch a lifeboat on short notice. The crew usually does not have to remain on the lifeboat station but must be on call (up and awake) and ready for action on short notice.

The navigation watches include the quartermaster of the watch and the after steering watch.

An operations specialist on the bridge of the dock landing ship USS *Pearl Harbor* (LSD 52) exchanges information on the sound-powered phone with watchstanders in CIC while tracking surface contacts on the radarscope. *Michael Russell*

Quartermaster of the Watch (QMOW)

The QMOW maintains the ship's **Deck Log**, which records among other things all orders to the helm or lee helm and all

other major events of interest during each watch, and assists the OOD in navigational matters. The QMOW is a qualified helmsman.

After Steering

This watch is stationed in an emergency steering station in the aft part of the ship's hull. The watchstander is able to take over the helm in the event of a casualty to the bridge. In such an event he or she has direct control of the steering gear. Usually the OOD routinely directs actual shift of steering control to the after steering station at least once each watch. This guarantees that all gear is working correctly and keeps after steering watchstanders alert.

A seaman stands after steering watch on board the guided-missile destroyer USS *Stout* (DDG 55) on deployment with the Sixth Fleet.
Amanda Gray

In-Port Watches

The in-port topside watch on a ship is similar in many ways to the underway watch, but there are important differences having to do with where the watch is stood and by whom. In the first place, the primary watch station is shifted from the bridge to the quarterdeck. The quarterdeck is located on the main deck of the ship, usually at the head of the brow (access platform) through which crewmembers and visitors board or leave the ship. The OOD stands watch on the quarterdeck, as do several members of the enlisted in-port deck watch team. On smaller ships such as a destroyer, the in-port OOD may be a senior enlisted person, but on larger ships he or she is normally an officer, similar to the underway OODs. Normally on smaller ships there is only one OOD standing watch on the quarterdeck in port, but on larger ships there may also be a JOOD and perhaps a JOOW assigned for training. As with underway bridge watches, the OOD has an enlisted watch team to assist him or her, but the team members are different.

Petty Officer of the Watch (POOW)

The enlisted in-port topside watch team is normally headed by the POOW, who usually stands his or her watch at the quarterdeck along with the OOD. This is a senior petty officer qualified to lead the enlisted watch, often but not always the same individuals that stand watch as BMOW on the bridge when under way. The POOW is the OOD's primary enlisted assistant in port. He or she supervises and instructs the other deck watchstanders and carries out the daily routine and orders as the OOD directs. When neither the OOD nor any JOOD or JOOW is near the brow, the POOW returns salutes of those leaving and arriving. The POOW calls away boats in accordance with the boat schedule, calls away evolutions scheduled in the plan of the day, and assembles liberty parties for inspection by the OOD. If a QMOW (see below) is not assigned, the POOW maintains the Deck Log, keeps the OOD informed of significant changes in barometric pressure, and requires the messenger to make wake-up calls listed in the call book.

Most of the time the POOW is the only watchstander on the quarterdeck besides the OOD, unless a JOOD and JOOW are assigned on larger ships. Some or all of the following in-port watchstanders report to them, again depending on the size and type of ship: a brow watch, sounding and security patrols, sometimes a quartermaster of the watch, an anchor watch if at anchor or moored to a mooring buoy, a messenger, duty masters-at-arms, and boat coxswains and side boys as required. These are all described below.

Brow Watch

A brow watch is sometimes posted at the foot of the brow on the pier. This person maintains security of the brow and will attend to military and ceremonial duties for visiting dignitaries.

The OOD on the quarterdeck of the guided-missile destroyer USS *Gravely* (DDG 107) stands watch as a member of the crew returning from liberty steps off the brow. *Rafael Martie*

Quartermaster of the Watch (QMOW)

When assigned, the QMOW maintains the Deck Log, handles absentee pennants (flags hoisted on the signal bridge that indicate absence of the CO and any embarked officials), checks anchor and aircraft warning lights, hails boats, and assists with the rendering of honors. He or she takes bearings and plots periodic fixes when at anchor to guard against unknowingly dragging anchor, and records temperature and barometric readings every hour if this is not done automatically. If a QMOW is not assigned, these duties will be carried out by the POOW, the messenger, or the duty quartermaster in the navigation division or department.

Anchor Watch

When a ship is at anchor or moored to a buoy, this watch is posted near the anchor chain that connects the ship with the submerged anchor or the mooring buoy. He or she keeps a continuous watch on the anchor chain to check the strain and how the chain is tending, and notes any signs of dragging of the anchor or the buoy, such as vibration in the anchor chain. The anchor watch is connected via by sound-powered phone to the quarterdeck.

Sounding and Security Patrols

These watches are posted at sea and in port to increase the security of the ship. The patrol makes continuous rounds through all accessible spaces on the ship, being alert for evidence of sabotage, theft, or fire; checking security of weapons magazines; making periodic **soundings** (measurements made with weighted lines to determine fluid depth, or lack thereof) of designated tanks, voids, and other spaces; and inspecting damage control closures. They make hourly reports to the OOD.

Duty Master-at-Arms (MAA)

The duty MAA is a watch of the executive department. This person is a regular member of the MAA force who stands duty under the direction of the XO. He or she also performs the duties of the sergeant of the guard in ships without Marines. In this job the duty MAA is responsible for brig sentries and orderlies.

The coxswain and crew of the captain's gig secure the boat alongside an amphibious assault ship. A boat boom to which the gig will be moored is visible on the left. *James Bartels*

Boat Officers and Coxswains

If the ship is at anchor or moored to a buoy, the ship's boats make continuous runs with liberty parties going ashore or returning to the ship during liberty hours, and they convey crewmembers visiting shore facilities or other ships on official business at other times throughout the day. Under normal conditions the boats are operated by an enlisted **coxswain** who is in charge of the boat and its operation, plus one or two crewmembers who handle lines and boat hooks. During inclement weather or other hazardous conditions, each boat often also has a **boat officer** placed in charge of it who is a junior line officer responsible for giving direction to the coxswain in emergency situations and monitoring the safety of the boat and its crew and passengers. Boat officers and coxswains of boats without boat officers report to the in-port OOD and obtain permission from him or her to depart and to come alongside to discharge passengers.

At least one duty boat coxswain and crew is on call throughout the night hours. The CO and any embarked senior officials will generally inform the quarterdeck when they wish to use the captain's gig, and the POOW ensures that the gig and its coxswain and crew are ready when required.

Side Boys

When high-ranking officers or other dignitaries are expected to arrive or depart on official visits to the ship, enlisted **side boys** are mustered, inspected, and instructed in their duties by the POOW. At the appropriate time the side boys are lined up on either side of the quarterdeck, or sometimes on the flight deck of an aircraft carrier or other ships so equipped if the officials are arriving via helicopter, to render ceremonial honors to the arriving or departing officials. They normally wear dress uniforms. On a carrier they may wear the colored jerseys of the

A Navy official passes through side boys during a ship visit. *Daniel Viramontes*

flight deck crew, in which case they are referred to as "rainbow" side boys. When the POOW pipes the side on the boatswain's pipe, two to eight side boys, depending on the rank of the official to be honored, will form a passageway to or from the brow, or the ship's interior. They salute on the first note of the pipe and drop their salutes together on the last note. Side boys must be smart in appearance and grooming, with polished shoes and immaculate uniforms. Enlisted women may be detailed to this duty, but they are still called "side boys."

Watches Ashore

All major naval stations and bases, like ships, have watches that are stood by officers and enlisted personnel assigned to duty there. However, with the exception of forward bases supporting high-tempo operations overseas, the tempo of activity ashore is usually not as fast as that on board ship, so watch and duty assignments are usually not so frequent, except during special exercises or times of increased readiness.

Because they are not so often stood, nor as demanding as most shipboard watches, most shore station watches are longer than those on board ship, usually eight or twelve hours' duration. On occasion, especially during evening hours and on weekends and holidays, duty personnel not on watch may be allowed to stand their duty on call in quarters or at home.

Major shore staffs and stations usually have an officer assigned as CDO for each day, and they may also have an OOD, who stands his or her watches in a duty office. These may be assisted by several enlisted watchstanders, including a duty MAA, communications watch, and, on larger stations, a shore patrol watch (petty officer with the duty of policing and maintaining order and discipline).

Barracks Security Watch

A **barracks security watch** is maintained in all military barracks for protection against fire, for the safety of personnel and material, and for carrying out routines. This watchstander is responsible for fulfilling the provisions of the fire bill, emergency bill, and barracks regulations. The barracks watch is also responsible for keeping order and discipline.

All NJROTC cadets must be aware of the need for a barracks security watch and learn how to stand one. Why? Because NJROTC cadets often attend Basic Leadership Training Camps and other leadership programs held at various military bases around the country as part of their Naval Science program. While there, cadets normally stay in barracks at the base and may post barracks security watches.

NJROTC units also routinely visit naval bases and installations around the country. During these visits cadets are often housed in barracks as guests of the base commander. NJROTC units are responsible for the security, cleanliness, and discipline of the barracks that they occupy.

Critical Thinking

1. In the future many of the watchstanders described in this chapter may be replaced with automated systems. Describe which watchstanders might be replaced on board a typical Navy surface warship of the year 2030, and which positions if any will probably still be manned by humans.

Study Guide Questions

1. A. What are three possible meanings for a "watch" in the Navy?
   B. What governs how many watchstanders are on station on board a Navy ship at any given time?
   C. What is meant by "dogging" a watch?
2. What do the eleven general orders of the sentry embody?
3. A. What are readiness conditions for Navy ships?
   B. When is each readiness condition set?
4. A. How long does a traditional shipboard watch last?
   B. A typical shore station watch?
5. What is meant by "relieving the watch on time"?
6. A. Who constitutes a watch section?
   B. What is a "duty section"?
7. How many watch sections might a ship have during peacetime
   A. In port?
   B. When under way during routine operations?
8. How many duty sections is a ship's crew normally divided into during peacetime?
   A. When in U.S. ports and naval bases?
   B. When visiting a foreign port while deployed?
9. What are the responsibilities of a command duty officer?
10. A. What are the responsibilities of the officer of the deck?
    B. What does it mean to "have the conn"?
11. What are the responsibilities of a tactical watch officer when a ship's combat systems are manned?
12. What are the two basic types of enlisted watches in a topside underway section?
13. Who is the main enlisted assistant to the OOD on the bridge when under way?
14. A. What do lookouts report during their watches?
    B. When should additional lookouts be posted?
15. A. What is the purpose of the lifeboat watch?
    B. What does it mean for a person on a duty or watch assignment to be "on call"?
16. What are the duties of the QMOW?
    A. During underway watches?
    B. During in-port watches, if assigned?
17. Where is the primary shipboard watch station in port?
18. Who is the primary enlisted watch assistant of the OOD in port?
19. What is the purpose of the sounding and security patrols?
20. A. When and where is an anchor watch posted?
    B. What are his or her duties?
21. A. What name is given to the enlisted person in charge of a ship's boat?
    B. Who is placed in charge of a ship's boat during inclement weather or other hazardous conditions?
22. For what purpose are side boys stationed?
23. A. What is the purpose of a barracks security watch?
    B. Why should NJROTC cadets be aware of barracks watch requirements?

New Vocabulary

watch
readiness conditions
general quarters
duty section
night vision
TAO
the conn
deck watches
boatswain's mate
helmsman
lookout
after steering
brow
POOW
coxswain
side boys
shore patrol
barracks
watch section
dogwatch
port and starboard (duty, watches)
duty day
OOD, JOOD, JOOW
command duty officer (CDO)
CIC/SMC/CDC
navigational watches
BMOW
lee helmsman
QMOW
quarterdeck
plan of the day (POD)
soundings
boat officer
boatswain's pipe

Glossary of Naval Knowledge Terms

A2/AD operations—anti-access/area denial operations.

administrative discharge—discharge of a person from naval service initiated by the government for reasons of unsuitability or inaptitude for service life.

admirality law—a combination of national and international law that deals with contracts, torts (civil damages), injuries, or offenses that occur on the navigable waters of the world.

agents (chemical or biological warfare)—chemical compounds, germs, or substances that can debilitate or kill intended victims.

AGM—military designation for an air-launched guided missile designed to attack surface targets.

AIM—military designation for an air-launched air-intercept guided missile.

airfoil—the surface of a body in flight.

airframe—all external parts of an aircraft or missile.

air superiority—total and extended control of the airspace over a contested battle area or battlespace.

air-to-air warfare—offensive and defensive measures carried out by one or more aircraft against each other.

air-to-surface warfare—measures used by aircraft to attack surface targets on land or sea.

air warfare (AW)—warfare directed against airborne vehicles; formerly called antiair warfare (AAW).

ALMDS—airborne laser mine detection system, used by helicopters operating from littoral combat ships.

ALUSNA—the acronym for American Legation, U.S. Naval Attaché.

antiballistic missile (ABM)—a missile used in defense against incoming ballistic missiles.

antiradiation missile—a missile designed to home in on radiations emitted from enemy weapons or radar sites.

AOA—amphibious objective area, the battlespace around an amphibious operation.

aquaculture—the science of farming the sea for fish or plants.

area defense—protection of an entire formation of ships or land or sea area.

ARG—amphibious ready group, comprised of ships of the amphibious task force and the landing force they carry.

articulated tug—a tug that uses mechanical swivels to connect to its barges.

ASROC—antisubmarine rocket, fitted with a homing torpedo warhead.

asylum—protection and sanctuary granted by a sovereign state to a foreign national who seeks such protection because of persecution based on race, religion, nationality, or political affiliation.

asymmetric warfare—warfare between adversaries of greatly differing strengths wherein the weaker opponent attempts to avoid direct engagement with the forces of the stronger opponent, often by attacking nonmilitary targets.

ATF—amphibious task force, comprising amphibious-type warships and transports.

atomic bomb—a nuclear weapon that derives its explosive power from nuclear fission; a nuclear weapon such as a hydrogen bomb that produces energy by nuclear fusion.

autonomous underwater vehicle (AUV)—a crewless self-propelled underwater vehicle that can operate independently without external guidance.

auxiliary combatants—merchant ships that can be easily converted to perform combat roles at sea.

auxiliary ships—support ships such as mobile logistics ships, oilers, and repair ships; and smaller vessels such as tugs, salvage, and special mission ships.

avionics—electronic aircraft weapons control, communications, and navigation gear.

bad conduct discharge (BCD)—type of disciplinary discharge that can be awarded by either a special or a general court-martial as punishment to an enlisted service member convicted of a violation of the UCMJ, often preceded by a period of confinement.

ballistic missile—a missile that goes on a free-falling path after a powered and guided ascent.

ballistics—the study of flight characteristics of projectiles in free fall.

barrage—a formidable barrier of weapons.

base surge—an initial surge of heavy radioactive mist at sea or a cloud of debris and dust particles on land created by a nuclear surface burst.

battlespace—the total space within which a battle is conducted, including undersea, surface, air, littoral (coastal) areas, and near-Earth space.

belligerent—an opponent or nation engaged in warfare against another.

billet—job assignment within a military organization.

biological warfare—the military use of living organisms or toxins to infect enemy personnel in order to reduce their ability to wage war.

blockade—a naval operation wherein ships are prevented from entering or leaving certain ports or areas.

breach of discipline—a disciplinary infraction or violation of a rule of military conduct.

break bulk cargo—packaged cargo that must be loaded individually in bags, boxes, crates, drums, or barrels.

CAG—the air group commander on a carrier.

caliber—in naval guns up to 3 inches in diameter, the diameter of the bore in inches, decimal fractions of an inch, or millimeters; in guns larger than 3 inches, the length of the gun in inches divided by the bore diameter.

caliphate—an all-powerful ruling Islamic state.

captain's mast—a nonjudicial punishment proceeding.

carrier strike group (CSG)—a naval strike group built around an aircraft carrier.

cavitation—the formation and collapse of bubbles of water vapor formed by a rotating screw (propeller) in water. For a given propeller the effect increases with rotational speed and decreases with ambient water pressure around it.

CBR weapons—chemical, biological, and radiological or nuclear weapons.

CDO—command duty officer, an officer designated in port and sometimes at sea to represent the CO when he or she is off the ship or otherwise unavailable.

C4ISR—military command, control, communications, computers, intelligence, surveillance, and reconnaissance systems.

chaff—an airburst of magnetic or aluminum foil strands or fragments designed to interfere with the passage or orderly reflection of radar beams.

chain of command—the hierarchy by which authority in an organization is wielded from top-ranking officials to lower-ranking personnel.

chemical warfare—the military use of any chemical to harass or cause casualties.

chivalry—principles involving the qualities of bravery, honor, courtesy, respect for noncombatants, protection of the weak, generosity, and fairness to enemies.

CIWS—close-in weapons system, such as the Phalanx Gatling gun or SeaRAM missile system.

collateral damage—unintended damage to innocent civilians or private property by an attack.

collateral duty—a duty assigned and performed in addition to a primary duty.

combatant ships—warships such as aircraft carriers, surface warships, submarines, and amphibious warfare ships.

combined operations—military operations involving forces from more than one nation.

combined task force (CJTF)—a joint task force that includes forces from other nations for multinational operations.

compromise (security breach)—loss of security resulting from the loss or revelation of classified material.

ConRo ship—a hybrid combination of a roll-on roll-off ship and a containership.

containership—a merchant ship equipped to load, transport, and discharge van-type boxes containing general cargo; the boxes then can be transported on land via trucks or trains.

containment strategy—the Cold War strategy formulated by the Truman administration to counter the expansionist communist ideologies and actions of the USSR and Communist China.

continental shelf—the gradually downsloping sea bottom adjacent to a shoreline to the continental margin, not to exceed

350 nautical miles from the shoreline or 100 nautical miles beyond the 2,500-meter bathymetric curve.

contraband—any cargo specifically prohibited by law or rule from transport, import, or export.

convening authority—the command legally empowered to initiate a court-martial, court of inquiry, or board of investigation.

convention—in international law, an agreement or pact, especially an international agreement dealing with a specific subject, such as the treatment of prisoners of war.

conventional weapons—weapons that are in relatively wide use other than weapons of mass destruction, such as guns, mines, nonnuclear bombs, shells, rockets, missiles, and cluster munitions. They depend mostly on some form of explosive chemical energy or kinetic energy for their effectiveness.

convoy—a group of merchant ships sailing together for mutual protection.

correctional custody—confinement to a specific area or place ordered as part of a nonjudicial punishment for a disciplinary offense.

counterintelligence—the protection of a nation's secrets against espionage or other intelligence-gathering activities.

coup—shorthand for *coup d'état*, the overthrow of a government by force.

coup de grâce—a death blow administered in battle.

court-martial—a military court appointed by a convening authority to try persons accused of offenses under military law.

crude carrier—a type of tanker designed for the transport of crude oil.

cruise missile—an air-breathing, surface attack guided missile.

cyber domain—users of cyberspace, including devices, software, logic flow, and the geographic and physical location of users, circuits, and systems.

cyber operations—digital forensics, cyber reconnaissance, cyber security, cyber attack, and cyber defense.

cyber security—measures taken to safeguard computers, their networks, and the information they contain from unauthorized use or hacking.

cyberspace—the sum total of all the world's computers, servers, and networks.

cyber terrorism—cyber warfare conducted by extremists or terrorists.

cyber warfare—large-scale hacking attacks on government or military computer systems, communications networks, and infrastructure such as power grids.

decontamination—removal or neutralization of dangerous substances such as nuclear fallout or chemical contamination.

degaussing—the reduction or nullification of a ship's induced and permanent magnetic fields by sending a current through a system of coils surrounding the inside of the hull.

deperming—the reduction of a ship's permanent magnetic field by wrapping its hull with energized external electrical coils after construction, done as a mine countermeasure.

depth charge—an antisubmarine weapon consisting of a large canister of high explosives that can be detonated at a preset depth that is dropped or fired from a surface vessel.

deterrent—measures taken by a state or an alliance of states to prevent hostile action by another state.

digital forensics—a subsequent reconstruction of past events of concern that occurred within a computer system, often done as a part of a post–cyber attack analysis; a cyber-related criminal or civil law investigation.

diplomatic recognition—acknowledgment or acceptance of the national status of a new government by another nation.

dipping sonar—a sonar device lowered into the sea from a hovering helicopter to echo-range a submerged submarine.

directed energy weapon—a weapon that uses projected electromagnetic energy to damage or destroy a target.

dirty bomb—a conventional explosive laced with radioactive material that disperses upon detonation; a nuclear weapon containing components that will produce an extraordinary amount of radioactive fallout upon detonation.

dishonorable discharge—discharge of an enlisted service member resulting from a conviction for reprehensible misconduct, disobedience of *Navy Regulations*, or a serious violation of the UCMJ. It can be awarded only by a general court-martial.

dogfight—close-in air-to-air warfare wherein enemy warplanes are engaged with guns.

dogwatches—watches set between 1600 and 2000 in a traditional watch schedule to facilitate evening meals and a daily rotation of the watch.

dosimeter—a wearable device that measures the cumulative amount or dosage of radiation a person receives during a given exposure to it.

dry bulk cargo—unpackaged cargo commodities such as grain, ore, and cement.

dual-purpose weapon system—a weapon system designed to be effective against both air and surface, and in some cases against subsurface, targets.

effective gun range—the range at which a gun has a high probability of hitting a desired target, as opposed to the maximum

range, which is the maximum distance a gun will deliver a projectile.

electromagnetic pulse (EMP)—an intense burst of electromagnetic energy released by a nuclear explosion.

elevation (of a gun)—the vertical angle that the axis of a gun bore makes with the horizontal.

emergency destruction bill—an administrative bill for naval activities detailing who is to be responsible for rendering classified materials safe from imminent capture or compromise by an enemy, and how and in what order this is to be done.

ESG—expeditionary strike group, composed of an amphibious ready group plus an associated carrier strike group and other air, surface, or subsurface assets accompanying it.

espionage—the act of spying on others, or the use of spies by a government to obtain secret military or political information about another government.

flag of convenience—ship registration in which a ship owned and controlled by a shipping company of one nation sails under the flag of another to take advantage of more favorable labor and insurance rates, taxes, or government policies and regulations.

flexible response—a modification of the U.S. massive retaliation strategy by the Kennedy administration following the Cuban Missile Crisis to cope with all levels of aggression.

foreign internal defense (FID)—measures undertaken by both regular and special operations forces to assist a foreign government to irregular warfare threats.

forward presence—the maintenance of forward-deployed forces overseas to demonstrate national resolve, strengthen alliances, provide deterrence, and enhance ability to respond quickly to crisis situations.

general purpose forces—forces armed mainly with conventional weapons and able to carry out a variety of offensive or defensive missions against an enemy.

general war—armed conflict between major powers in which the total resources of the belligerents are employed and the survival of a major belligerent is in jeopardy.

geographic chokepoints—open waters constricted by depths or geographic features through which vessels must pass in order to transit a given area.

geographic rimland—peripheral lands surrounding a continent.

Gertrude—an underwater sound communication system.

grand strategy—the art and science of employing national power to achieve national objectives.

ground zero—the site of a large explosion, usually in reference to a nuclear detonation.

handling caveats—qualifications that can be applied to classified documents to restrict them to or from specific viewers.

hawser—a heavy rope or cable used for mooring or towing.

high seas—all parts of the world's oceans not included in the internal or territorial waters of a state.

homing torpedo—a torpedo with a self-contained guidance system based on seekers that detect sound emanating from a target.

hot spot—a concentration of nuclear contamination from fallout.

humanitarian assistance/disaster response (HA/DR)—assistance to victims of a large-scale natural disaster.

hydrogen bomb—a nuclear weapon that derives its explosive power from nuclear fusion.

hydrophone—a microphone designed for use underwater.

ICBM—intercontinental ballistic missile.

ideological warfare—attacks against a society's system of ideals and governing principles.

IED—improvised explosive device.

incendiary—causing or capable of causing fire.

influence mines—mines detonated by magnetic, acoustic, or pressure effects.

information warfare—actions taken against an adversary's information, C4ISR, or information technology (IT) systems while defending one's own similar systems.

innocent passage—under international law, the right to make a transit of a nation's territorial waters in order to enter into or make a passage to international waters. The ship may not linger in the restricted waters except if in distress and may not engage in any act prejudicial to the peace, good order, or security of the coastal nation.

insular safety—safety of a nation resulting from separation from likely aggressors by surrounding oceans or other bodies of water.

integral tug—a tug that can be rigidly connected to barges fore and aft.

intelligence—any information of possible military value about an enemy.

intelligence estimate—evaluated, integrated, and interpreted intelligence information.

intelligence process—the analysis and evaluation of intelligence information.

intermodal ship—a ship that carries cargo that can be loaded directly onto other forms of transport, such as vans, railroad cars, or vehicles.

internal (inland) waters—waters located within the established boundaries of a nation inland of a baseline conforming to the low-water line of its beaches.

international waters—waters external to any nation's territorial seas or internal waters, open to free use by the ships of all nations.

interventionism—a national strategy involving use of military force or other forms of coercion to attain national foreign policy objectives.

isolationalism—a national strategy of avoidance of entangling alliances.

jihad—a holy war undertaken by Muslims to defend or spread their Islamic faith.

joint operations—military operations involving forces from more than a single military service.

joint task force (JTF)—a task force composed of forces from two or more services.

jurisdiction—lawful authority.

LASER—acronym for light amplification through the stimulated emission of radiation.

laser weapons—directed-energy weapons that use high-powered laser beams to damage or destroy targets.

launch platform—the aircraft, ship, ground vehicle, or other conveyance from which a missile or other ordnance is launched.

light water—a firefighting liquid chemical compound designed to form a surface film to smother fires.

limited war—armed encounters in which one or more major powers restrict their actions in order to prevent escalation to general war.

line of demarcation—a baseline along a coastal area defining the boundary between territorial and internal waters of a littoral state.

lines of communication—sea-lanes or land routes over which communications, supplies, war matériel, personnel, ships, or land vehicles travel.

littoral—offshore coastal regions vulnerable to attack by naval forces.

littoral state—a nation having at least one shoreline bordering on international waters.

LNG carrier—a merchant tanker ship specially designed to carry liquefied natural gas.

logistics—at the national level, the total process by which the resources of a nation are mobilized and directed toward achieving military goals; at the theater level, the supply chain by which food, fuel, munitions, spare parts, and related information are conveyed from their point of origin to the point of consumption.

longshoremen—cargo handlers in a port.

LPG carrier—a merchant tanker ship specially designed to carry liquefied petroleum gas.

magnetic anomaly detection (MAD)—the detection of a submerged submarine by variations in the Earth's magnetic field that it creates.

magnetic signature—the magnetic field associated with a metal ship.

MAGTF—Marine air-ground task force, the basic unit of Marine amphibious warfare.

main battery—the largest or most powerful armament of a ship or plane.

malware—malicious computer software used in cyber attacks.

Maritime Prepositioning Force (MPF)—U.S. government and chartered merchant ships loaded with military gear and war matériel and predeployed to major theaters around the world to render immediate contingency support to deployed U.S. military forces in the event of an outbreak of hostilities.

massive retaliation—threat of the use of nuclear arms to counter any military invasion of Western Europe or the Americas by the USSR during the Cold War.

mate—a supervisory-level crewmember on a merchant marine ship, roughly equivalent to a commissioned line officer or senior petty officer on a naval vessel.

material readiness conditions—states of watertight integrity set on a Navy ship, ranging from X-RAY and YOKE for routine operations during peacetime in port and at sea, to ZEBRA and circle WILLIAM under battle conditions.

military law—regulations and rules pertaining to the discipline and administration of the armed forces.

military strategy—the plans for attainment of goals through the use of military force.

mine—a weapon containing an explosive charge in a watertight casing floating on, moored in, or planted under a waterway for the purpose of damaging or destroying an enemy vessel that strikes it or passes nearby.

mine barrage—a field of mines sowed in a water area to discourage the passage of shipping through the area.

mine countermeasures (MCM)—the branch of naval warfare that includes all methods, procedures, and techniques for preventing or reducing damage to ships from mines.

mine hunting—the methodical employment of sensor and neutralization systems in the air, on the water surface, or underwater to locate and dispose of individual mines when

sweeping is not feasible or desirable, or to verify the presence or absence of mines in a given area.

minesweeping—the technique of clearing mines using either mechanical, explosive, or influence sweep equipment.

MIRV—multiple independently targetable reentry vehicles (missile warheads).

moral warfare—the steadfast advancement of basic principles of humanity.

MRV—multiple reentry vehicles (missile warheads).

mutual assured destruction (MAD)—Cold War doctrine of unavoidable mutual destruction of each side by the other in the event of a nuclear war.

Nancy—signaling via the use of infrared light.

NATO—North Atlantic Treaty Organization.

naval attaché—a naval officer assigned to an embassy staff whose major duties are advising and representing the ambassador or other head of mission on naval matters and collecting intelligence. *See also* ALUSNA.

naval gunfire support—gunfire from ships in support of a land operation.

naval operations—significant activities conducted by naval forces; day-to-day activities within the operations department of a ship.

network-centric warfare—warfare directed and executed through the use of modern command and control C4ISR systems.

neutrality—the state of nonparticipation in a war.

nonjudicial punishment—punishment by a CO imposed on a crewmember without trial by court-martial.

notch tug—a tug whose bow fits into a notch on a barge pushed ahead.

nuclear fission—splitting of atomic nuclei.

nuclear fusion—the combination of atomic nuclei to produce a more massive nucleus of a heavier element.

nuclear triad—the nation's strategic long-range nuclear weapons delivery systems, consisting of the Navy's ballistic missile submarine fleet and the Air Force's land-based ICBMs and strategic bombers.

nuclear warfare—the use of weapons or devices that use nuclear fission or fusion to produce their explosive effects.

OAS—Organization of American States, an organization composed of almost all of the noncommunist states of the Western Hemisphere.

OOD—officer of the deck, in charge of the bridge or quarterdeck watch of a Navy ship.

peremptory challenge—the automatic removal of a prospective member of a military court-martial on demand from the accused, with no reason necessarily given.

plan of the day (POD)—a daily published bulletin of planned events and deck watch assignments.

point defense—the defense of a portion of a perimeter surrounding a ship or outpost by a weapon system capable of interdicting any threat that might materialize at that location.

POL—petroleum, oils, and lubricants.

political warfare—the use of political means and diplomacy to compel an opponent to do a nation's will.

preemptive attack—an attack carried out to thwart a possible future enemy attack before it can occur.

preliminary inquiry—under military law, an informal investigation conducted for the purpose of determining whether or not an alleged offense chargeable under the UCMJ has been committed, and that the accused committed the offense.

preparedness—in relation to national strategy, the maintenance of the appropriate strength or power base from which to take actions essential to the implementation of a grand strategy.

prepositioning ships—ships loaded with contingency military supplies and maintained at key locations around the globe for emergency resupply of deployed military forces before normal resupply methods can be activated.

preventive war—a war initiated by making a strike against an enemy to prevent the enemy from taking an anticipated aggressive action.

principles of humanity—the principles by which humankind should be treated humanely in all circumstances by saving lives and alleviating suffering while ensuring respect for the individual.

prize court—a court or official within a seizing ship's nation empowered to decide whether a ship has been lawfully captured or seized, and if so, what the disposition of the ship should be.

product carrier—a type of tanker designed for transport of refined petroleum products.

proxy war—a form of limited war in which a major power avoids direct military involvement in a conflict with another by having satellite states engage the other major power or its allies in its stead.

psychological operations (psyops)—operations intended to influence the emotions, motives, objective reasoning, and/or behavior of target organizations, groups, and individuals.

pursuit curve—the curved trajectory followed by a homing or beam-riding missile as it maneuvers to intercept a crossing target.

pyrotechnics—ammunition, flares, or fireworks used for signaling, illuminating, or marking targets, or for setting them on fire.

Q-ships—merchant raiders used by the German navy in World War I and World War II that appeared to be cargo ships but had hidden weapons.

quarantine—in military usage, a limited form of naval blockade directed against specific prohibited cargo.

radiac—an instrument such as a Geiger counter used to detect and measure the radiation emitted by a radioactive material.

radioactive fallout—radioactive particulate materials and airborne dust, dirt, and water vapor contaminated with radioactive material produced by a nuclear explosion.

radio-frequency weapons—weapons that use bursts or beams of high-power microwaves or other wide-band electromagnetic radiation to disable electronics or personnel.

raid—a sudden attack against a limited target, area, or facility.

rail gun—a weapon that fires an inert metallic projectile propelled by electromagnetic force from a set of rails at ultra-high speeds.

range (of guns)—the distance a projectile from a gun can be fired.

RAP—rocket-assisted projectile; the incorporation of a rocket motor in the base of a gun projectile to extend its range.

ratings—junior unlicensed seamen serving on board merchant marine vessels; formerly, a designation of a skill set of a Navy enlisted serviceman or servicewoman.

R&D—research and development.

readiness conditions—states of readiness under which Navy ships are operated, ranging from IV to V for peacetime operations in port to II and I for wartime operations at sea.

rebate—business term for a partial refund, kickback, or bribe.

reefer ship—a refrigerated cargo ship used to transport perishable goods.

registered publications—highly classified and numbered publications that have very limited distribution.

religious extremism—in the context of human conflict, a fanatical belief that it is legitimate to injure and kill if this is justified as a tenet of religious faith.

remote operating vehicle (ROV)—an underwater vehicle operated via control cables by operators on the surface.

reprisal—retaliatory action for an injury or attack.

restriction (punishment)—to keep on board a ship or shore station for some prescribed length of time as a nonjudicial punishment for a discipline offense.

retrograde—war matériel subsequently removed from a theater of operations.

rifling—spiral grooves cut inside a gun bore to impart a spin to a projectile being fired, for stability in flight.

right to approach—right accorded by international law to warships to verify a merchant ship's nationality, and under certain specific circumstances to stop and board, and examine the ship's documents.

RIM—military designation for a ship-launched air-intercept guided missile.

rimland—peripheral land on the margins of a larger land area.

riparian—having a border along a river.

RoLo ship—roll-on lift-off ship; variety of RoRo ship with vehicle decks accessible by a ramp but also having cargo holds accessible by a crane.

RoPax ship—hybrid version of RoRo ship designed to carry passengers on upper decks and vehicles on a lower car deck.

RoRo ship—roll-on roll-off ship having ramps and large hold openings designed to accommodate either containerized or unitized cargoes, or wheeled and tracked vehicles.

rules of engagement (ROE)—a set of criteria detailing the circumstances under which an enemy may be engaged, and by what means.

safe haven—an area in which enemy forces are not engaged because of political constraints.

sea control—mastery over the entire surface, subsurface, and air and near-Earth space over a maritime battlespace.

sealift—marine transportation of personnel, supplies, and equipment by ship.

sea power—the ability of a country to use and control the sea, and to prevent its use by an enemy.

security breach—loss or compromise of classified materials or information.

semaphore—a visual signaling method using various arm positions of the signalman for short-distance communication between ships.

shoring—bracing, usually wooden, placed against structures or cargo in a ship to enhance watertight integrity; to prevent breaking, sagging, or movement in a seaway; or to hold a ship upright in dry dock.

shrapnel—shell fragments from a high-explosive shell.

side boys—a group of enlisted personnel arranged on either side of a ship's quarterdeck or other arrival or departure site

to render ceremonial honors to arriving and/or departing high-ranking officers or other dignitaries.

smart weapons—highly accurate precision-guided missiles or bombs controlled by self-contained computerized guidance systems.

sonar—underwater sound navigation and ranging system that can be used for navigation or for detection of a submarine.

sonobuoy—a small, buoyant, cylindrical disposable sensor containing a hydrophone and radio transmitter used to help locate a submerged submarine.

sovereign—a self-governing independent country.

special contiguous zone—the twelve-mile stretch of water adjacent to and outside the twelve-mile territorial sea, within which the coastal state has only special limited jurisdiction.

special operations force (SOF)—specially trained operatives such as SEAL team personnel able to carry out special warfare tasks.

special warfare—irregular military operations that are unconventional in nature and often done in a clandestine manner by specially trained SOF personnel and other operatives. It also includes the conduct of foreign internal defense and counterinsurgency.

special weapons—unconventional chemical, biological, or nuclear weapons of mass destruction, especially nuclear weapons.

specified command—a broad U.S. national command composed of forces from only one service, with only functional responsibilities such as special operations or strategic warfare.

star shell—a projectile that detonates in the air and releases an illuminating parachute flare.

stevedore—alternate name for a longshoreman.

steward—an enlisted Navy Sailor or merchant marine rating who serves meals and performs housekeeping duties on board ship.

strategic forces—forces capable of delivering offensive nuclear weapons against an enemy.

strategic weapons—intercontinental-range weapons of mass destruction, especially nuclear bombs or ballistic missiles with nuclear warheads.

strategy—large-scale planning on a regional, national, or international level, or in the military.

strike—a form of military power projection meant to damage, seize, or destroy a targeted objective.

strike force—force intended to carry out an offensive attack against an enemy.

strike warfare—the destruction or neutralization of enemy targets at sea or ashore.

surface action group (SAG)—surface warfare ships constituting a battle formation.

surrogate forces—forces usually indigenous to an area, engaged by a major power to fight in its stead so as to avoid direct military involvement.

sweep—a series of strikes against several enemy targets in a general area; a mine-clearing operation on land or sea.

tactical data links (TDLs)—secure C4ISR radio nets used by U.S. and NATO military forces to transmit tactical data among dispersed forces.

tactical force organization—the grouping of military units to achieve a proper balance for a specific war-fighting requirement.

tactical nuclear weapons—low-yield nuclear weapons delivered by artillery and short- to intermediate-range missiles within a battlespace.

tactics—the art and science of fighting battles.

TAO—tactical action officer, a watch officer stationed in the operations center of a Navy ship, authorized to employ offensive or defensive weapons under emergency conditions until the CO or XO arrives on station.

telecommunications—communication by electronic transmission of impulses, as by telegraphy, radio, or microwave.

territorial sea—ocean waters within twelve miles of the shoreline that are controlled by the adjacent coastal sovereign state.

terrorism—the use of violence and threats of violence to intimidate or coerce, especially for political purposes.

TEU—twenty-foot equivalent unit, a standard-size shipping container used on containerships, used as a standardized measure of their capacity.

thalweg—the boundary line between two adjacent nations consisting of the center of a navigable channel in a waterway (international river) separating them.

theater—in military usage, the geographical area for which a commander of a geographic unified combatant command has been assigned responsibility.

thermonuclear weapon—a nuclear weapon such as a hydrogen bomb that derives its explosive power by nuclear fusion.

towed array—a line of sensors that can be streamed behind warships to detect low-level sounds emitted from a submerged submarine.

train (of a gun)—horizontal rotation of a gun or gun mount.

trajectory—the curved flight path of a missile or other body in flight through air or space.

triangulation—the determination of the position of an object by systematically decreasing the size of a geometric shape formed by three or more lines of position.

Trojan horse (computer)—a computer program that appears to have a useful function but has malware imbedded within it.

twist locks—fittings on the corners of standardized container-ship shipping containers enabling them to be handled, hoisted, and stacked.

UCMJ—Uniform Code of Military Justice, detailing offenses under the code and covering procedures for the trial and punishment of offenders in the U.S. armed forces.

unauthorized absence (UA)—absence from a military unit without proper authorization.

unified command—a U.S. national military command composed of forces from at least two military services with a broad continuing mission within a geographical area of responsibility or a broad functional responsibility such as for special operations, power projection, or transport.

unitized cargo—like kinds of cargo banded or otherwise fastened together and often transported and shipped on pallets.

unmanned aerial vehicle (UAV)—a remotely piloted or autonomous crewless aircraft.

unmanned surface vehicle (USV)—a remotely operated or autonomous crewless surface craft.

unmanned underwater vehicle (UUV)—a remotely operated or autonomous crewless underwater craft.

U.S.-flag ships—merchant ships registered in the United States and operating under the American flag on the high seas.

USNS—United States Naval Ship: a ship owned by the U.S. Navy but not commissioned as part of the Navy. Normally crewed by civilians and operated by the Military Sealift Command.

variable time fuse—a projectile fuse that is actuated by the reflection of self-generated radar emissions from the target as the projectile passes near it.

vertical launch system (VLS)—missile launch tubes mounted vertically within a ship's hull.

violent extremism—the pursuit of political or societal change through fear and intimidation.

virus (computer)—self-replicating computer programs that can hide in the memory of an infected computer system and attack targeted programs or files.

visit and search—a procedure under international law wherein a belligerent warship may cause a merchant ship operating on the high seas in wartime to stop so that qualified naval officers may board and determine the nature of its cargo and whether it is enemy or neutral, innocent or hostile.

V/STOL aircraft—aircraft capable of vertical or short takeoff and landing.

warhead—forward section of a torpedo or missile that carries the explosive charge; the nose cone or payload.

war matériel—military supplies, ordnance, and related equipment.

water washdown system—a system of external piping on a ship, sometimes temporary, that allows topside external surfaces to be continually wetted with spray to minimize adhesion of chemical and biological agents and nuclear fallout.

weapons of mass destruction (WMD)—chemical, biological, or nuclear weapons that can inflict massive destruction over a large area and mass casualties among a population.

worms (computer)—malicious self-replicating programs that use networking mechanisms to spread themselves.

Leadership

1. The Challenge of Leadership 238
2. Qualities of a Leader 242
3. Evaluation of Performance 250
4. How to Give Instruction 254

Leadership

Although each leadership position may be different, the challenge of naval leadership at all levels remains the same: to get people to do their job. In *Naval Science 2* you were introduced to basic principles of leadership that will help you rise to higher levels of responsibility in your NJROTC unit and in other life activities in which you may be involved. This section expands on those and provides information on more advanced topics that you will also need as you proceed to higher levels of leadership. We will discuss many of the practices and qualities that are common to successful leaders both in the military and in civilian life along with effective techniques of instructing and evaluating subordinates, both of which will be very useful to you as you assume greater leadership roles within your unit.

1

The Challenge of Leadership

Good leadership stresses the qualities that enable a person to inspire and manage a group of people successfully. Effective leadership, therefore, is based on personal example, good organization and administration, and personal moral responsibility. The second of these, organization and administration, deals with a leader's personal attention to and supervision of subordinates. Because the Navy is made up of people, naval leaders must learn to understand and value the many individuals with whom they must work.

The naval leader must have a philosophy of leadership based on firmly held **moral values** and **integrity of character**. Leaders must understand how to act toward seniors, peers, and juniors. A naval leader will be ineffective if he or she does not understand good leadership and administration and is not able to inspire the teamwork necessary for the unit to carry out its mission.

Leadership involves human relations—specifically those between a leader and a group. A leader must be able to impose, either through command or persuasion, his or her will upon

Leadership is an art, gift, or science by which a person can direct the thoughts, plans, and actions of others in order to obtain their obedience, respect, confidence, and loyal cooperation. This NJROTC class is fortunate to be able to interact with two very proficient naval leaders. *Leonard Adams Jr.*

that group. Also required is a willingness on the part of the leader to sacrifice personal time and material gain to achieve this personal "power." Still, a person who is to become a truly successful leader must first of all have learned the principles of good "followership," as set forth in *Naval Science 1.*

Philosophies of Leadership

Philosophies of leadership differ widely. One extreme view holds that leaders are born, not made. The opposite extreme contends that anyone who can master various leadership principles can lead effectively. Other viewpoints stress leadership as a managerial process, or as a matter of character and moral development. Still another holds that leadership can best be learned by studying the lives of great men and women. Each of these philosophies has merit, but none by itself answers the question of how effective leadership can be developed.

There is no denying that some people are born with physical and mental qualities that make them natural leaders. However, history is full of examples of people who reached great heights of leadership as the result of study, discipline, and hard work, in spite of handicaps such as small size, physical disabilities, or a lowly family background.

Leadership is an art, gift, or science by which a person can direct the thoughts, plans, and actions of others in order to obtain their obedience, respect, confidence, and loyal cooperation. Each of these objectives is essential. Lack of any one may well cause failure in any situation where leadership is needed.

Obedience

Obedience is the first lesson every military person must learn and the most important of the qualities that good leaders should strive to instill in their personnel. The first lessons parents teach their children involve obedience: come here, go there, sit down, eat, don't touch, be careful, pick it up, and so forth. Obedience is necessary in order for the child to do basic activities and to protect him or her from dangers. In adult life, however, obedience is of greater concern in military life than in most civilian environments.

While disobeying the law will result in punishment of one sort or another in either environment, the loss of their jobs is probably the most significant result when civilians disobey their boss. The military "product," however, is defense of our country and our way of life. Military service people, therefore, must be more idealistic than the average civilian because they are serving, protecting, and defending the United States and its allies—even to the extent of giving up their lives in peace or war. Thus there is a greater need for obedience from service members in uniform.

Obedience in the Military Services

In the military, an **order** is a directive to action of some kind, generally given by a senior to a junior. The oath of service all enlisted personnel take upon enlistment is their promise to faithfully obey and carry out the lawful orders of those appointed over them. Obedience to orders has two forms in the military, each with its own time and place. *Blind obedience* is automatic response to orders such as commands (see below) issued during close order drill or steering commands to a helmsman. There is no time for questioning or determining the reason for this type of order. *Reasoned obedience*, on the other hand, allows for some personal initiative in carrying out an order.

Reasoned obedience is the type most often desired in the Navy and NJROTC. Navy work involves constant learning, and it has been well established that people work and learn best when allowed to use their own ideas. Most day-to-day routine orders give the receiver some freedom in deciding exactly how to carry them out in a responsible manner.

Orders may be given in various ways. A senior may use polite phrases such as "please" or "would you" and other common courtesies when giving an order, but even if the order has the sound of a request, it is still an order. When time permits, the leader may explain the reasons for an order. The juniors may be encouraged to ask reasonable questions, or even suggest possible alternatives, but this does not imply that subordinates may decide whether or not they will obey. Often, however, a more specific form of order called a command may be appropriate.

A **command** calls for immediate blind obedience. Courteous terms normally are not used in commands. There is usually no time for hesitation or questions regarding such orders.

These NJROTC cadets are learning firsthand that it takes everyone pulling together with all their individual strengths and weaknesses to accomplish a mission. *Annapolis HS NJROTC*

Examples might be commands to commence fire on an enemy or to abort a dangerous landing approach to an aircraft carrier.

Aside from the sense of duty and professionalism in a military organization, people often obey the orders of lawful authorities because of either the hope of reward or the fear of punishment. Reasoned obedience to an order often involves hope of some kind of reward. This may take the form of a simple verbal compliment ("Well done!"), public recognition and praise, the privilege of greater responsibility, or improvement of status in the organization. Blind obedience to a command seldom lends itself to a particular reward at the moment and is more often associated with the threat of punishment should it be disobeyed.

The good leader should strive to have the respect, confidence, and loyal cooperation of subordinates, but it is impossible for him or her to lead without first obtaining their obedience.

The Military Leader: A Legal and Moral Obligation

Civilian executives hold their positions by virtue of superior knowledge and experience and strong character or personality. The executive probably is not legally responsible for the people his or her organization employs, and any concern for their well-being is primarily a moral one.

Military leaders, on the other hand, have both a legal and a moral obligation to do all in their power to lead their subordinates effectively and to be concerned about their welfare. In the United States, the President, as representative of the American people, has granted each military leader extensive authority to do so based on a legal contract.

The military leader must depend upon subordinates to accomplish assigned missions. Consequently, leaders must be aware of their subordinates' capabilities and limitations. The leader must personally be concerned with subordinates' health, welfare, and any problems that may affect their peace of mind and efficiency on the job, such as family illness, debts, and other difficulties. The leader must gain the confidence of his or her personnel so that they will feel free to consult the leader about any problems.

The Challenge of Leadership

The leader has an especially difficult task in trying to motivate disinterested persons or troublemakers, who always seem to be present in most groups. Ideally, the leader will be able to guide and assist most such individuals to gain a sense of moral responsibility so they too can become assets to the organization. After all, everyone must live by rules and regulations, whether in the Navy or in civilian life. These rules, if followed, make life more pleasant and easier for all.

Naval personnel must be taught that the more they discipline themselves, the less they will have to be disciplined by others. They must be fully aware of their importance to the team. Their shipmates must be able to depend on them in day-to-day routine matters as well as in battle. All should be led to understand that learning, advancing in rate, and assuming more responsibilities are duties of every sailor and citizen, not just the choice of a select few.

In the Navy, as in the other military services, officers and petty officers have the responsibilities of leadership. Although each leadership position may be different, the challenge of leadership remains the same: to get people to do the job.

Leadership and discipline are vital in any military organization. The same qualities that make a good leader in the military services are equally helpful to the civilian leader.

Critical Thinking

1. In which ways is it harder to be a leader in the military than in civilian life? In which ways is it easier?
2. What are some ways to get the cooperation of a disinterested or uncommitted subordinate?
3. What are some circumstances in which a military person may use reasoned obedience? Justify your responses.

Study Guide Questions

1. What is the challenge of naval leadership?
2. Upon what is effective naval leadership based?
3. What are the two extremes in philosophy of leadership?
4. What is the first lesson that military personnel must learn?
5. Why must military personnel have a more idealistic outlook on the importance of obedience?
6. A. What are the two forms of military obedience?

   B. Why is there a need for each?
7. What is the difference between a senior's request or order and a command?
8. What makes the military leader different from the civilian executive?

New Vocabulary

moral responsibility
reasoned obedience
blind obedience
order
command

2

Qualities of a Leader

No two leaders are exactly alike. They do not possess the same traits; neither do they accomplish their goals in the same ways. All great leaders, however, have certain characteristics and abilities. Not every leader will possess every quality discussed here, but all will have many of them. It stands to reason that it is important for a leader with less natural ability to work on those qualities needed to become more effective.

Moral Responsibility

A high sense of **moral responsibility** is one of the most important leadership characteristics. All truly great leaders have personal codes of conduct that will not permit them to use their abilities and positions to take unfair advantage of their fellow citizens or subordinates.

Most of us understand the written and unwritten laws that guide our actions and know that appropriate punishments are likely to result if we break them. It is more difficult, however, to define moral laws, since most of these cannot be legally enforced. Each person must establish these laws for himself or herself. Depending upon the person's character, the sense of moral responsibility may be extensive or almost nonexistent. The only enforcer is the individual's own conscience.

Loyalty

Loyalty means faithful and enthusiastic devotion to one's country, organization, and associates. In the military this must be broadened to include one's superiors and subordinates. Everyone must earn the right to loyalty.

Loyalty is a two-way street. Subordinates are particularly sensitive about loyalty extending downward to them and are quick to notice when it is absent. The loyalty of a senior toward his or her personnel has a great effect on the morale within the organization, and this may translate into that extra effort that is so often necessary to accomplish a mission.

Devotion to Duty

Devotion to duty may be defined as loyalty to one's position or job. In general, devotion to duty is shown by someone who not only exerts maximum effort on the present job but also takes initiative to learn about tasks and billets demanding increased levels of responsibility. Positive recommendations,

This Master Chief Petty Officer of the Fleet has demonstrated the best qualities of naval leadership throughout his service career.
Jennifer Villalovos

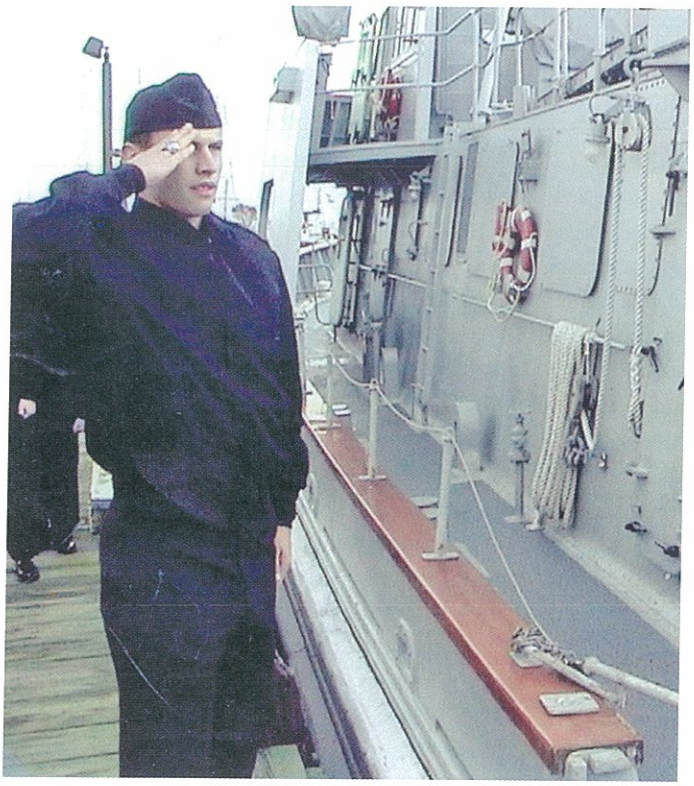
advancements, and promotions are likely to result from such performance of duty.

A young person showing ambition on the job in a civilian company is considered a valuable asset; such a person might eventually be considered for a management role. Mere ambition is not enough in the military service, however. All in the military are expected to place duty above self. All must do their duty to the best of their ability at all times—not because personal gain might occur, but because that is the best way to accomplish the mission. The unit might fail in its mission if some individuals fail to do their part.

Professional Knowledge

In order for a leader to be regarded as knowledgeable, he or she must know the job thoroughly. A person who knows and can demonstrate this knowledge is far better qualified to lead than one who does not. Also, mere schoolbook knowledge is not sufficient; experience is also essential. The new leader, therefore, must not hesitate to call upon more experienced individuals to assist when appropriate.

The person being relieved by a new leader normally provides information concerning the duties and difficulties of the job and the abilities and personalities of the assigned personnel. Subordinates will be eager to help if their new leader shows interest in gaining from their experiences. It pays to be willing to listen to advice and suggestions, because most people will lose the desire to help if their leader shows lack of interest or caring.



All young people need good examples of how to be the best they can be. This sharp NJROTC cadet demonstrates pride in himself and his unit as he goes on board a Navy training ship. *Annapolis HS NJROTC*

Self-Confidence

Self-confidence is one of the most important qualities of leadership. As a leader's knowledge grows, self-confidence should also grow. In fact, knowledge is meaningless without confidence and ability. Past accomplishments and educational degrees by themselves will not suffice; proven ability on the job is the most basic requirement. Arrogance, however, is never acceptable. Arrogance on the part of an untried, inexperienced junior officer or new leading petty officer will result in the loss of subordinates' respect, which will make the leader's job much more difficult.

Initiative and Ingenuity

The military services have so many regulations, instructions, and policies that a new leader might believe there is little room for personal initiative and ingenuity in the service today—but this simply is not so. With new ships, new equipment, new weapons systems, and new concepts of warfare, the demand for officers and petty officers with these qualities is greater now than ever before. All of these new developments require leaders with the imagination, skills, and daring to find the best ways to use new systems and new ideas.

In the NJROTC as in the Navy, few days will pass without some opportunity to exercise **initiative** and **ingenuity**. The new leader must take advantage of small, everyday opportunities in order to gain the self-confidence necessary to handle bigger challenges when they arise.

Before tackling any problem, though, it is necessary to have solid background knowledge of that problem. You can be sure that problems that exist today did not suddenly materialize out of thin air; problems grow over a period of time, as do new ideas and new equipment. Consequently, when problems need to be solved, it is wise to be aware of what has been tried before. To try again with a flawed method that has failed before is often a waste of time and effort.

While accomplishment of all assignments given is always a precondition of being an outstanding leader, no one earns acclaim as an outstanding leader unless he or she exercises ingenuity and initiative to constantly strive to find new and better ways to accomplish assigned tasks and accepts responsibility for other things that may need to be done without necessarily being told to do them by a superior.

Courage

Courage is the quality that enables us to accept our responsibilities and carry them out regardless of the consequences. It would be difficult to imagine a true leader who did not possess it. A courageous person can meet dangers and difficulties with firmness. A courageous person is not necessarily fearless, but he or she has learned to conquer inner fears in order to concentrate on the tasks at hand. Courage is a quality of the mind and may be developed and strengthened with use. Each time a person overcomes an obstacle—whether it is a tough examination, a sports opponent, or peer pressure—the courage of that individual will be strengthened.

We should be careful to add, however, that continuous success with every problem, while encouraging and satisfying at the time, may not necessarily prepare an individual for the disappointment of failure. Courage grows when a person learns to strive again for success after an initial setback.

Moral Courage

To possess **moral courage** is to show firmness in difficult situations when the danger of death or injury is not an immediate concern. It is a form of courage less glamorous than physical courage—risking one's life to save another, being fearless in the face of enemy fire, or braving the unknown dangers of the deep seas or outer space. Situations requiring moral courage, however, occur far more often than the more glamorous ones.

The pressures of our daily lives can be great at times, and this is where moral courage comes in. It may be easier to allow the wrong thing to be done and say nothing, or to observe incorrect procedures or damaged equipment and let it go unreported. Sometimes it is hard to disagree with a senior—or worse, to agree with a senior when you are certain that he or she is wrong. Fear of anger from seniors, fear of ridicule by peers, and lack of confidence due to immaturity or ignorance are some of the pressures that make the exercise of moral courage difficult.

Moral courage on the part of subordinates is necessary, however, to ensure that seniors get the information they need to make good decisions—even if such information upsets them. A person needs moral courage to bring forth new ideas for improvement, especially if those ideas go against precedent or well-laid plans. The person who says nothing, or agrees with seniors and then criticizes them behind their backs, loses both the respect of juniors and the trust of the seniors. On the other hand, the leader who shows respect for the opinions of others, especially subordinates, is admired and respected for having moral courage.

It takes moral courage to admit your mistakes. It takes moral courage to be honest, just, and truthful at all times. It takes moral courage to insist on abiding by regulations and laws when others are disregarding them. It takes a very special moral courage to stick to your high principles in the face of ridicule by peers and friends, because everyone wants to feel like "one of the gang."

Ability to Organize and Make Decisions

A military leader's primary job is to coordinate the efforts of personnel to achieve a common purpose. Leaders must be able to **organize their subordinates** so that their labors and training can be used to achieve the best results. A first requirement for effective organization is thus full awareness of the skills and capabilities of assigned personnel.

While it is entirely proper to call upon the expertise and experience of seniors to assist in the accomplishment of a mission, young leaders must eventually make most of the final decisions themselves. A leader who cannot make good decisions is useless.

Subordinates expect **clear-cut decisions** from their leaders when they bring personal problems to them for discussion or when professional problems require solutions. If complicated problems arise, especially those clearly beyond a junior's authority, he or she will want to discuss them with a superior. Honest mistakes will occasionally occur, but from mistakes comes experience, and from experience comes wisdom.

Personal Example

All young people have a strong need for examples or **role models** to live by. By following the good example of someone admired—father, mother, sibling, teacher, sports hero, or celebrity—the young person can acquire the qualities he or she needs for success. When leaders' conduct is outstanding, those around them are often inspired to pattern their own actions after them, to the good of the whole organization. No leader, then, can live by the rule of "Do as I say, not as I do." It will not work. As many events in recent years have shown, bad things can happen to elected, appointed, and commissioned and noncommissioned military and civilian leaders if their private lives are not as exemplary as their public and professional lives.

Leaders cannot ignore rules and regulations and still expect subordinates to follow them. Such leaders will not be trusted and will lose control of subordinates. Regaining respect and control once they are lost is exceptionally difficult.

Rank has its privileges, but that does not excuse improper conduct. Rather, when it comes to conduct, it should be stressed that rank also has its responsibilities. "Conduct" in the military means conduct ashore as well as on board ship or station. No good citizen and certainly no service member would do anything to dishonor the uniform, because such conduct can bring dishonor upon the United States and its armed forces.

These two members of an NJROTC relay race team know that it takes mutual trust and confidence in each other's ability to make a good exchange of the baton in the stress of competition. *Annapolis HS NJROTC*

Mutual Trust and Confidence

Officers and petty officers must set a **proper example** by letting subordinates know that they are trusted. If leaders fail to show trust in their subordinates, they will find themselves constantly checking up on their people, distrusting the records and reports prepared by them, and consequently performing their own duties less efficiently.

It would be naïve, however, to suggest that all leaders in the Navy, the government, business, or anywhere else are continuously efficient, invariably honest, and always perform their duties responsibly and with honor. We know that our leaders should do things that way, of course, and we have a right to expect them to. When leaders fail to fulfill their responsibilities, society has the right to demand corrective action and, in serious cases, punishment under the law.

In any event, when a leader fails to back subordinates, shows favoritism, condones dishonesty, allows sloppy work, or evades legitimate regulations, the reputation of not just that leader but of all leaders in the organization is jeopardized. Mutual respect, trust, and understanding can prompt all hands to exercise a greater degree of personal responsibility. Then morale will be higher, efficiency will be improved, and burdens will be lighter.

The word of a leader should be **dependable**. Consequently, if leaders cannot make good on their word or their promises, they should not make commitments. *Never promise what cannot be delivered.* Keeping your word is important evidence of personal honor. If you do not make a special effort to uphold your word, you will lose the respect of subordinates and associates, and the attitudes of all around you will be adversely affected. A sense of honesty and mutual trust must be present if a military unit, or indeed any organization, is to operate efficiently.

Conduct and Correction

The naval leader must do all in his or her power to prevent improper actions by naval personnel. Often the cause for such bad conduct is dissatisfaction with conditions in their unit, ship, or station. If a person does not like his or her work assignment or living conditions, feels that command policies are unfair, or has troubles at home, bad consequences can result. Weaker subordinates may resort to unauthorized absence, to alcohol or substance abuse, or to other forms of escape. Such individuals may make it impossible for the unit to accomplish its mission.

A military leader has the responsibility to know the needs of subordinates and to know their anxieties. It is his or her duty to remind them of their responsibility to conduct themselves properly at all times; to reflect credit on their families, their service, and their nation; and to be ready to perform their duties whenever required to do so.

The big difference between civilian and military leadership, however, comes in the **corrective actions** for undesirable conduct that leaders are expected to take. Leaders in civilian institutions generally exercise a certain degree of concern—often reflected in things like insurance coverage and some concern for health and safety conditions on the job—mostly with a view to increase productivity, satisfy laws, or abide by union agreements. But there is little concern for, or involvement in, the employee's home life, recreation, financial well-being, ethics, or living conditions. The worker punches in, does the job, punches out, and leaves. A civilian worker who does not do the job satisfactorily may be warned, but the worst that can happen is being fired from the job. On the other hand, a worker who is dissatisfied with a job may quit.

In the military, corrective actions are a primary responsibility of leadership. The leaders must know their personnel and take care of their needs, and must insist on the acceptance and exercise of personal moral responsibility. The naval leader must accept this responsibility by regulation, but also for the practical reason that it is necessary if the crew is to be a working team that can respond properly to emergency situations and carry out the unit's mission.

Discipline

Discipline is the basis of true democracy. It requires rules of conduct that humans, through experience, have found desirable for governing relations among members of civilized society. Such rules of conduct do not deprive an individual of fundamental rights; in fact, they protect everyone's equal rights.

Formal rules that are put into effect by duly constituted authority, such as a city council or state legislature, are called **laws**. Other, informal rules that have become a part of our culture by custom and usage are called **conventions**.

Discipline is the training that develops self-control, character, or efficiency. It is important in both civilian life and military life. Discipline does not imply severity, unreasonable restraint of freedom, or unnecessary restrictions. Discipline means control of conduct so there can be a coordination of effort for the good of all.

A dictionary defines *discipline* as "control gained by enforcing obedience" or "that state of orderliness gained through self-control and orderly conduct." A description of discipline in military terms would be "that degree of control which moves an organized group to appropriate action upon receipt of an order, or in anticipation of that order when circumstances prevent its being given."

A military organization could not function properly without orderliness and orderly conduct. Adm. Arleigh Burke, a famed former Chief of Naval Operations, once said that "a well-disciplined organization is one whose members work with enthusiasm, willingness, and zest, as individuals and as a group, to fulfill the mission of the organization with expectation of success." The signs of discipline in a military organization can be seen in smart salutes, proper wearing of the uniform, and prompt and correct action in any emergency.

The purpose of discipline in the military services is to develop an efficient organization of personnel trained to achieve a common goal. Each person should know where he or she fits into the organization. Each should understand that all in the group have a common purpose and that all are to follow and obey their leader. Such a group is so well organized and trained that it can handle any emergency as well as normal routine tasks. A well-disciplined military unit responds automatically to an emergency and will not panic.

Self-Discipline

True discipline demands loyal but reasoned obedience to authority. Such obedience allows for initiative and is present even in the absence of the leader. **Self-discipline**, therefore, is essential before true discipline can be developed. The self-disciplined person will always be dependable and will carry out responsibilities under all circumstances without need of direct supervision.

Self-discipline lessens the need for specific rules and regulations. Traffic laws, the Uniform Code of Military Justice, civil rights laws, alcohol and drug laws, and even things like school conduct and dress codes would be unnecessary if we were all perfectly self-disciplined individuals. Self-disciplined people need little or no supervision.

Self-discipline begins with the realization that there is a need for **self-control**. Development of self-discipline comes only through repeated practice of self-control. The person who has developed self-control in day-to-day life is also the one who can hold up in the face of hardship and danger.

Consistency in Disciplinary Action

In the military, disobedience of regulations must be handled immediately, justly, and consistently. Wrongdoing that is dealt with severely one day cannot be treated as insignificant the next. Such inconsistency can only result in confusion, poor morale, and distrust of the leader.

If service members are allowed to defy any regulation openly, they will develop an indifferent attitude toward other regulations as well. Two fundamental rules apply: (1) never make a regulation that you cannot or will not enforce, and (2) take immediate, fair action that leaves no doubt in the mind of the offender about the reason for the reprimand or punishment.

Delay in taking appropriate disciplinary action brings resentment toward the entire system—especially if the offender "gets off" because of a time lapse that dulls memories or makes it seem as though the offense has been overlooked. Wrong acts and poor performance require immediate guidance and correction in order to bring about the necessary changes.

New leaders may have a tendency to be too lenient with minor infractions, thereby penalizing good people while favoring bad ones. When this error is pointed out to some junior leaders, they may become uncertain of themselves, and in trying to compensate for the fault they overreact, becoming too arbitrary. In either case the leader will lose the confidence of subordinates because of such inconsistency. It is best to chart a steady course when dealing with disciplinary matters.

Loss of Temper = Loss of Control

A leader cannot afford to lose his or her temper. Losing one's temper is a show of personal weakness and usually does not improve the effectiveness of the leader and his or her status within the organization. To be sure, it is not always easy to refrain from anger, but a conscious effort to do so must be made.

A person who loses control of himself or herself usually loses control of the situation. Rare is the case when proper action or desired results come from an expression of anger. In admonishing error or administering punishment, the leader must remain calm, impersonal, and dignified. A leader who is extremely incensed might want to pace the deck for a few minutes rather than take unwise, precipitous action. The calmer the leader is in the usual performance of duty, the more action he or she can get when the occasion demands. The leader who is inconsistent, quick-tempered, or constantly shouting only creates confusion

A good leader knows that everyone responds to recognition for a job well done. Here, a cadet receives his Leadership Academy cord from his NSI, acknowledging his effort and dedication in completing the course.
East View HS NJROTC

and soon stops being effective, since those actions eventually will get little or no response from subordinates.

Knowing Personnel

It is vital that leaders get to know the people working for them. As part of this, it is important for the young leader to develop a style of communication with personnel that will create mutual respect. The key to this is learning the personality and character of every one of those juniors—understanding what makes them tick.

It is leaders' duty to study their people, watch them, learn their approach to problems, work with them, and guide them. To maintain discipline, the leader must always be genuinely concerned about his or her people and should not wait until they get into difficulties to help them. This means ensuring that they are comfortable and as well cared for as circumstances permit, seeing that they receive their fair share of earned privileges, and showing them that their personal and family lives are of real interest. The good leader will always make sure people are fully aware of what is being done on their behalf.

A leader should bear in mind that everyone wants, needs, and responds to recognition. If the best in people is to be brought out, they must be made to feel important. They must feel respect from their associates, and they must feel that their superiors think they are competent.

A good leader continually strives to learn all that he or she can about human nature and to apply that knowledge through experience and study. The better his or her insight into human nature, and the better he or she understands the intelligence, education, and backgrounds of personnel, the more effective the leader will be in handling people.

Friendship and Familiarity

In recent years personal relationships between leaders and subordinates have become an area of great concern, both in the military and in civilian life. The relationship between leaders and their subordinates influences discipline. There is a great difference between **familiarity** and **friendship**. The leader who talks to subordinates in a friendly manner, taking a personal interest in them and being concerned with their problems, quickly gains their confidence and respect. Young men and women want to be able to look to their seniors for guidance; they want to be proud of their leaders. Friendly and approachable leaders will be the first ones they turn to for advice.

On the other hand, leaders who become too familiar with their subordinates will often have difficulty in leading them. The old adage "familiarity breeds contempt" is applicable to these situations because subordinates who perceive themselves as favored may feel the leader will not require them to obey and perform well. Those who do not feel so favored may perceive unfair or unequal treatment, whether or not it actually exists.

The Navy and the other military services have strict regulations against seniors becoming overly familiar (developing close personal relationships) with personnel of lower rank, especially those in their immediate chain of command. Such relationships are called **fraternization**. Unsolicited or otherwise undesirable or inappropriate advances or actions of one service member toward another based on sexual attraction, especially involving either explicit or implied promises of reward or threats of punishment or other forms of intimidation, is called **sexual harassment**.

Fraternization and sexual harassment can be extremely destructive to the morale of both those directly affected and their fellow crewmembers or coworkers on the job. Such actions cannot be tolerated in the Navy or other military services, and persons found guilty of this type of behavior are subject to severe discipline or separation from the service. Most civilian institutions are very concerned about these issues as well, both because of potential legal issues and also because of their impact on the productivity and morale of the organization.

Cyber Safeguards

Much has been made recently of the pitfalls associated with the use of social media and cyberspace in ways that are potentially harmful to oneself or to other people. The implications of inappropriate use of these media insofar as they relate to national security were discussed in chapter 8 of the Naval Knowledge

section of this book. A Navy poster depicting the "do's and don'ts" in this area appears on page 78. While these concerns may be of much more importance to you later on if you elect to pursue military or other government service, other aspects of safeguarding your **cyber persona** (your own self in cyberspace) should be of great and much more immediate concern to you and every young person in today's world. These concerns fall into four major areas: cyber bullying, abuses of privacy, scams, and information permanence.

Cyberbullying is the act of harassing someone, often anonymously, using electronic technology such as the Internet or social media to send or post inappropriate, mean, or demeaning textual, photographic, audio, or video material harmful to that person or other people. Cyberbullying has come to be of great concern in the secondary education system nationally because of the great harm it can cause not only to victims but also to those apprehended for doing it. Such behavior can lead to permanently ruined reputations, civil lawsuits, and even criminal charges against the perpetrators.

Privacy of personal information is one of your most important assets. Good rules of thumb are never to post something negative or personal about anyone else that you would not want posted about you, and never request any personal information from someone else that you would not be comfortable giving out about yourself.

Be especially wary whenever personal information like social security numbers, credit card numbers, bank accounts, or your home address is requested. A good rule of thumb is never to give out either solicited or unsolicited personal information or plans over social media in general, and to untrusted Internet sites in particular. **Scams** and **fake news** are unfortunately becoming increasingly prevalent on all forms of social media and the Internet. "I just saw it on the Internet [or some social media]!" is an all-too-common mantra in today's world. Remember that just because something is presented via social media or appears on the Internet, that fact alone without any other corroboration does *not* make it valid or true.

Lastly, remember that everything posted online can stay in cyberspace forever, whether it was sent to a friend or to an absolute stranger. This attribute of the Internet and social media is called **information permanence**. Inappropriate posts can never be fully retrieved. They can negatively affect one's future job aspirations, permanently damage one's public reputation, and be circulated without any control for years far beyond recipients originally intended to receive or view them.

All NJROTC cadets and especially those in or who aspire to a leadership role should be aware of the potential dangers of unwise or otherwise unsafe or illegitimate use of the Internet and social media, and they should encourage the use of safe practices whenever interfacing with cyberspace.

Critical Thinking

1. Why is the issue of friendship and familiarity between leaders and subordinates within the same military unit of greater concern than between individuals working within a civilian firm?
2. What are some ways two individuals of different ranks or sexes within a military unit can maintain a friendship while not violating military rules against fraternization?

Study Guide Questions

1. What are the qualities of a good leader that are discussed in this chapter?
2. Why must loyalty be a two-way street?
3. What is devotion to duty?
4. What two main qualifications are necessary for a leader to be regarded as knowledgeable?
5. How can a good leader who accomplishes all assigned tasks earn recognition as an outstanding leader?
6. How can courage be strengthened?
7. A. What is moral courage?
   B. What are some factors that can make the exercise of moral courage difficult?
   C. How can a lack of moral courage lead to the loss of both the respect of juniors and the trust of seniors?
8. Why could it be especially dangerous to neglect reporting a disagreeable fact to a senior?
9. A. Why is decision making important for a leader?
   B. How can a young leader obtain help when confronted with problems beyond his or her experience to solve?
10. Why is the leader's personal example so important in leading subordinates?
11. Why are mutual trust and confidence so important in dealing with people?
12. What is the difference between civilian and military leadership with regard to corrective action for undesirable conduct?
13. What was former CNO Admiral Burke's definition of a well-disciplined organization?
14. What is the purpose of military discipline?
15. How does a person acquire self-discipline?
16. A. What are two fundamental rules that apply to consistency in disciplinary action?
    B. Why is consistency in disciplinary action essential?
17. What is the usual result if leaders lose their temper?
18. What should a leader always keep in mind with respect to giving recognition to his or her personnel?
19. A. What is the difference between friendship and familiarity?
    B. Why is fraternization or familiarity between officers and enlisted personnel prohibited in the military services?
20. A. What is sexual harassment?
    B. Why can it not be tolerated in the military services?
21. A. What is cyberbullying?
    B. Why is it of great concern in the American secondary education system?
22. A. What is *information permanence* in regard to cyberspace?
    B. How can inappropriate material posted on the Internet and social media negatively impact someone's future?

New Vocabulary

character
loyalty
self-confidence
arrogance
initiative
fraternization
sexual harassment
leniency
infraction
familiarity

3

Evaluation of Performance

All people are involved in **evaluation** from an early age. Babies respond to some types of personalities better than others. Youngsters select friends based on performance and ability to satisfy their needs for companionship. The process becomes more sophisticated and important as years go by. In the Navy and in NJROTC, officers are concerned with the selection of personnel for instructors, for school nominations, for advancement in rate, for filling billets in the unit, and for carrying out specific assignments. The overall performance rating of a naval leader is greatly affected by his or her ability to select appropriate people for various roles and to judge their capability to take on future assignments of greater responsibility.

Performance, Ability, Aptitude, and Achievement

Performance refers to what a person does—actual behavior or actual output. **Ability** is often confused with performance. Ability often applies to performance over a considerable period of time; it also applies to what a person could do at a given moment under particular conditions, or to potential performance at some point in the future. For example, a long-distance runner may be hampered in a particular race by illness, but that person's basic ability is not questioned. One often hears comments on potential performance such as, "He could do it if he really tried," or "She just doesn't seem to care." In the final analysis, true ability cannot be judged except by observing performance. It is the results that count!

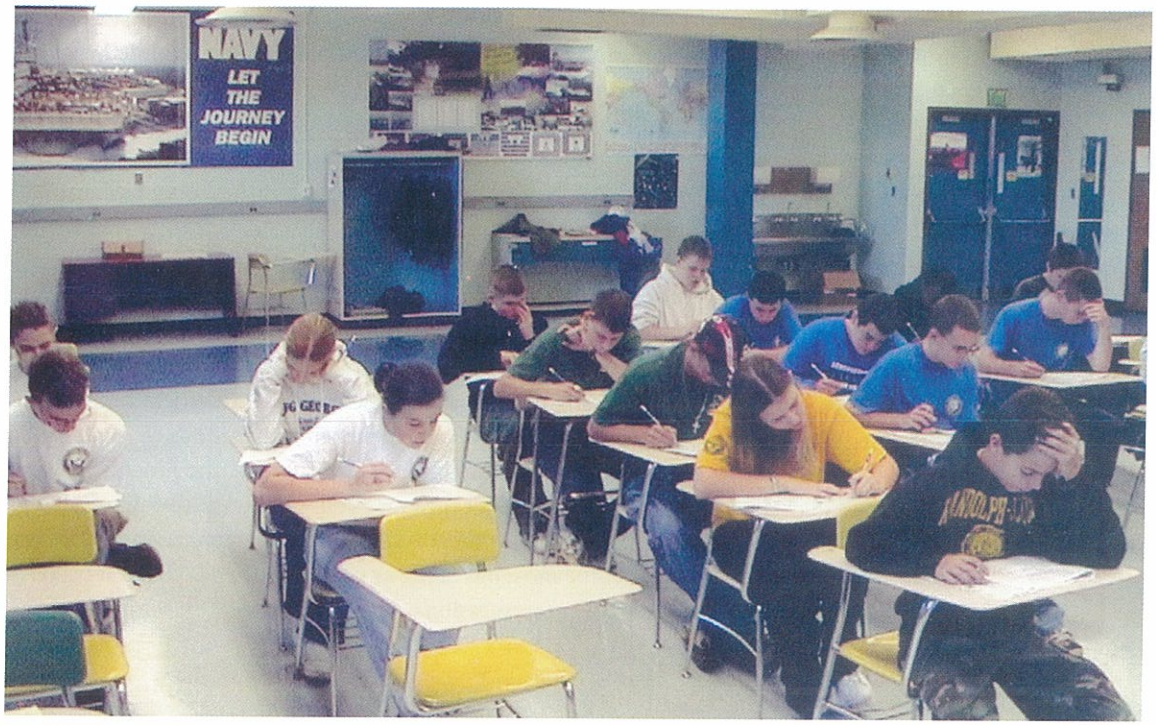
Both performance and ability refer to the present—what the person is doing, or can do, now. **Aptitude**, on the other hand, refers to potential skills and abilities in the future. Aptitude tests such as the SAT (Scholastic Aptitude Test) and ASVAB (an armed services aptitude test), as well as evaluation of background experiences, are fairly reliable indicators of individuals' suitability for training in certain areas. For example, high school musicians proved to be very adept radiomen in World War II, when an individual's ability to read international Morse code was crucial to the rating. Likewise, the farmhand who has driven and repaired tractors, cars, and machinery from an early age is a good prospect to become a successful engineman or machinist's mate. A long list of such examples could be drawn up.

Achievement generally refers to performance in the past, to work that has already been done. When properly evaluated, past achievements of individuals in the same field can be quickly compared for selection for promotion or future job assignments. Properly evaluating the achievements of subordinates is one of the most important responsibilities of a leader.

Evaluation in NJROTC

Since developing leadership ability is one of the main objectives of NJROTC, it follows that all NJROTC cadets should know about performance evaluation. The cadet officers of an

To advance in the NJROTC, as in the Navy, an individual needs to grow steadily both personally and professionally. The experience these cadets are getting as they learn how to handle the helm and engine order telegraph on a Navy training ship will serve them well. *Annapolis HS NJROTC*



These NJROTC cadets are going through an important phase in personal development called progress assessment. Upon completion of this quiz, the cadets taking it can use it to judge for themselves how well they learned the material presented to them and can take personal corrective action to improve future performance if necessary.
Annapolis HS NJROTC

NJROTC unit have already been through a selection process to attain their ranks and their positions. Their predecessors undoubtedly helped their naval science instructors to make the current appointments. Perhaps more important to cadets is the fact that their current officers and instructors will evaluate and nominate their successors at some time during the school year.

Prospective NJROTC cadet officers are evaluated on character, honesty, motivation, academic effort and success, cooperation in unit ventures, record of loyalty to school and unit, appearance in uniform, and many other attributes. These evaluations will be reflected in their leaders' recommendations and resulting awards, advancements, and promotions. Such is the way of the Navy as well, and it really is no different in civilian life. The system works; sound evaluation grounded in sound personal leadership is the key.

Self-Evaluation

It is not necessary for a person to wait until a formal evaluation time or period to evaluate his or her own performance. Everyone in NJROTC, and anyone else who aspires to get ahead either in the military or in civilian life, should go through a periodic **self-evaluation** process. Such a process is roughly like guiding a ship from one place to another. As navigator, you have to know your present location and where the ship is going or you cannot possibly determine whether or not you are on the correct course to get there. Two analogous processes in self-evaluation are goal-setting and progress assessment.

Goal-Setting

Most people who have been successful in life did not achieve their success by luck or by proceeding in a random manner. Almost every success story features the setting of realistic and attainable **goals**. Such goals may be as simple as saving to buy a new piece of athletic gear or as complex as getting an A in a tough high school course or getting a job in a desired profession. Depending on how difficult the goal is to attain, one or more **subgoals** may also have to be identified—waypoints along the route to the final destination.

Progress Assessment

Once realistic goals have been decided upon, the next step is to assess progress toward them. In the school setting, such progress assessment is facilitated by the assignment of periodic progress grades by the teacher. Broader progress can be assessed by end-of-quarter or term tests (i.e., final exams) and by such standardized tests as the preliminary and regular Scholastic Aptitude Tests (PSATs and SATs) and various achievement tests. In the military, progress is measured by periodic formal and informal performance ratings, advancement exams, and aptitude tests such as the ASVAB. Similar methods are used to assess progress in civilian occupations.

However, in all roles of life, truly successful people do not sit back and wait until they are formally evaluated to judge their progress toward the goals they have set for themselves. Rather, they go through an almost continuous process of self-evaluation to determine how they are progressing and whether

corrective action is necessary to get back on track. After all, it is much easier to stay on course toward a goal by making periodic small corrections than it is to make large corrections only once or twice along the way.

The Self-Evaluation Process

The main tasks in any self-evaluation process are to set **realistic criteria** by which to measure progress and to make **realistic assessments** of performance against those criteria. In school, such judgments might involve performance on daily or weekly quizzes. In athletics, such criteria as times to run various distances in track, percentage of foul shots made that day in basketball, or percentage of first serves good in tennis might be useful. In personal relations, how well you handled tensions between yourself and a teacher or peer could be assessed. The important thing is to be truly honest with yourself so that a realistic evaluation can be made.

If the self-evaluation indicates that some corrections are necessary, the next step is to decide on the most effective course of action to make the desired adjustment, such as by more study or improving technique in the academic or sports areas, or personal behavior in the case of interpersonal relations. It is here that more successful individuals are often separated from less successful ones, because such adjustments and changes in behavior are often accomplished only by hard and continuous effort.

To advance in NJROTC, the Navy, or another armed service—and indeed in almost any organization—an individual needs to grow steadily both personally and professionally. One of the best ways to do so is to set both short-term and long-range goals in each area of concern, and then to take appropriate corrective action whenever trends develop that, if left uncorrected, would hinder your progress. The process may not always be fun, but it provides you with a real feeling of accomplishment as you meet each short-term goal. Ultimately, you can get the most out of life as you achieve your major long-term personal and professional objectives.

Critical Thinking

1. Why is it important to seek input from a cadet's peers and their cadet leaders when evaluating them for possible cadet leadership positions?
2. How can the ability to go through a periodic self-evaluation process be of great benefit to those desiring to be better students or athletes in addition to those trying for leadership positions in the NJROTC?

Study Guide Questions

1. Explain why evaluation of performance of subordinates is important to officers in the Navy and NJROTC.
2. What is the difference between a person's ability and his or her performance?
3. Why should NJROTC cadets know about performance evaluation?
4. Why is self-evaluation important?
5. What is a common factor in most personal success stories?
6. A. How can a person assess his or her progress toward a personal goal in the school setting?
   B. How do successful people go about their personal evaluation?
7. What are the main tasks in self-evaluation?
8. What must a person do to advance in the Navy or in any other large organization?

New Vocabulary

performance
evaluation
aptitude
performance assessment
self-evaluation

4

How to Give Instruction

As you become an upperclassman in your school and achieve higher ranks within your NJROTC unit, you will often be called upon to give either formal or informal instruction to schoolmates or to junior NJROTC cadets. This chapter discusses many things that will be helpful when you find yourself in this situation. These include learning theory, preparation for instruction, and techniques for delivery.

Learning Theory

The good instructor is master of many skills. Successful instruction demands competence in the subject matter and knowledge of teaching skills. But the methods of instruction depend largely on an understanding of how people learn and the ability to apply that understanding.

What Learning Is

One of humankind's outstanding characteristics is the ability to learn. People learn continuously from the time they are born until they die. As a result of learning experiences, people may change their ways of perceiving, thinking, feeling, and doing. Thus, ***learning*** can be defined as a change in behavior as a result of experience. The behavior can be physical and apparent, or it can be intellectual or attitudinal, not easily seen.

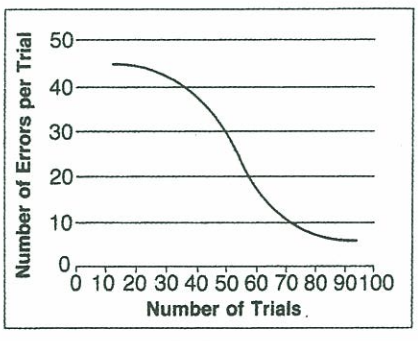
Each student sees the classroom situation differently because he or she is a unique individual whose past experiences affect readiness to learn and understanding of the requirements involved. The responses differ because each person acts in accordance with how he or she sees the situation.

Most people have fairly definite ideas about what they want to do and achieve. The student brings these purposes and goals into the classroom. Some of these purposes may be personal, and others may be shared with classmates. Individual needs may determine what the student learns as much as what the instructor is trying to get him or her to learn. So the effective instructor seeks ways to relate new learning to the student's personal goals.

Learning is an individual and self-motivated process. The instructor cannot pour knowledge into the student's head. The student can learn only from what he or she experiences. Psychologists sometimes classify learning by types: verbal, conceptual, perceptual, motor, problem solving, and emotional. The learning process may include many types of learning, all taking place at once.

Research has shown that some types of learning appear to take place mainly on one side of the brain while others occur mainly on the other side. Activities involving numbers, logic, word puzzles, and analysis appear to stimulate the **left side** of the brain, while activities involving music, imagination, colors, motion, and creative expression stimulate the **right side**. For many people, one side or the other appears to dominate how they think, behave, and learn, although much interaction takes place between the two sides. Traditionally, academic instruction has focused more on *left-side* activities while somewhat neglecting the *right side*. Not surprisingly, much recent educational research has shown that the rate of learning can be greatly increased when instructors involve both sides of the brain in their teaching strategies.

The process of learning a skill appears to be much the same regardless of whether it is a right- or left-brain activity. Graphs of the progress of skill learning usually follow the same pattern (see the figure below). There is rapid improvement in the early trials, but the curve may tend to level off thereafter for significant periods. Such **learning plateaus** may signify any



A typical learning curve for acquiring a skill. As the number of trials increases, the number of errors decreases rapidly until a "learning plateau" is reached, after which further improvement comes slowly.

of a number of conditions. The student may have reached the limits of his or her capability, may be consolidating the level of skill, may have lost interest, or may need a different method for increasing progress. One should keep in mind that the apparent lack of progress does not necessarily mean that further learning is impossible. The point is that a leveling-off process is normal, especially when learning motor skills, and should be expected after an initial period of rapid improvement. The instructor should prepare the student for this situation to ward off discouragement and frustration.

Getting a student ready to learn is important. A student with a strong purpose, a clear objective, and a well-defined reason for learning something makes more progress than one who lacks motivation. A student who is ready to learn meets the instructor at least halfway, and this simplifies the instructor's job.

Several factors in the learning situation are known to speed, strengthen, or otherwise enhance learning:

- Learning occurs best when it progresses from *known to unknown* and from *concrete to abstract.* The new learning can be attached to areas of existing knowledge.
- Learning is strengthened when accompanied by a pleasant or satisfying feeling and is discouraged when it is associated with an unpleasant feeling. Any experience that produces feelings of defeat, frustration, anger, confusion, or futility in the student is unpleasant and thus not conducive to learning.

An instructor should be cautious about using *negative motivation* in the classroom. Impressing students with the seeming impossibility of a problem can make teaching them how to solve it difficult; usually it is better to show that a problem is well within the student's capability to understand and solve. Regardless of the learning situation, it should contain at least some things that affect the student positively and give him or her a feeling of satisfaction. Every learning experience does not have to be entirely successful; nor does the student have to master each lesson completely. But a student's chance of success is increased if the learning experience is pleasant.

Certain states of mind are known to affect learning, and **motivation** is perhaps the most important of these. No one will learn something very well that he or she does not want to learn. *Motivation* is the drive or desire to do a particular thing—the force that causes a person to move toward a goal. This force can be rooted in any or all of the needs of the student—for example, the need for security, for new experience, for recognition, for self-esteem, for belonging, or for helping others. Such needs cause people to act, to move, to start working toward an objective, or to achieve a purpose. The instructor's responsibility is first to recognize and identify these needs in students, and then to seek ways of satisfying them through teaching.

Major Factors Influencing Learning

Much research has been done in recent years on the critical factors that influence how learning takes place. Some of these have already been discussed above. The results of this research are summarized below in the form of nine major **factors that facilitate learning**:

- *Learning is facilitated when related to past personal experience.* Students need to understand how new information relates to that which they already know.
- *Learning is dependent upon motivation.* A student must want to learn the new material.
- *Learning is reinforced through personal hands-on experience.* If a student has hands-on experience with a subject, he or she will put it into context better.
- *Learning is facilitated by linking with prior knowledge.* It is much easier to learn new material that is linked to something already known. One of the main goals of teaching is to help students make these connections.
- *Learning is more efficient when new information is logically related.* By grouping new information in logical ways, the brain forms a *schema*, or concept, and gives it meaning.
- *Learning is enhanced by providing time for reflection.* Reflection, or extended thinking, helps put new information in long-term memory. Activities such as group discussion and writing in journals assist in this process.
- *Learning is enhanced by sensual and emotional involvement.* The more senses and emotional stimuli that are involved in learning new material, the better it will be retained in long-term memory.
- *Learning occurs best in an environment that enables more than one kind of learning.* Students have many different kinds or styles of intelligence (motion, visual/spatial, verbal/linguistic, musical, etc.) that need to come into play during learning.
- *Learning requires repetition.* Without repetition, new learning begins to fade in about thirty seconds. Instructors need to cover important new information several times in several different ways.

Interpersonal Interactions

Learning requires much of students. They must pay attention. They must involve themselves actively, responding and manipulating. They should participate responsibly. To do all these things, students must feel secure, accepted, and capable of success. But even the most perfect lesson plan cannot develop such positive attitudes and feelings. The creation of such an environment is the instructor's responsibility, and the type and manner of **instructor-student interactions** can either improve or hinder learning. Therefore, the instructor must be aware of

Navy divers give instruction in water survival skills to a group of NJROTC cadets during a Leadership Academy. The effective instructor is careful and thoughtful in his or her interactions with students. They should be challenged to learn, not intimidated. *James Foehl*

and work to avoid any of the following **conditions that inhibit learning**.

- *Destructive sarcasm.* Sarcasm (a mocking or cutting remark) can be funny—when a comedian is dishing it out. It is not so funny to be on the receiving end in front of peers. It can hurt and embarrass students, and it effectively stifles learning. Instructors do best to forget sarcasm.
- *Intimidation.* Physical **intimidation** (threats of harm) is pretty scary, but intellectual intimidation may be even worse, especially when it comes to learning. It is a message that says the student is a stupid person whose opinions have no value, whose knowledge has no depth, and whose insights miss the mark. The intimidator picks out the student's errors and makes sure that everyone else knows about them. If the intimidator is the instructor, the student will dread the class, and learning will suffer.
- *Boredom.* Boredom accompanies monotony (too much of the same), irrelevance (lack of importance), and blandness (lack of appeal). Bored students no longer pay attention; they daydream, and that greatly hinders learning. No one likes to be bored; the result can be a poor attitude toward learning.
- *Frustration.* Frustration occurs when students keep trying to do tasks beyond their abilities, or when tasks take too long to complete. The result is increased tension and a desire to get away from the task. It is cured through shortening tasks, making them easier to complete, and eliminating barriers to their completion.
- *Fatigue.* Tiredness, whether physical or mental, inhibits learning. It reduces attention and motivation and decreases active involvement. Fatigue comes as a result of tasks that are too long or too difficult. Breaks, movement, and changes of pace revitalize learners.
- *Lack of purpose.* If the student does not see any point in what he or she is doing, motivation to learn it is often lacking. Sense of purpose provides direction, helps focus attention, increases motivation, and thus assists learning and retention. Without it, students drift; they resist learning.
- *Sense of failure.* A sense of failure reduces motivation to learn. It makes things seem not worthwhile. *Errors* can help students learn, but *failure* cannot. The key point is that there is a world of difference between making errors and feeling oneself a failure. The difference depends on the instructor's ability to help his or her students learn.

At first it may seem unnecessary to spend time discussing the foregoing conditions. They seem like common sense. However, new instructors are often overwhelmed by the role

and feel safest when focusing their attention and energies on preparing and delivering a "good" lesson. It takes more than just good mechanics to produce learning. Instructors must understand and appreciate the fact that every classroom interaction is a potential teachable moment, and that the conditions that hinder learning are always potentially present and must be consistently avoided.

Preparation for Instruction

Every instructor, no matter how competent and experienced, needs to prepare before entering the classroom. How well a lesson was prepared has a direct bearing on the amount of learning that can take place. Adequate preparation is a must for efficient and effective instruction.

The Lesson Plan

The first step in preparing to instruct is to prepare a **lesson plan**. Sometimes a lesson plan will already be prepared for you when lessons are presented in conjunction with a formal course of instruction. Most Navy educational programs fall into this category. The instructor need only become familiar with the plan and perhaps personalize it with a few notes. In other cases, however, no plan exists, and you must make one up.

Format of a Lesson Plan

An effective lesson plan at a minimum should contain the following:

- The *objective* or *outcome* of the lesson, including some specific *criteria that students should achieve*
- The *intended audience* for the lesson
- Identification of any *training aids/equipment* needed for the lesson
- The *technique(s) of instruction* to be used
- An *outline* of the material to be presented, with enough detail to allow the instructor to present the material easily
- The means to be used to *assess the effectiveness* of the instruction
- A *closing* or *summary* of the lesson

The length of the lesson plan can run from a page or less to several pages or more, depending on the material to be presented and your experience.

Site Preparation

Before instruction begins, you should ensure that the site of the instruction is adequately prepared. If the instruction is to take place in a classroom, for example, you might check the following:

- Is there an adequate number of seats/desks/tables for the expected number of students?
- If lighting, ventilation, heating, cooling, electric power, or other services will be required, are they sufficient and in good working order?
- Are adequate demonstration/board space and markers/chalk/erasers available?
- If audiovisual equipment will be required, is it available, hooked up, tested, and ready to run?
- Are sufficient numbers of instructional materials such as books, handouts, paper, pencils, and the like present?
- Is any necessary equipment/hardware/computers on hand in adequate numbers and properly set up?

Similar checklists can be made up for other sites such as the drill hall or field, basketball court, or other places of instruction.

Personal Preparation

Along with preparing the lesson plan, you should have decided on the best method of instruction to use for the occasion, based on the students and their level of knowledge or prior exposure to the subject matter. Depending on the method used, you may want to rehearse your delivery, techniques for chalkboard work, equipment handling, and whatever else will be required for an effective lesson. You may want to review the names of the students in order to be able to ask questions and respond to them by name. Just before entering the area where the students are, you may want to check your personal appearance—hair, clothing or uniform, and shoes.

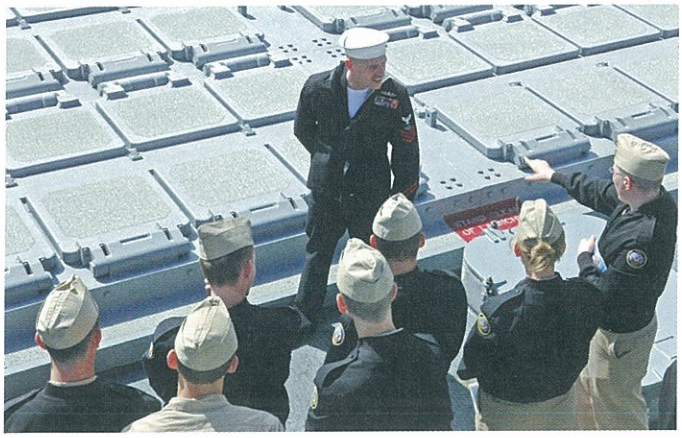
Techniques for Instruction

No one technique of instruction is ideal for all occasions. The technique you choose should fit the type of material to be presented, the objective of the instruction, the nature of the students who will receive the instruction, and your experience and personality.

There are several main methods of instruction that have been widely used over the years by those involved in education both in the military and in civilian life: the lecture method, the lecture with audiovisual support, the demonstration, role-playing, the case study, the discussion method, and cooperative learning. Each of these is described in the following sections along with the particular advantages, disadvantages, and procedures for the more commonly used methods.

Lecture

A **lecture** is a presentation of information, concepts, or principles by a single individual to a large group of listeners. It is one-way communication. The lecture assumes that the instructor



A lecture, as in this presentation about a ship's vertical launch system to a group of NJROTC students, is a fast and efficient way to impart a maximum amount of information in a minimum amount of time, but students often have little opportunity to ask questions or offer comments. *Joseph Caballero*

has expertise in the subject matter and the student knows little about it. In this form of instruction the students have little opportunity to ask questions or offer comments. The lecture is often a good technique to use to supplement, summarize, or emphasize material from other sources, or to present information difficult to obtain in other ways. If students do not have time for research or do not have access to reference material, the lecture can fill the bill.

Advantages. The lecture is the most efficient instructional method for presenting many facts or ideas in a relatively short time. Material that has been logically organized can be presented rapidly and concisely. The lecture is particularly suitable for introducing a subject to ensure that all the students have the necessary background to learn it. A brief introductory lecture can give direction and purpose to a demonstration or prepare students for a discussion. The lecture is an efficient method for instructing large groups. If necessary, a public address system can be used to ensure that everyone can hear. The lecture is sometimes the only practical technique to use if the student-to-instructor ratio is high.

Disadvantages. Lengthy or overly frequent lectures that allow students no opportunity to ask questions can easily lead to boredom. The lecture tends to promote student passiveness. Avoid restating or repeating what a student could easily understand by quickly reading a few paragraphs in a textbook.

The lecture format does not lead to maximum achievement in certain types of learning. Speech skills, cooperative group thinking, and motor skills, for example, are difficult to instruct through the lecture. Because it allows for little or no student participation, the lecture may also be unsuitable for lessons in which complicated concepts and principles are developed.

It is hard for the instructor to judge how well the audience is reacting to the lecture and whether students' needs and interests are being met.

The lecture assumes active listening and adequate note-taking skills on the part of the student. All students may not possess these skills.

Lecture Procedure

The first task for the instructor is to gather and organize the information to be presented. He or she must determine the point of view from which the subject is to be addressed and tailor the lecture to the student. After this preliminary preparation, the delivery technique for a lecture includes three main steps:

Step One: Introduction. The instructor establishes contact with the class by introducing him- or herself and stating the objectives of the topic. He or she gets the students ready to learn the material by developing interest through explanations of how the students will use the lesson material, why the students need to know the material, and how the material will apply to future topics or to the students' work. This is followed by an overview of the lesson as a whole.

Step Two: Presentation. The instructional material breaks down the general concepts into their simplest component parts, which are presented one by one. The instructor provides examples, illustrations, explanations, and the like.

Step Three: Summary. The instructor provides recapitulation (a summary) that emphasizes and ties together the principal points of the lesson, including the objectives. This helps the students to select and take note of the most important parts of the information presented.

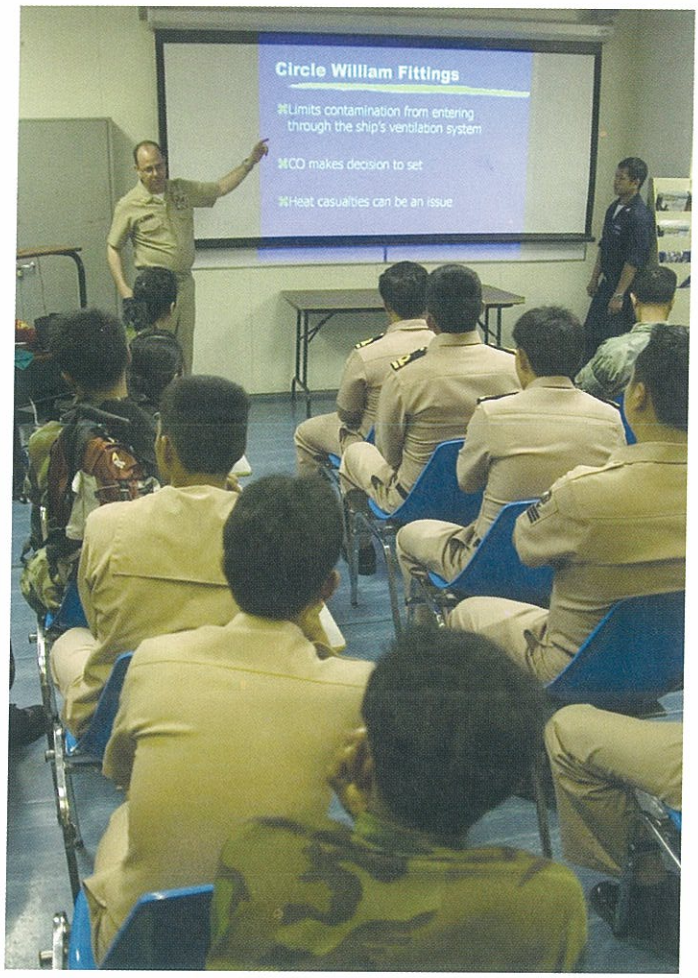
Guidelines for Effective Use of the Lecture

Know the specific objectives of the topic. Ensure the lecture is well organized. Avoid monotony by varying voice stress and intensity. Watch the students' expressions and actions (attentiveness) to determine the effectiveness of the instruction.

Lecture with Audiovisuals

The addition of **audiovisual aids** such as the chalkboard, the movie and slide projector, and the overhead projector or presenter is the most common variation of the lecture instructional technique. This strategy encourages comments and questions from students. Although audiovisual aids are both appropriate and useful with all instructional techniques, they are especially important with the lecture. A multiple approach through several senses makes for more complete understanding and greater retention.

Instructors who rely only on oral presentation find that their students frequently are unable to relate their new learning to any previous experience. The background of the group



A lecture with audiovisuals, as this senior chief damage controlman is giving to a group from the Royal Thai Navy, helps students grasp whole concepts in situations where word explanations alone are inadequate.
Matthew White

may be so varied that the new learning does not result in a clear concept common to all, but rather emerges in as many shades of meaning as there are students. Frequent use of visual materials by the instructor should help students grasp whole concepts where word explanations are often inadequate.

Students' imagination, while necessary to learning, cannot be expected to form completely accurate mental pictures of the concept about which they are hearing. Thus it is important that the instructor use some kind of audiovisual material to relate concepts being discussed to reality. As soon as the object or picture is presented, the word descriptions come into focus with new meaning and lasting effect. The drill instructor, for example, would find it very difficult to communicate drill procedures without the use of charts, drawings, and diagrams. This in turn permits the student to translate the content into logical and meaningful knowledge. Many students are visual learners who cannot absorb material well if it is just presented orally with no visual links.

Advantages. The lecture with audiovisuals is an efficient instructional method for presenting many facts or ideas in a relatively short time. Material that has been logically organized can be presented concisely in rapid sequence. The lecture with audiovisuals is particularly suitable for introducing a subject, to ensure that all students have the necessary background.

The lecture with audiovisuals is often useful to supplement, summarize, or emphasize material from other sources or to provide information difficult to obtain in other ways. This is especially true when complex material is being presented. The audiovisuals will help to focus the students' attention on the specific concept being presented.

Disadvantages. The lecture with audiovisuals is not good for development of motor skills.

Although the use of audiovisuals will help to hold the students' attention, it still requires considerable speaking skill on the instructor's part. This strategy also assumes active listening and adequate note-taking skills on the part of the students.

Procedure for Lecture with Audiovisuals

The first task for the instructor is gathering the required audiovisual aids for presenting the desired topic, and testing out any required projection and sound equipment to be sure he or she can operate it and that it is ready and adequate for the presentation. After this preliminary preparation, the delivery technique for a lecture using audiovisuals is similar to the basic lecture method discussed earlier.

Demonstration

Demonstration is the process wherein one person does something in the presence of others to show them how to do it or to illustrate a principle. The demonstration is the most commonly used small-group teaching technique done in a classroom or laboratory to develop students' ability to operate equipment or acquire physical skills. It involves the presentation or portrayal of a sequence of events to show a procedure, a technique, or an operation, frequently combining explanation with the operation or handling of systems, equipment, or material. Thus, demonstration utilizes both hearing and sight to communicate the information.

Advantages. Demonstrations are especially beneficial in skill areas. They add to learning by giving students the opportunity to see and hear what is actually happening. They can be used to illustrate ideas, principles, and concepts for which words are inadequate, thus holding the students' attention. A demonstration may be the only practical technique to use if the procedure, operation, or equipment is unique, complicated, delicate, potentially dangerous, or requires expertise or prior training.

A group of NJROTC cadets learning how to handle a fire hose. Participation in a demonstration like this one is an excellent way for students to learn new skills. *Everett HS NJROTC, Casey Jones*

Demonstrations can save money, since only the instructor needs materials. They can reduce hazards before students begin experimentation or handling of materials themselves (especially in labs or workshops). Demonstrations lead to a reduction in the length of trial-and-error time.

Disadvantages. The demonstration cannot be properly used in large classrooms or with extremely small objects because not all students will be able to see. Demonstrations can be ineffective if the instructor only "shows and tells" without obtaining feedback from students.

Demonstrations may lead to imitation without understanding. Unless given proper direction and guidance, students may concentrate on the aids used and ignore the lesson itself.

Demonstrations can become time-consuming.

Demonstration Procedure

The actual steps in a demonstration will vary with the situation. There are three basic steps, with several variations of step two.

Step One: Show and Tell. Related to every skill, mental or physical, there is a body of background knowledge that the student must know to perform the skill properly. Some kinds of background knowledge can best be taught in a standard classroom. Others should normally be presented in the actual environment or laboratories in conjunction with demonstrations.

Position the students and training aids properly. If the instructor directs the students to gather around a worktable or a training aid, he or she should recheck their positioning to make sure that everyone has an unobstructed and safe view.

Show and explain the operations. Perform the operations in step-by-step order. Wherever possible, simultaneously tell and do. Do not hurry; speed in performing operations or in moving from one operation to another should normally not be emphasized in the demonstration step. The instructor should make certain that the students understand the first step before proceeding to the second, and so on. Repeat difficult operations. Pause briefly after each operation to observe reactions and to check for understanding.

Special mention should be made of skills in which a distinction between right and left is important—for example, the manual of arms or knot tying. For teaching the manual of arms, or skills of a similar nature, the use of an assistant instructor or a well-coached student is advisable. The assistant is positioned so that the class may see what he or she is doing and performs the activity at the direction of the instructor. Meanwhile, the instructor can circulate among and observe the reaction of the students.

Observe safety precautions. It takes only a few more seconds to rig a safety line, put on gloves or safety goggles, or tag

an electrical cable, but the time is not wasted. The students are being shown the importance of exercising extreme care in dealing with potentially hazardous equipment.

Give proper attention to terminology. The instructor must call each part of a training aid by its proper name each time he or she calls attention to it. But something more than just mentioning the names of parts is necessary if the students are to retain the correct nomenclature. The following suggestions will prove helpful:

- List the names of parts on a chalkboard or chart.
- Refer students to a previously made chart that shows the parts and their terminology.
- Conduct a terminology drill on the parts of the training aid while the aid is in its assembled or disassembled condition, as appropriate.
- Check student comprehension carefully. Ask questions during the demonstration that require the students to recall nomenclature, procedural steps, underlying principles, safety precautions, and the like. Watch the class for reactions indicating lack of attention, confusion, or doubt, but do not depend solely upon visual observations.

Step Two: Repetition. Keeping in mind the definition of the demonstration strategy, the lesson plan will always call for a demonstration step and usually a performance step. But generally there is a need for the inclusion of one or more repetition steps between the demonstration step and the performance step.

Step Three: Performance. The performance step is the step in which the students practice under supervision until they have attained the required proficiency. During this step, they apply what they have previously learned as a result of the demonstrations.

Guidelines for Effective Use of the Demonstration

Practice or rehearse the demonstration in its entirety with an eye on time limitations. When it is time to put on the demonstration, make sure that all materials are at hand and are in working order as appropriate. Make sure seating arrangements are such that the students can see and hear. Use questions during the demonstration to obtain feedback. At the end of the demonstration, conduct a brief review of the steps involved or a short summary of what has happened.

Role-Playing

Role-playing is an instructional technique involving a spontaneous portrayal (acting out) of a situation, condition, or circumstance by selected members of the class. It is a form of improvisation in which the participants assume the identity of other persons and then react as they believe those persons would in a particular situation. Role-playing is especially useful in helping students understand perspectives and different ethnic and cultural backgrounds, and in problem-solving situations where different roles are in opposition to each other. Role-playing is often effective in counseling or tutoring.

Advantages. Role-playing can be fun, interesting, motivating, and meaningful, and it helps to break the routine of other classroom experiences. It provides insight into common individual and group problems, reveals different attitudes, and tests various ideas in a practical situation. Students learn to organize thoughts and responses instantly while reacting to a situation or question.

Disadvantages. Students sometimes emphasize performance (showing off) over the intended objectives of the topic. Role-playing is time-consuming. Some students are unable to identify with the roles or situation. "Hot topics" and controversial issues sometimes get out of hand in role-playing. Role-playing may benefit only the actual participants unless the objectives for the class have been clearly specified.

Case Study

The **case study** is an instructional approach that requires the student to analyze problem situations that may be hypothetical or real. The student receives a "case"—a report containing all pertinent data—and must then analyze the data, evaluate the nature of the problem, decide upon applicable principles, and finally recommend a solution or course of action. The case may be handled by the class as a whole, by subgroups of the class, or by an individual. Also, the case may be designed to be handled in varied time periods, ranging from a single class period to the entire course.

Analysis of the data involves such things as the use of reference materials prepared for the study, or knowledge and theory already possessed by others and listed in manuals and books. Evaluating and determining applicable principles calls upon the students to make some kind of "reasons-why-this-has-happened" statement. Recommended solutions should be a natural outgrowth of the analysis and evaluation.

Discussion

The **discussion technique** of instruction is basically a supervised conversation during which the students take an active role by stating their views on a certain topic while the instructor guides the group to discover certain principles.

The discussion may be implemented in a number of ways. The types of discussion include whole-class discussions, debates, panels, buzz sessions, and forums. Each type has its own slightly different characteristics. The whole-class discussion is the type generally referred to when instructors use this technique and is the type often found in the NJROTC classroom. The instructor simply leads an informal discussion involving the class as a whole. The instructor asks questions,

clarifies comments, and makes tentative summaries to help students achieve understanding of the topic and stay on task. The emphasis is on student-centered rather than instructor-centered learning.

Discussion techniques get at attitude development. By taking part in meaningful discussion with fellow students, participants find their own values and beliefs both reinforced and challenged.

Discussion provides students with the opportunity to develop questioning skills and responses. It gives them the chance to develop organization and formulate answers.

Discussion is motivational. Since the role of the student is not as passive as it is with some other strategies, the student maintains a high degree of mental alertness.

A potential disadvantage of the discussion technique is that like role-playing, "hot topics" and controversial issues can get out of hand, or the subject of the discussion may wander from the objective and need occasional refocusing by the instructor. Loud or highly assertive students can sometimes try to monopolize the discussion, while less assertive students may be reluctant to participate without coaching from the instructor.

Cooperative Learning

In **cooperative learning**, a class of students is subdivided into groups or teams whose members work with and depend upon each other to accomplish a learning goal. Each team member is responsible for accomplishing some portion of the assigned objective as an individual goal. They then instruct other team members about what they have learned or accomplished, and receive similar information from the other members. Team members are encouraged to assist others to achieve their individual goals when needed, and to work together to achieve the overall group objective. The instructor monitors the individual group activities and may be used as a resource for the group, but does not actively take part in the group work effort.

A cooperative learning strategy is best used when sufficient time is available for the group to gather, discuss, digest, and disseminate information. It is an excellent strategy to use when the material to be learned is complex or important and requires both mastery and retention in long-term memory.

As with the discussion, the instructor needs to monitor the various groups to be sure focus on the objectives is maintained, and that highly assertive students do not monopolize the group while less assertive students are discouraged from taking an active part.

Cooperative learning, as in this group of NJROTC cadets building a tennis ball launcher as a STEM project, is an excellent way to achieve a group-learning goal. *Dave Gordon*

Final Thoughts

No one can teach something to someone without doing it in some particular way, and that way of instruction has significant effects on the learning outcomes. In deciding which technique is best for a particular lesson or series of lessons, the instructor must consider the following aspects: the number, ability, maturity level, and previous experience of the students; the nature of the subject matter; and what needs to be emphasized—skills, knowledge, or values/attitudes.

The instructor must also consider the time requirements, the demands the technique will make on the instructor and students, the materials required, and the results expected. There is no single correct way to instruct a class; there are many good ways. Some things can be learned more thoroughly by observation or group involvement rather than through lectures or drill. Some materials need experimental and demonstration treatment. Controversial topics lend themselves best to discussion or role-playing. The instructor must learn how to use the different techniques.

Critical Thinking

1. Learning requires much from the person receiving instruction as well as from the instructor. What are some things students can do to maximize their ability to learn during all types of instruction?
2. Make up a complete lesson plan for delivering instruction on some aspect of NJROTC to fellow NJROTC cadets.

Study Guide Questions

1. What is the definition of learning?
2. What mental characteristics does the student bring into the classroom?
3. What are the types of learning as classified by psychologists?
4. Describe the shape of the typical learning curve.
5. When do people learn best?
6. What are the factors that speed and strengthen learning?
7. A. What is motivation?
   B. What is negative motivation?
8. What are the conditions that tend to hinder learning?
9. What should a lesson plan include?
10. What are the main techniques for delivery of instruction?
11. What are the advantages and disadvantages of the lecture with audiovisuals?
12. What are the steps for the demonstration type of instruction?
13. When is the use of the role-playing type of instruction appropriate?
14. What is the case study approach to instruction?
15. When is the use of the discussion method of instruction appropriate?
16. Under what conditions can cooperative learning strategies be employed?

New Vocabulary

learning theory
psychologists
learning plateau
abstract
negative motivation
sarcasm
right-brain, left-brain
intimidation
audiovisual aids
role-playing
case study
demonstration
lesson plan
cooperative learning

Naval Skills

UNIT 1: SHIP CONSTRUCTION AND DAMAGE CONTROL

1. Ship Construction, Propulsion, and Naming 268
2. Damage Control and Firefighting 289

UNIT 2: DECK SEAMANSHIP

3. Marlinspike Seamanship 307
4. Anchoring, Mooring, and Underway Replenishment 315
5. Small Boat Seamanship 327

UNIT 3: NAVIGATION

6. Introduction to Navigation 338
7. Marine Navigation 349
8. Aids to Navigation 362
9. Time 369

UNIT 4: RULES OF THE ROAD AND MANEUVERING BOARD

10. Nautical Rules of the Road 378
11. The Maneuvering Board 388

GLOSSARY OF NAVAL SKILLS TERMS 395

Unit 1

Ship Construction and Damage Control

Navy ships are complicated. They have propulsion plants, weapons, storerooms, repair shops, offices, and operating spaces. They provide for their crew's living, sleeping, and eating needs. They are almost like cities with their lighting, sanitary, communications, mail delivery, water, and power systems. Large ships have libraries, dental and medical offices, legal services, newspapers, TV stations, chapels, and recreation spaces. All must be able to operate on their own for long periods.

Unlike commercial ships, naval ships must be capable of continuing their missions even if they are damaged in battle or as a result of operations. Because of this, Navy ships have a damage control organization to deal with damage while keeping the ship in optimum operating condition. The following chapters discuss the principles and nomenclature of naval ship construction and the damage control capabilities of naval ships.

1

Ship Construction, Propulsion, and Naming

Ship designers try to build as many good features as possible into their ships while keeping in mind their intended missions. All ships are the result of compromise; not every desirable feature can be built into every ship. Nevertheless, all ships have certain essential qualities. This chapter highlights these characteristics and discusses other fundamentals of surface warship construction and propulsion. It also discusses naval terminology, how Navy vessels are named, and how they are grouped into classes. As is the case with ships' organizational principles, much of this discussion is also applicable to submarines, although there are significant differences because of the type of medium in which they are designed to operate and their unique missions.

There is a lot of nautical terminology related to the design, construction, and description of ships, and much of this will be introduced in this chapter as well.

Principles of Ship Construction

The major factors considered in the construction of any naval vessel are mission, armament, protection, seaworthiness, maneuverability, speed, endurance, and habitability.

The ship's **mission**, or main purpose, is the biggest consideration in its design. The weapons systems, speed, crew size, and almost everything else depend on the ship's intended mission.

The **armament** consists of all the weapons used to fight an enemy on or under the sea and in the air. Generally, we think of armament as being guns, torpedoes, missiles, and so forth, but the term also includes aircraft used for offensive purposes (an extension of the ship's attacking capability) and landing craft used for amphibious operations.

A ship's protection consists of the defensive features that help it survive enemy attack. In addition to its weapons, a ship's sturdy construction, armor, and compartmentation to limit the spread of flooding make up its protective features.

Seaworthiness relates to hull design and other features that enable a ship to operate in all kinds of weather, high winds, and heavy seas. Stability, size, and freeboard (the hull space between the waterline and the main deck) determine a ship's seaworthiness. **Stability** refers to the way a ship returns to an upright position after a roll in heavy seas. Stability also affects the value of a ship as a weapons or aircraft platform.

Maneuverability refers to the way a ship or submarine handles in turns, in backing down, in going alongside another ship, in coming to a stop, in evading enemy weapons, and for a submarine, in diving and surfacing. Combatants such as carriers and destroyers must be able to change course and speed rapidly.

Speed is affected by the weight (displacement) of the ship, its underwater hull shape, and the power of its propulsion plant. A ship's speed determines how quickly it can get to a scene of action, overtake an enemy, or avoid being overtaken, and also plays a role in a ship's maneuverability and vulnerability.

Endurance is the maximum time or distance a vessel can cruise at its most economical speed. It depends on fuel capacity, freshwater capacity, fuel consumption, and storage space and refrigeration for food provisions. Most warships powered by steam engines can steam for one to two weeks without refueling, and gas turbine–powered ships can cruise for several days to a week or more. The Navy's nuclear-powered ships can cruise for years, limited only by their need to replenish food and other consumables. Another term sometimes used as a measure of endurance of surface warships is *cruising range*.

Habitability refers to the features designed to provide comfortable living conditions for the crew. Adequate heads (lavatories) and washrooms; laundries; air conditioning; and comfortable, safe, and clean berthing and messing spaces are important habitability features.

Nautical Terms

In civilian life you become accustomed to using terms like upstairs, downstairs, windows, floors, ceilings, walls, hallways, and so forth. In the Navy you must learn to describe objects and places on board a ship using nautical language. To use civilian terms on board a ship marks a person as a *landlubber*, one who knows nothing of the sea.

In some ways a ship or submarine is like a house. Its outer walls form the *hull*, the supporting body of the ship. Rooms are

called *spaces* or *compartments*. Floors are called *decks*, inner walls are called *bulkheads* or partitions, ceilings are *overheads*, and hallways are *passageways*. The *quarterdeck* might be compared with an entrance hall or foyer, and a front door landing or stoop is called the *brow* on a ship. Stairs are *ladders*; an *accommodation ladder* is the stairs from the brow of a ship to a pier or boat landing, and a *Jacob's ladder* is any portable ladder made of rope or metal.

The lengthwise directions on a ship or other vessel are *fore* (toward the front) and *aft* (toward the back); crosswise is *athwartships*. The front end of a ship is the *bow*; to go in that direction is to go *forward*. The back end of the ship is the *stern*; to go in that direction is to go *aft*. The maximum width of the ship is the *beam*; locations off to the side are *abeam*. Locations behind the beam are *abaft*. Behind the ship, in the water, is *astern*. The forward part of the main deck of a ship is the *forecastle* (pronounced foc'sle), and the back part of the main deck is the *fantail*.

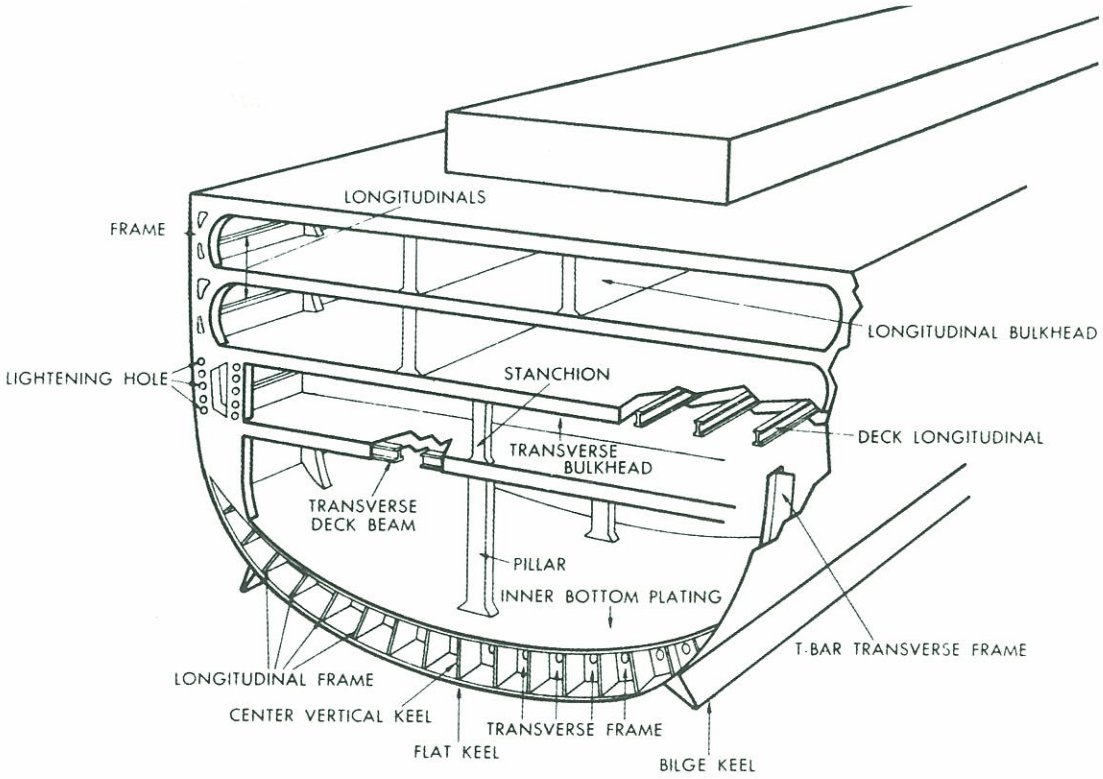
Ships, submarines, and boats are divided lengthwise in half by the *centerline*. Everything to the right of the centerline is to *starboard*, and everything to the left is to *port*. The direction from the centerline toward either side is *outboard*, and from either side toward the centerline is *inboard*. The section of a vessel around the midpoint area is called *amidships*. Sightings by lookouts are noted and reported as being off the port or starboard bow or beam, and off the port or starboard *quarter* (area abaft of the beam toward the stern).

You never go downstairs in a ship; you go *below*. To go up to the main deck or above is to go *topside*. However, if you climb the mast, stacks, rigging, or any other areas above the solid structure of the ship, you go *aloft*.

A vessel *rolls* from side to side around its longitudinal axis; it *pitches* when it goes up and down fore and aft around the athwartships axis; it *yaws* when the bow swings to port and the stern to starboard, or vice versa, around its vertical axis.

Ship Structure

The *hull* is the main body of the ship, submarine, or boat. It is like a box. Its inner construction might be compared with the girders of a steel bridge. The *keel* is the backbone of the hull; it is on the centerline like an I-beam running the full length of the bottom of the vessel, with heavy castings fore and aft called the *stem* and *stern posts*. Girders attached to the keel called *transverse frames* run athwartships and support the watertight skin or *shell plating*, which forms the sides and bottom. Most Navy ships also have *longitudinal frames* running fore and aft. When covered by plating, the longitudinal and transverse frames form a honeycomb structure in the bottom of a surface ship called a *double bottom*. This type of construction greatly strengthens



Transverse and longitudinal structure of a ship. Note that transverse beams and bulkheads run athwartships, while longitudinals run the "long way" from stem to stern.

the bottom and makes the ship more resistant to damage from collision or grounding.

The spaces between the inner and outer bottoms may form *tanks* or *bilges*, which may be used for fuel and water stowage or ballast (usually in the form of concrete or pig iron). Many of the tanks are fitted with pumps that can transfer liquids from one tank compartment to another to help keep the ship level, or "on an even keel." The tanks at the extreme bow and stern, called the forward (or forepeak) and after *peak tanks*, are used for *trimming* the ship (leveling it fore-and-aft). If the spaces are empty, they are called *voids* (air spaces).

Surface warships built today have unarmored hulls. Ships of the last century (the old battleships and heavy cruisers) had vertical armor belts of very thick steel running fore and aft along the sides of their hulls to protect engine rooms and magazines from torpedoes and shell fire. They also had horizontal armor—steel plates built into exposed decks and gun turret tops to protect against falling bombs and shells.

The top of the hull, the *main deck*, is analogous to the main floor of a building. It is normally the uppermost complete horizontal structural surface extending fore-and-aft from the stem to the stern, and from one side to the other, and is partially or completely exposed to the weather. In aircraft carriers, LHAs, and LHDs, however, the uppermost complete deck is the *flight deck*, from which aircraft take off and land, and the main deck is considered the *hangar deck* below, where aircraft are stowed and serviced. Smaller ships that operate aircraft also have a flight deck, but it is usually a partial deck above the main deck.

The intersection of the main deck with the shell or side plating of surface ships is called the *gunwale* (pronounced gun'el). Projections at the joint between the side plating and the bottom plating are called *bilge keels*; their purpose is to reduce rolling of the ship.

The *waterline* is the water level along the exterior hull of the ship. The vertical distance from the bottom of the keel to the waterline is the ship's *draft*. The *freeboard* is the distance from the waterline to the main deck.

Superstructure

The *superstructure* of a ship includes all structures above the main deck; or on carriers and amphibious aviation ships, all structures above the flight deck. It will vary according to the type of ship, but most surface warships have a navigation bridge, signal bridge, chart room or "chart house," some type of operations center, a radio room or "radio shack," and probably a sea cabin for the captain. The superstructure of an aircraft carrier or amphibious LHAs and LHDs that operate aircraft is called its *island*, and on a submarine, its *conning tower* or *sail*.

The navigation bridge, usually referred to simply as the *bridge* on surface ships, consists of an enclosed compartment on the upper front part of the superstructure with a bank of windows on the front and sides, and often open observation platforms on the sides called *bridge wings*. Submarines have a small open bridge on top of the conning tower. On a surface ship under way, the OOD and other members of the deck watch team direct maneuvers and monitor all ship operations from the bridge. The helm (steering wheel) and lee helm (engine order telegraph) are normally located on the bridge, but on some older ships they are in a separate enclosed area of the bridge called the *pilothouse*. On surfaced submarines under way, the OOD and a small maneuvering watch team are stationed on the bridge, but most other operations are monitored by a more junior officer who stands watch in the control room beneath. When the vessel is submerged, the OOD stands watch in the control room, and all operations are directed from there.

Larger ships such as aircraft carriers and amphibious command ships have a second bridge below the navigation bridge called the *flag bridge* that is the command center for an admiral who may be in charge of a carrier strike group or amphibious force. There is also another windowed bridgelike structure high atop the inboard forward corner of the island on carriers, LPAs, and LHAs called the *primary flight control* center, or *PriFly*, from which all aircraft movements on the flight deck, catapult launches and other takeoffs, landings, and aircraft flying within five miles of the ship are monitored and controlled. Extending

The island of the aircraft carrier USS *George Washington* (CVN 73). Atop the island are the ship's mast, electronic sensors, radio antennas, and the signal bridge. The top level of windows on the left front corner is primary flight control (PriFly), with "vulture's row" extending aft from it. Below it is the navigation bridge, and on the third level down is the flag bridge. *Stephanie Tigner*

The *Virginia*-class attack submarine USS *Illinois* (SSN 786). Its only superstructure is its conning tower, or sail. There is a small bridge at the top, and the main control station is below it inside. *General Dynamics*

A close-up view of the bridge atop the conning tower of the *Ohio*-class nuclear-powered guided-missile submarine USS *Michigan* (SSGN 727) with the underway maneuvering watch team. Note the diving planes on each side and the periscope housings on top. *Chelsea Mandello*

aft from PriFly is a narrow observation walkway with an unobstructed view of the entire flight deck below called *vulture's row.*

On submarines, about all that projects above the main deck is the conning tower, or sail. In addition to the small bridge on top, it houses the periscopes and the primary control station and acts as a vertical stabilizer when the submarine submerges. On some submarines the sail also supports a pair of diving planes that assist diving, surfacing, and stability.

The superstructure of surface ships is topped by the *mast.* It will be at least one large, vertical pole fitted with a horizontal yardarm that extends above the ship and carries flag halyards and navigational and signal lights. The mast may also be in the form of a tripod on some ships. On most ships there also will be electronic devices, radar antennas, radio aerials, and meteorological instruments on the mast or the yardarm. Most Navy ships have only one mast, but many merchant ships and some naval vessels have two. The one forward is called the *foremast,* and the one aft of this is called the *mainmast*; the mainmast is usually taller than the foremast, making it normally the highest structure above the main deck. A large sailing ship might have a third, lower mast aft of the mainmast called the *mizzenmast.*

The top of a mast is called the *truck.* The *pig-stick* is a slender vertical extension above the mainmast from which the ship's commission pennant is flown. The *gaff* extends at an angle abaft of the mainmast. It is from the gaff that the national ensign (U.S. flag) is flown when the ship is under way. The small vertical pole at the bow on the forecastle and the slightly raked (diagonal) pole at the stern, often removable at sea, are called the *jackstaff* and the *flagstaff* respectively. When a Navy ship is at anchor or moored, it flies the First Navy Jack (a flag consisting of a rattlesnake superimposed across thirteen horizontal alternating red and white stripes, with the motto Don't Tread on Me) on the jackstaff and the national ensign on the flagstaff from 0800 to sunset. Prior to 11 September 2001, the flag flown from the jackstaff was the Navy Union Jack, a flag consisting of the white stars and blue background in the *canton* of the national ensign. Now called the U.S. Government Jack, this jack is still flown by non-Navy government ships, but after the 9/11 terrorist attacks, Secretary of the Navy Gordon England ordered that the First Navy Jack would henceforth be flown by all Navy ships for the duration of the war on terror.

The *stack* of most surface ships supplies air to the main propulsion engines and exhausts smoke and hot gases from

A Sailor hoists the First Navy Jack on the jackstaff at the bow of a Navy ship during morning colors. *Gary Mihalko*

Sailors hoist the national ensign on the flagstaff on the after part of the flight deck on the littoral combat ship USS *Freedom* (LCS 1) during morning colors. Note the incline (rake) of the flagstaff and the anchor light at the top of it.

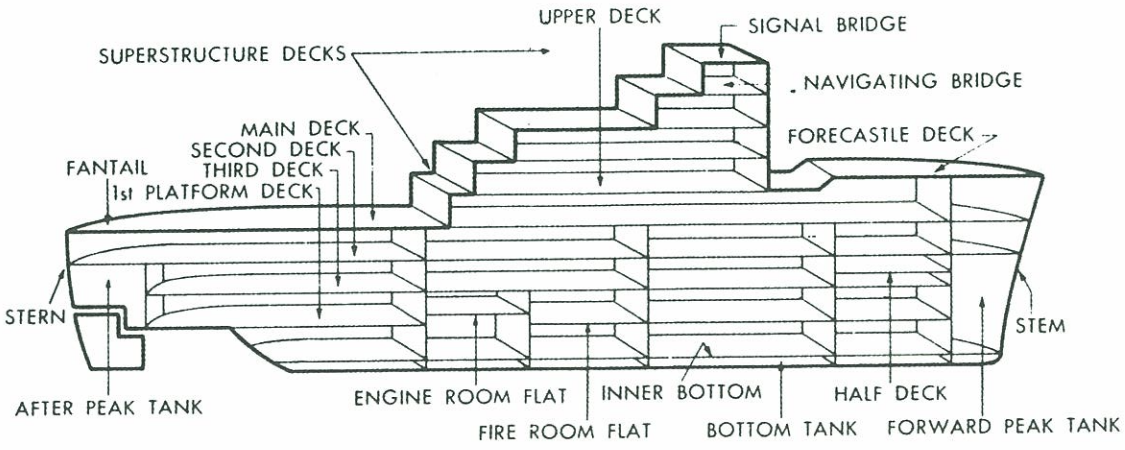
them. Nuclear-powered ships do not need stacks because their reactors require no air for combustion and they produce no smoke or gas.

Decks

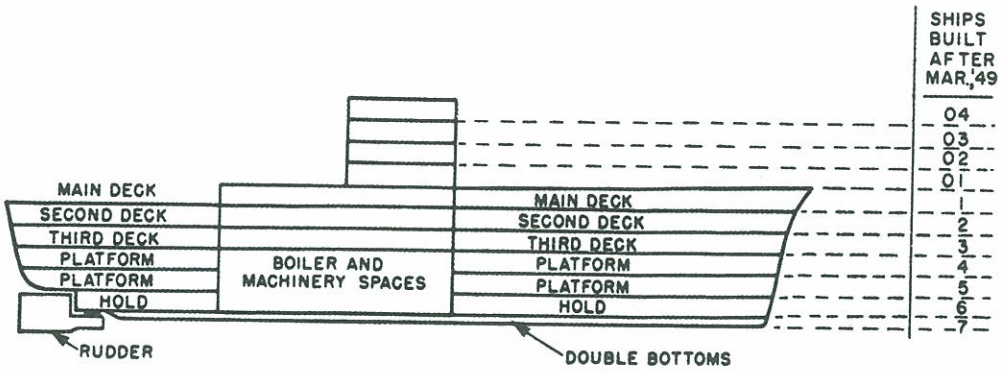
A surface ship's hull and superstructure are vertically subdivided into layers above and below the main deck by a series of horizontal decks parallel to it, in the same way that a building is subdivided into stories by floors above and beneath the main floor. Decks that extend throughout the ship from side to side and stem to stern like the main deck are called *complete decks*. A *half deck* is any partial deck between complete decks. *Platform decks* are partial decks below the lowest complete deck. A partial deck at the bow above the main deck is called the *forecastle deck*. Amidships it becomes an *upper deck*, and at the stern it is a *poop deck*. Main deck areas between the forecastle and poop decks are called *well decks*. Very few Navy ships have forecastle and poop decks today, but these are often built into merchant ships. Well decks on amphibious ships are the lower decks on which their amphibious vehicles and craft are housed and from which they are launched.

Decks are named by their position in the ship and their functions, and are numbered according to their relationship with the main deck.

Any deck above the main deck, forecastle deck, or poop deck on a surface ship is a *superstructure deck*; these are generally called *levels*. They are numbered in increasing order up from the main deck, which is number 1. The first level above the main deck is the 01 (pronounced oh-one) level, the second the 02 level, and so on. Many have names related to their use, such as boat deck, signal bridge, and navigation bridge. Complete decks below the main deck are numbered in sequence down



Decks are named in accordance with their position in a ship and their function.



The deck-numbering system of Navy ships is standardized to the system shown here. The main deck is always numbered 1. Decks below the main deck are numbered sequentially 2, 3, 4, and so forth, and decks above the main deck are called "levels" and are numbered 01, 02, 03, and so forth.

from it, with the next complete deck beneath it being the second deck, the next the third deck, and so on down.

The *weather decks* are all parts of a ship's exterior decks that are exposed to the weather. *Bulwarks* are a sort of low, solid-steel fence along the gunwale of the main deck; they are fitted with *scuppers*, rubber or metal drains that allow water to run off the deck during rain or heavy seas.

Spaces and Compartments

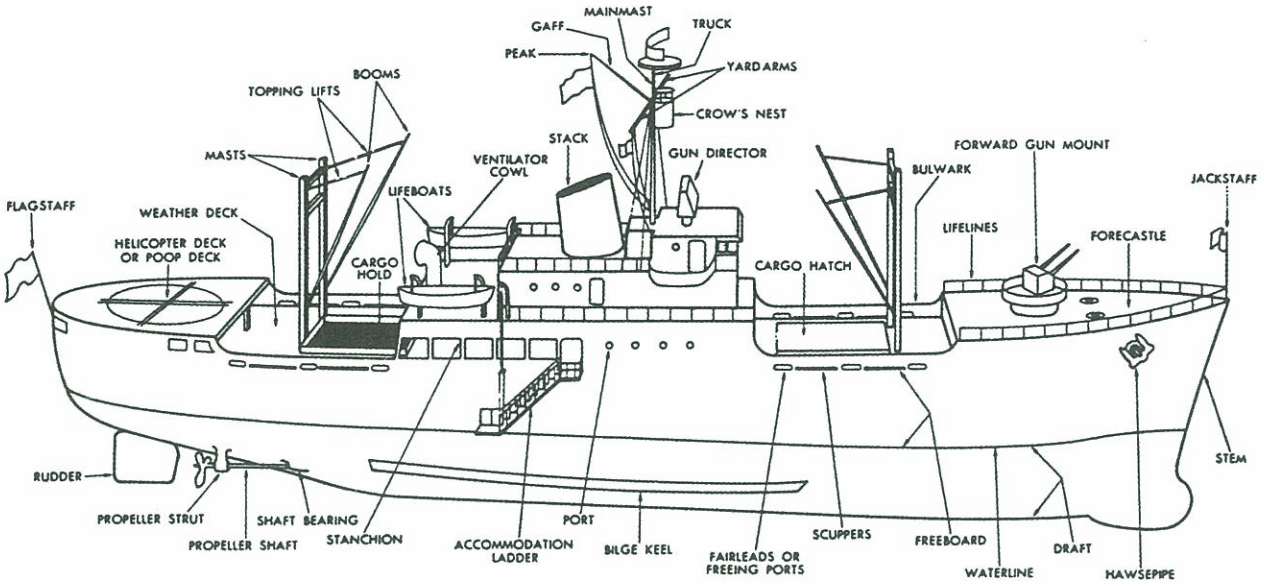
The decks of a ship, together with the longitudinal and transverse frames, and subdivisions of them, form **spaces** or **compartments** within the ship analogous to rooms in a house. The underside of each deck forms the overhead of the spaces below, and the frames form the support structure for main watertight bulkheads. Spaces formed by watertight decks and weight-bearing bulkheads are called *watertight compartments*, and these contribute to the **watertight integrity** of the ship. Sometimes such spaces are subdivided by nonwatertight walls called *partitions* into *rooms*, such as the wardroom (officers' dining room and lounge), staterooms (officers' bedrooms), and storerooms; but usually they are referred to simply as compartments. Other large watertight spaces may also sometimes be called rooms, such as the *fireroom* containing a ship's boilers and the *engine room* containing a ship's engines. Officers' living quarters on a Navy ship are collectively called *officers country*. The dining compartment for enlisted crewmembers is the *mess deck*, and their living quarters are *berthing compartments*. Kitchens are *galleys*, and bathrooms (lavatories) on a ship are *heads*.

The main compartments of cargo ships, and the main storage spaces of all ships, are called *holds*; holds are normally larger in merchant ships than in naval combatants or civilian passenger ships.

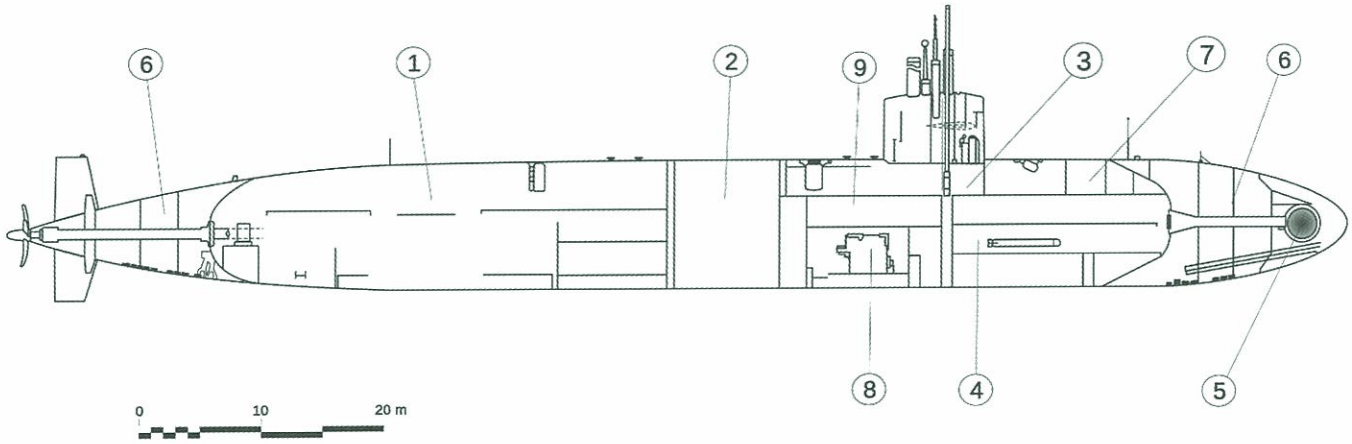
Submarines have far fewer spaces and compartments than do most surface ships, and most extend from top to bottom within the hull. From fore to aft, the main spaces in a typical submarine are the *forward torpedo room*; the *operations compartment*, containing the control room, sonar and radar rooms (if so equipped), and some officers' staterooms; the *crew's mess*; the *reactor compartment*; *missile rooms*, on fleet ballistic missile submarines; and the *engine room*. Some submarines may have an *after torpedo room*.

An enlisted berthing compartment on board the aircraft carrier USS *Theodore Roosevelt* (CVN 71). Beds such as these shown here are called *racks* in the Navy.

All vertical access fittings to a space or compartment on a vessel are called *doors*, and all horizontal access fittings are *hatches*.



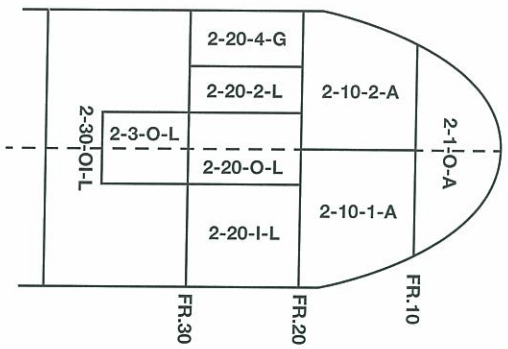
The principal features of a typical naval auxiliary ship. With the exception of cargo holds and booms, all of these features are found on surface warships as well.



The compartmentation of a *Los Angles*–class attack submarine. 1—engine room; 2—reactor compartment; 3—operations compartment; 4—torpedo room; 5—sonar array; 6—main ballast tanks; 7—sonar room; 8—auxiliary machinery; 9—crew's mess. *Voytek S*

Compartment Designation System

All spaces within a Navy ship or submarine are identified by standardized four-part designations commonly called **compartment numbers** that locate them and indicate their use. The first part identifies the deck the compartment is on; the second, the transverse frame, numbered sequentially from the bow, that the foremost bulkhead is on; the third part is the sequential number of the compartment from the centerline, with a centerline compartment numbered zero, compartments to port having even numbers, and those to starboard, odd; and the fourth part is one of about a dozen alphabetic letters that indicate the use of the compartment. Hyphens separate the various parts. For example, a living space on the main deck at frame 90 on the port side might be numbered 1-90-2-L, and a storeroom outboard of it might be numbered 1-90-4-A. A communications room on the same frame to starboard might be 1-90-3-C; and so on. The compartment numbers are prominently marked on the bulkheads, as well as on doors and hatches leading to



The Navy's compartment designation/numbering system. The first part of a compartment number designation identifies the deck the compartment is on; the second part identifies the forward-most transverse frame; the third part is the sequential order of the compartment from the centerline, with even numbers to port, odd to starboard, and centerline compartments numbered 0; and the fourth part is a letter indicating the compartment's use.

them. If sent to an unfamiliar space on a ship, a crewmember familiar with the compartment designation system can usually find it without too much difficulty.

Watertight Integrity

Watertight bulkheads supported by the ship's frames are built into naval vessels beneath their main decks to prevent the potential spread of flooding, and these along with the watertight decks above and below divide the hull into a series of watertight compartments. This compartmentation provides *watertight integrity*, meaning the vessel is sound, or without leaks. Watertight integrity is intended to limit flooding, which can cause a ship or submarine to *list* (lean) to port or starboard, lose *trim* (be "down" by the bow or stern), *capsize* (tip over), or sink.

The more watertight compartments a ship has, the more secure it will be from flooding and the better its watertight integrity. Any ship could be made almost unsinkable if it were divided into enough watertight compartments, but too much compartmentation would interfere with the arrangement of equipment and ease of movement within the ship. Warships are designed, therefore, with enough watertight compartmentation within the hull to ensure adequate watertight integrity, but not so many compartments as to unduly interfere with freedom of movement about the ship.

All surface warships have an exceptionally strong watertight bulkhead at the after end of the forepeak called the *collision bulkhead*. If one ship rams another head-on, the bow structure will collapse, hopefully somewhere forward of the collision bulkhead, thus preventing flooding of compartments aft of it.

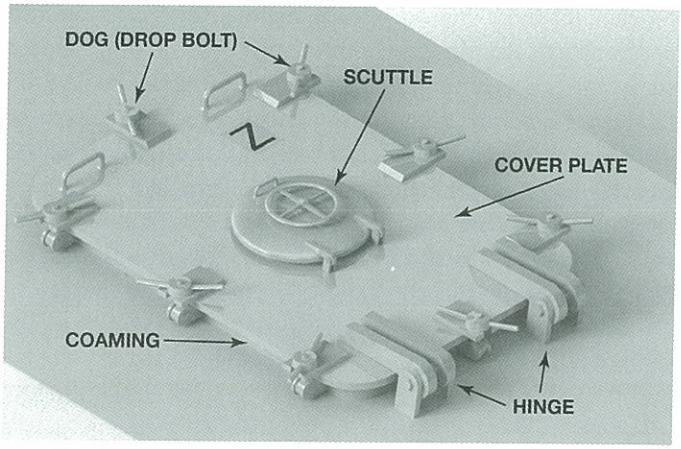
Internal Access Fittings

As we learned above, vertical doors in the bulkheads and horizontal hatches in the overheads and decks are used to gain access to spaces and compartments. Hatches have either inclined or vertical ladders beneath them to enable persons to climb down into or up from the space beneath. Large hatches may also have a circular access fitting called a *scuttle* in the middle of them, about the size of a manhole, that allows access from one deck or level to another without having to open the hatch.

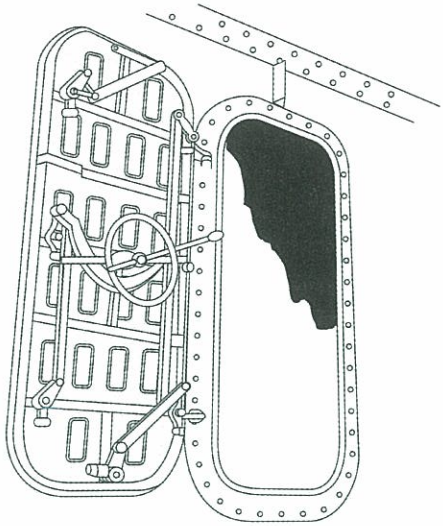
Large compartments may have many doors, hatches, and scuttles, along with smaller fittings that provide access to ventilation ducts, tanks, and voids within them. Depending on their location and purpose, these fittings may be either watertight, airtight, fume tight, oil tight, or nontight by design. Nontight *joiner doors* are like normal lightweight doors with doorknobs in a building; they provide access to spaces that are not watertight, airtight, or fume tight such as offices and staterooms.

Watertight compartments within the hull are accessed by heavy watertight doors, hatches, and scuttles. The doors and hatches are sturdily constructed with rounded corners, seals, and *dogs* (heavy latches) around the perimeter that securely fasten them in place when shut. Some doors and almost all hatches have dogs that have to be set and released individually. Most doors and all scuttles are fitted with lever or handwheel mechanisms that allow all dogs to be released together.

Piping and ventilation systems are designed on the same concept as compartment access fittings. Wherever steam, oil, air piping, electric cables, or ventilation ducts penetrate a watertight bulkhead or deck, they go through a watertight *stuffing tube* (a cylinder plugged with watertight filler material) to prevent leakage. Piping and ductwork have shutoff valves at strategic points that will isolate sections of the system, limiting the spread of any damage to smaller areas. Some have airtight, fume tight, or oil tight access and inspection panels or plates



A hatch with a scuttle in it and dogs around the perimeter.



A watertight door with a quick-acting dogging mechanism that sets all dogs around the perimeter of the door at once when the central lever is pushed down.

that are bolted or secured in place with small dogs when not in use.

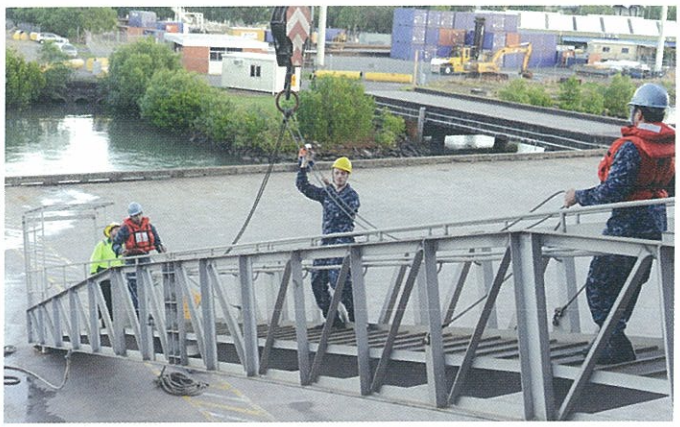
All watertight and airtight access fittings carry markings (described in the next chapter) that indicate when they may or may not be opened, depending on the condition of readiness in effect on the ship at any given time. Maintenance of watertight integrity is a function of **damage control**, the subject of the following chapter.

Ship Access Ladders and Gangways

With the exception of submarines, when a Navy ship is alongside a low pier or anchored out in a seaway, the freeboard distance from the water or pier up to the main deck can cause a problem for those boarding or leaving the ship. Personnel will not be able to step directly from the pier onto the ship, or vice versa, and boats coming alongside an anchored ship will be too far down for personnel to climb comfortably in or out. In these situations a special portable stairway called an **accommodation ladder** is suspended over the side of the hull. It extends from the main deck level down to near the waterline and has collapsible handrails and small platforms at both ends to serve as a landing for boats and to allow personnel to step onto or off the ship. If the ship is moored to a pier, the lower end rests on a roller on the pier with no lower platform necessary.

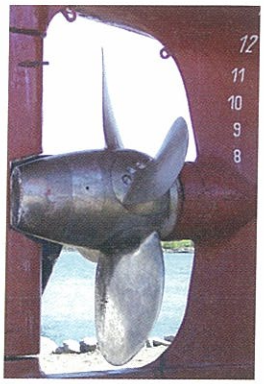
Boarding and departing a ship or submarine moored alongside a pier is often also made easier by putting in place a gangway called a **brow** (*not* a "gangplank") with handrails on both sides to bridge the gap between the ship and the pier. If the ship is very large, a portable accommodation platform fitted

Sailors carry supplies down the accommodation ladder of the dock landing ship USS *Fort McHenry* (LSD 43) to a pier below. If at anchor in a seaway, the lower end of the accommodation ladder would be fitted with a small platform to facilitate personnel embarking and debarking boats. *Brian Goyak*



Deck department boatswain's mates prepare to hoist the ship's brow onto the amphibious command ship USS *Blue Ridge* (LCC 19) after a port visit. A brow is sturdier than an accommodation ladder and has a flatter surface with treads instead of steps and more substantial, often permanent handrails. *Kelby Sanders*

with a staircase much like a boarding ramp used at an airport is put in place under the foot of the brow. Like the accommodation ladder, the foot of the brow is normally fitted with a roller that rests on the pier or the elevated accommodation platform to allow that end of the brow to move back and forth with the rise and fall of the tide. Ships such as carriers and LHAs normally carry brows and accommodation platforms with them, and they are hoisted into place by a ship's crane whenever needed.



A controllable variable pitch propeller on a merchant ship. Note the swivel at the base of each blade on the hub that gives the blade the ability to rotate to different pitch angles.

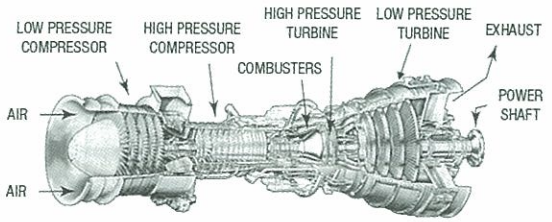
Propulsion Plants

Today's Navy ships are propelled mainly by gas turbine engines, conventional steam plants, or nuclear power plants, although the use of diesel and electric engines is steadily increasing.

Gas Turbine Engines

Gas turbine engines (GTEs) for marine propulsion originally were developed from aircraft engines in the middle part of the twentieth century. Nowadays their use is so extensive that marine GTEs are in a class by themselves. With the exception of U.S. Navy aircraft carriers and some large amphibious and auxiliary ships, GTEs propel almost all naval surface warships and large commercial vessels built since the 1960s both in the United States and in many foreign countries. GTEs have three basic components (parts): a *compressor*, a *combustion chamber*, and a *turbine*. The compressor draws in air, compresses it, and sends it under pressure to the combustion chamber, where it is combined with atomized (small droplets) fuel and burned. The combustion gases expand and flow through the turbine blades, causing the turbine to rotate at a high constant speed.

Because the turbines must spin at sustained speeds of several thousand revolutions per minute (rpm) but the large propellers that drive ships are not very effective above a few hundred rpm, **reduction gears**—like a transmission in an automobile—are used to make the transition from the high speed of the turbine (usually 3,000 rpm or more) to the necessarily much slower speeds of the propeller shafts and their attached propellers. GTE reduction gears can provide some ability to vary the propeller shaft speeds of rotation, but not nearly as much as the reduction gears of a typical steam engine, especially at slower speeds, at which the efficiency falls off significantly. Typically, therefore, ships with gas turbine propulsion systems are outfitted with **controllable-pitch propellers** that enable slower ship speeds by varying the pitch of the ship's propeller blades while the shaft rotates at a slow constant speed. Higher speeds are attained by increasing the shaft rotation rate with the propeller pitch set to a maximum. Since a gas turbine's direction of rotation cannot be changed, reverse thrust for backing the ship is achieved by reversing the propeller pitch to negative pitch angles.



Cutaway view of a typical marine gas turbine engine. *General Electric*

This type of engine powers *Arleigh Burke*–class destroyers and *Ticonderoga*-class Aegis cruisers, Coast Guard cutters, and landing hovercraft. The Navy's littoral combat ships (LCSs) are powered by a combination of two gas turbine engines linked with two diesel engines that power four steerable water jets, and the new *Zumwalt*-class (DDG-1000) destroyers have four gas turbines and two advanced electric induction motors.

The gas turbine engine has several advantages over traditional conventional steam propulsion plants. Because of its higher power-to-weight ratio, a GTE is much smaller and more compact, lighter, and easier to maintain and repair. Since it has a spark ignition system much like a car's, it can go from "cold iron" shutdown to fully ready to turn the propeller shaft in only a minute, in contrast to the several hours of warm-up time required to bring a much more massive steam engine on line. GTEs also operate at much lower pressures, requiring far lighter casings and much less bulky insulation.

A major disadvantage of a gas turbine propulsion plant is that because of its lower maximum power output as compared with a traditional steam engine, additional gas turbines must be brought on line for higher sustained ship speeds. As a result, under these conditions ships powered by GTEs have much higher fuel consumption rates compared with those powered by steam engines. An *Arleigh Burke*–class destroyer, for example, must bring three of its four GTEs on line for sustained speeds between twenty-four and twenty-eight knots, and all four for flank (highest) speeds in excess of that. Consequently, at these speeds the ship can run out of fuel and require replenishment in about half a day, as opposed to six or seven days for a comparable steam-powered ship. Also, because of its high turbine speeds, a GTE tends to become less efficient when driving a vessel at low speeds, as mentioned above. To

Two of the Navy's newest and most advanced ships. The USS *Zumwalt* (DDG 1000), foreground, is powered by four GTEs and two electric induction motors, and has a generating capacity of 78 MW. The USS *Independence* (LCS 2), background, has two GTEs, two diesel engines, and a water-jet propulsion system that give it top speeds in excess of forty knots. *Ace Rheaume*

overcome this deficiency, the Navy is in the process of retrofitting a **hybrid electric drive (HED) system** into its *Arleigh Burke*–class destroyers. In the HED system, electric motors powered by the gas turbines and attached to the main reduction gears drive the ships at speeds below thirteen knots. Over the normal course of a deployment this will save thousands of barrels of fuel and extend the average operational time between refuelings by about two and a half days.

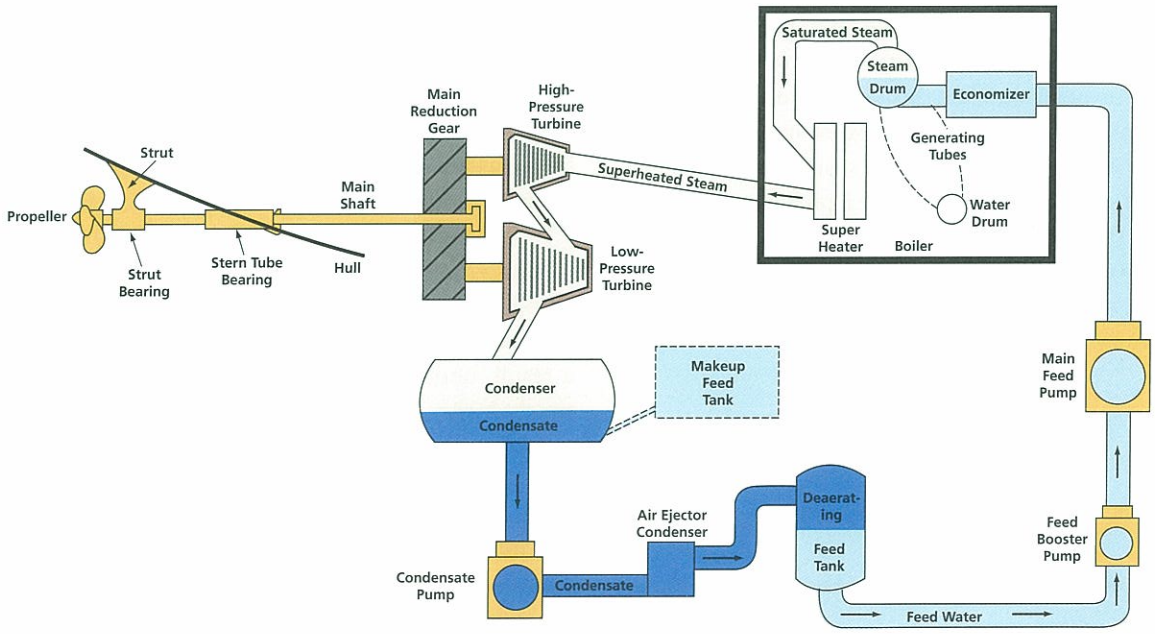
The Navy's LCSs use their two more economical diesels to power their water-jet propulsers for speeds under about eighteen knots for extended cruising, and they bring their GTEs on line for additional power whenever operations demand higher speeds (up to some forty-four knots or more) for shorter durations.

Oil-Fired Steam Propulsion Plants

A conventional oil-fired **steam propulsion plant** consists of boilers, main engines (steam turbines), reduction gears, propeller shafts, and propellers. At one time virtually all surface warships and auxiliary ships in the U.S. Navy were powered by such plants, but today only some auxiliary and amphibious ships have conventional steam propulsion plants. Most nuclear-powered ships and submarines have steam propulsion also, but the steam is produced by heat from a nuclear reactor instead of oil-fired boilers.

A *boiler* consists of a boxlike casing containing hundreds of water-filled steel tubes near the top that are arranged so that heat from furnace-like fireboxes beneath passes over them, turning the water into steam. The boilers of most steam-powered naval warships are located in compartments called *boiler rooms* adjacent to *engine rooms* containing the turbines and reduction gears. Within the boiler, fuel oil sprayed into the fireboxes under high pressure ignites and burns intensely, producing the heat.

After being raised to high pressure and temperature in a *superheater* in another part of the boiler, the steam flows



The components and processes of the basic steam cycle of a conventional oil-fired steam-driven ship.

through pipes to turbines, called the "main engines" in a conventional steam propulsion plant. After exiting the turbines, the spent steam is condensed back into water and returned to the boiler tubes to produce more steam for the next cycle. This "steam cycle" is repeated over and over to provide the energy to propel a ship through the water. Fresh water used to produce the steam in the boilers is distilled from saltwater by evaporators.

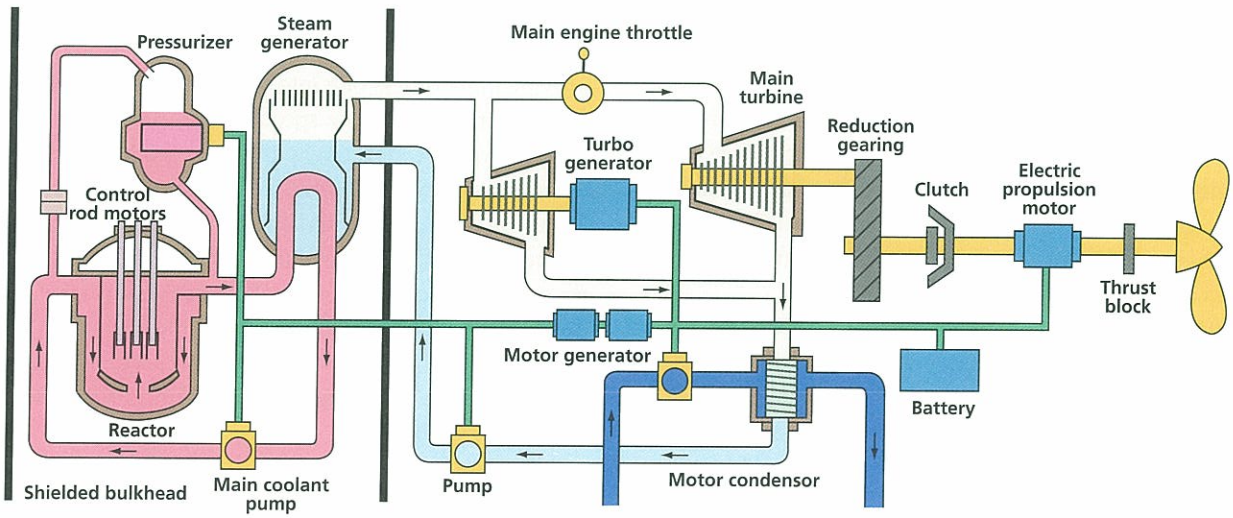
A *steam turbine* consists of a central rotating shaft to which are attached many alternating rows of movable blades similar to those of a fan, with stationary blades between them. The shaft and blading are enclosed within a thick airtight casing. As the steam passes through the turbine, it is directed through the stationary blades onto the rotating ones, causing the shaft to spin rapidly. As is the case with gas turbines, large reduction gears are necessary to make the transition from the high rotational speeds of the steam turbine to the much lower speeds of the propeller shafts. Unlike gas turbines, however, the rotational speed of a steam turbine can be varied to provide propeller shaft speed control; this is done by changing the amount of steam that is fed into the turbine by use of a throttle manned by engine room personnel. Rows of astern blading within the turbine allow its direction of rotation to be reversed when reverse thrust is needed for backing the ship.

Nuclear Power Plants

The main difference between a **nuclear power plant** and a conventional steam plant is how the steam to run the associated steam turbines is generated. Within a nuclear power plant, two separate primary and secondary systems are used to circulate water and steam. The primary water circulation system consists of the reactor, loops of piping, the primary coolant pumps, and a steam generator. These components are all located within the reactor compartment. Heat produced in the nuclear reactor by nuclear fission of highly enriched uranium is transferred to water that circulates within a loop of piping called the *primary coolant water loop*, which is pressurized to prevent the water from boiling. This hot water is then pumped by the primary coolant pumps through the steam generator, where steam to run the steam turbines is produced with the heat it contains, and then back through the reactor to be reheated for the next cycle. Some nuclear power plants use liquefied metal instead of water for the working fluid in this primary cycle.

Once generated, the steam flows within a separate secondary piping loop mostly outside the reactor compartment to the steam turbines, and then through condensers where it is condensed back into water. This condensate is then pumped back into the steam generator, where it is reheated to produce steam for the next cycle. In a conventional submarine or shipboard nuclear propulsion plant, the steam turbines drive propeller shafts via reduction gears in much the same way that this is done in a GTE or conventional steam plant. In some newer nuclear propulsion plants, the turbines drive generators that produce electricity that powers large electrical propulsion motors, eliminating the need for noisy reduction gearing.

Since there are high levels of radioactivity in a nuclear power plant's reactor during operation, no one is permitted to



A typical naval nuclear power plant showing the primary coolant water loop inside the reactor compartment (left part of drawing) and the secondary piping loop (right part of drawing). The primary coolant water flow is shaded in red, and the steam and condensate that flow mostly outside the reactor compartment are shaded in light green and blue, respectively. The green lines represent electricity flow from the turbo generator to the various plant components that utilize it.

enter the reactor compartment. Shielding around the reactor and reactor compartment, however, protects the crew so well that they receive less radiation than they would from natural sources when ashore. At one time it was necessary to replace the nuclear fuel used by U.S. nuclear submarines and aircraft carriers at least once about midway through their thirty- to fifty-year life cycle, a process that took two years or more, but more recent technology has resulted in smaller, more efficient reactors that do not require refueling for virtually the entire life cycle of the vessel.

Because the generation of nuclear power does not require oxygen, submarines with nuclear power plants can operate underwater for extended periods. Nuclear power in aircraft carriers allows for more tankage for the fuel required for their aircraft and more space to store their munitions. These features, plus no requirement for periodic replenishment of fuel oil for their own propulsion, permits these carriers to operate for extended periods without refueling or rearming. The U.S. Navy's nuclear-powered fleet inventory currently consists of ten nuclear-powered aircraft carriers, fourteen SSBN nuclear-powered ballistic missile submarines, four SSGN guided-missile submarines, and some fifty-five nuclear-powered attack submarines.

Diesel and Electric Power Plants

Diesel and **electric engines** are coming into ever wider use for ship propulsion, especially for merchant vessels, because of their economy and lack of need for massive reduction gearing between the engines and propeller shafts, or variable-pitch propellers. The rotating crankshaft can be directly coupled to the propeller shaft with slow-speed engines, via a gearbox or transmission for medium- and high-speed engines, or via an alternator and electric motor in diesel-electric vessels. The most notable Navy ships that use this means of propulsion are the *Avenger*-class mine countermeasures ships, which have four diesel engines and two electric engines. A number of smaller craft also use diesel engines, such as the yard patrol (YP) training craft of the U.S. Naval Academy. Some submarines in foreign navies also use diesel power.

As stated above, *Arleigh Burke*–class destroyers are currently being backfitted with supplemental HED electric engines to aid in fuel economy at slower speeds. Research and development is currently under way to produce an electric drive for future Navy submarines that would eliminate the need for both the steam turbine and reduction gearing.

Propeller Shafts and Propellers

However it is produced, in all types of conventional power plants except those incorporating water-jet propulsers (described below), **propeller shafts** extending aft from the reduction gears in the engine room and passing through watertight fittings on the after part of the ship's or submarine's hull convey the power to propellers behind or beneath the stern. The shafts can be several feet in diameter, and in surface ships, a hundred or more feet long. En route, the shafts go through long watertight spaces called *shaft alleys*.

Two of the huge fixed-blade propellers of the nuclear-powered aircraft carrier USS *George Washington* (CVN 73). *Glen Dennis*

The **propellers** (sometimes called **screws**) drive the ship and are very large. They are usually made of bronze and can weigh more than 30 tons with diameters in excess of 20 feet or more. Aircraft carriers have four fixed-blade propellers, and *Ticonderoga*-class cruisers and *Arleigh Burke*–class destroyers each have two **controllable-pitch propellers**. As described earlier, the blades of the latter can be swiveled on the hub to provide more or less bite into the water for control of the ship's forward motion at slow speeds, or to provide reverse thrust. When in reverse (negative) pitch, they can bring a *Ticonderoga*-class cruiser to a full stop from a speed in excess of thirty knots in sixty seconds, and an *Arleigh Burke*–class destroyer in twenty seconds, within distances of a few hundred yards or less. By contrast, the fixed screws of a large steam-driven ship must be slowed, stopped, and reversed while the astern steam turbine is engaged, a process that can take several minutes, during which time the ship might proceed for a mile or more before coming to a full stop.

Except for those fitted with water-jet-type propulsers, nuclear submarines have a single fixed-blade propeller aft of their hull on the centerline. These propellers have more blades than a surface ship propeller and the blades are much more slender in order to reduce the effects of **cavitation**, the tendency of a rotating propeller to form collapsing vapor bubbles around the blades. This causes noise that can give away a submarine's position, especially when operating in relatively shallow depths

where the effect is greatest. To further reduce the cavitation sound effects, the *Los Angles*–class attack submarines' propellers rotate within a metal ring called a *shroud* that can be swiveled to assist in steering control. Cavitation can also cause excessive wear on the edges of propeller blades and contribute to inefficiency at higher speeds.

Water-Jet and Pump-Jet Propulsers

A propulsion variation that is coming into increasing use for naval vessels such as fast patrol craft and the first of the Navy's new LCSs is **water-jet propulsion**. Water jets make possible much higher speeds and more maneuverability than traditional propeller-driven vessels of the same type can attain, with higher efficiency. In this type of system, the output power of the vessel's engines, usually either diesels or GTEs or both, drives powerful pumps within the water-jet casings that force water under high pressure out of nozzles in the back of the hull that can be swiveled to steer the vessel. They also have appendages called *reversing buckets* that can direct the water flow from the nozzles in a forward direction to stop or back the vessel. The Navy's new LCSs are each fitted with four water jets that can propel the ships at speeds in excess of forty-five knots at full power, and provide enough maneuverability that they can complete a turn within a diameter about equal to their length, making assistance unnecessary when docking.

Another version of water-jet propulsion is called a **pump-jet propulser**. These are currently installed on the Navy's latest *Seawolf*- and *Virginia*-class attack submarines and are planned for use on later versions of LCSs. Pump-jet propulsers consist of an elongated casing resembling a turbojet engine with a water inlet in front and an outlet nozzle in the back. There is a multibladed propeller that rotates in front of a set of fixed blades (the *stator*) in the rear of the propulser. The rotating propeller causes water to flow through the propulser. As the water flows through it, the configuration (shape) of the casing produces a pressurized water stream through the propeller and stator, and thence out the nozzle. The increased pressure at the rotating propeller blade tips within the propulser delays the onset of cavitation, thereby both increasing the efficiency of the propulser system and raising the speed at which the submarines can operate quietly. The pump-jet propulser can propel them to speeds in excess of thirty-five knots, and forthcoming LCSs at projected speeds greater than forty knots.

Because the propulser greatly reduces cavitation, submarines equipped with this propulsion system are much quieter even at higher speeds than those with traditional propellers. A disadvantage of submarine propulser systems, however, is that they have poor maneuvering and backing characteristics when the submarine is surfaced, making the assistance of tugboats almost a necessity when coming alongside a pier.

Shipbuilding

Almost all large ships constructed in shipyards throughout the world today are built on land in a type of structure called a **building dock**. These are normally constructed perpendicular to an adjacent body of water, so that ships built in them can easily be launched from the end nearest the water. A building dock can be constructed either above the ground and water level or beneath it. If beneath the ground and water level, such docks are also referred to as **dry docks** or **graving docks**. These are structures from which water can be pumped to leave a ship within them high and dry and resting on blocks beneath the keel for repair or maintenance, or on which a ship can be built and then floated out after flooding. The blocks stabilize the ship while in the dock and enable workers to work underneath it. Scaffolding is often placed alongside the sides of the ship to make construction or repairs easier, depending on what needs to be done.

Some shipyards and overseas naval bases also have **floating dry docks** that can be lowered down into the water so a ship or submarine can be floated in, then raised above water level to evacuate the water from around the vessel. These are almost always used exclusively for ship repair, though some have also been used for ship construction.

Smaller ships and submarines are typically built on blocks in **building ways**, open construction areas of the shipyard, rather than in building docks. After construction they are then either launched from these ways if close to the water, or transported by huge cranes or large, wheeled cradles to the water's edge for launching.

Some building docks and ways are covered so that vessels built in them, mostly submarines, cannot be seen from the air or from spy satellites in space during the building process.

The dock landing ship USS *Pearl Harbor* (LSD 52) sits on blocks in a floating dry dock at a shipyard in San Diego, California, prior to its return to sea. *Joshua Martin*

The nuclear attack submarine USS *Virginia* (SSN 774) shortly after final assembly on a building way at the General Dynamics Electric Boat shipyard. *Navy photo by General Dynamics*

Whether built in docks or building ways, ships or submarines are constructed step by step. The first operation is erecting the keel sections on the building blocks. After the keel is laid, frames are extended in both directions, from the center outboard and at the same time forward and aft. In most shipyards today, large sections of a ship or submarine are built in covered subassembly bays away from the main assembly site so that construction can proceed regardless of the weather. Much of the interior partitions, wiring, ventilation ducting, and piping is also installed within the sections at these sites. As whole sections are completed they are carried to the building site by large crawler tractors or mobile cranes, where they are welded

The stern section of the nuclear attack submarine USS *South Dakota* (SSN 790) being transported from a subassembly bay to the building site. *Chris Oxley*

Large portions of ships are often built in subassembly bays away from the site where the main part of the ship is being built. Here the 555-metric-ton superstructure island of the new aircraft carrier *Gerald Ford* (CVN 78) is being lifted into position above the flight deck by a gigantic crane, one of the largest in the world, during its construction at Newport News Shipbuilding yard. *Nathanael Miller*

together. This method of building, called **block construction**, enables the projects to move along much faster than they would if the vessel were just built frame by frame in the building or dry dock.

Once the complete hull is assembled and all hull fittings and perhaps some or all of the superstructure and bulkier equipment components are added, the ship or submarine is ready to be launched. The remainder of the construction and *fitting out* (outfitting) is then normally done alongside a fitting-out pier within the shipyard. The last step is painting the vessel's superstructure and exterior hull.

Launching

A new ship or submarine can be launched in one of several ways, depending on the facility in which it was built. Launching methods include end-on launching, float-off launching, side launching, and a new technique developed in recent years called roll launching.

End-on launching from building docks or ways is one of the oldest launching methods and is almost always done stern-first. When launching is done by this method, large cradles are attached to the hull fore and aft, then the vessel is lifted off the building blocks so that the entire weight rests on the cradles. At the proper time, the cradles with the vessel on them are made to slide along a pair of broad, flat metal tracks called *slipways* out the end of the building dock or building ways and down into the water. A disadvantage of this method is that it can place a large strain on the middle of the keel and hull when the stern is in the water but the fore part of the vessel is still supported by cradles sliding on the slipways. Warships are generally sturdily enough constructed, however, that this does not present a problem.

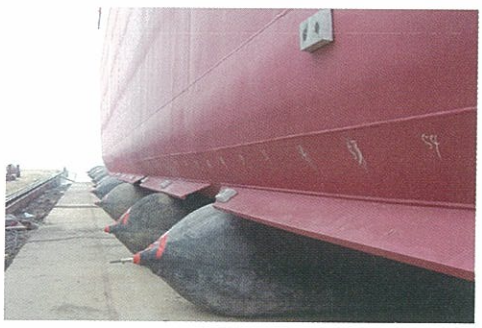
Float-off launching, as mentioned above, is used when a building dry dock can be flooded. The vessel is simply floated out and towed to the fitting-out dock. It is the method most widely used by most shipyards.

In **side launching**, once the completed vessel is transported from building ways to the water's edge, it is placed parallel to the water onto cradles atop an oiled inclined metal slideway. The cradles are released and the vessel slides by gravity sideways in the cradles, down the inclined slideway, and into the water, where it hits with a big splash and rights itself. Side launching is used primarily for small- to medium-sized ships when the waterway alongside the building ways is too narrow to permit end-on or float-off launching. It also more evenly distributes the strain along the hull during the launch process.

In **roll launching**, a vessel is either completed on perpendicular building ways near the water, or a completed vessel is brought by cranes to a sloping shoreline. If still on the ways the vessel is jacked up off the building blocks. Then in either

The guided-missile destroyer USS *John McCain* (DDG 56) is end-on launched after being christened at the Bath Iron Works shipyard. Note the scaffolding inside the building dock, the launch cradle underneath the bow, and the slipways on the floor of the dock.

The USS *Freedom* (LCS 1) is side launched from the shore near its building ways at a Lockheed Martin shipyard. *Lockheed Martin*



A large merchant ship positioned for roll launching on pneumatic air bags. *Blue Ocean Tackle Inc.*

case the vessel is lowered down onto sausage-shaped, inflated cylindrical reinforced rubber air-bag rollers placed every few yards beneath and perpendicular to the keel. When ready for launching, the vessel is rolled down atop the rollers either by gravity or by cables attached to the vessel until it fully enters the water, usually stern-first. At present roll launching is done mainly in Asian shipyards.

Launching Ceremonies

When a new Navy ship or submarine is to be launched, a **christening ceremony** at which the vessel is formally named and launched is customarily held. By naval tradition, the Secretary of the Navy selects a female **sponsor** for the vessel, usually someone with some connection with the namesake. At the time of launching, the sponsor, senior naval officers, officials of the shipbuilding company, and the commandant of the naval district in which the vessel is being built gather on a flag-decorated platform at the bow. Other dignitaries and guests are seated nearby. There may be some speeches, and a chaplain offers a prayer: "May this new vessel of our Navy be guarded by Thy gracious providence and care. May she bear the sword to bring peace on Earth among the nations. Let her be a terror to those who do evil and a defense to those who do well."

The band plays the national anthem, flags and pennants wave, and just before the vessel begins to move, the sponsor christens it by breaking on its bow a gaily wrapped bottle of champagne, wine, or water, and saying, "I name you —— in the name of the United States." She often adds, "May success always attend you."

In the days following the christening and launching, the ship or submarine is fitted out alongside a pier, where giant cranes hoist the heavy equipment into it. Masts, guns, machinery, and electronic components are installed, and spaces are painted and fitted with furniture and equipment. The fitting-out process may take more than a year.

The ship's sponsor breaks a bottle of champagne on the bow of the guided-missile destroyer USS *John Flynn* (DDG 113) at its christening ceremony. *Martin Carey*

Commissioning

On the day when the ship or submarine is ready for **commissioning** (formal placement on active government service), the vessel's officers and crew assemble in dress uniforms. Dignitaries and guests including the vessel's sponsor are always present, along with the CNO's representative or shipyard commander to act as the commissioning authority. As the band plays and all stand at attention, the commissioning authority formally transfers responsibility for the vessel to the prospective commanding officer and orders the vessel to be placed into commission. The national ensign and jack are hoisted, and the commission pennant is unfurled at the mainmast.

The CO then reads aloud his or her command orders from the Navy Department, and assumes command. The first order, usually delivered by the sponsor, is "Bring our ship to life and set the watch!" By tradition the officers and enlisted members of the ship's commissioning crew then jog on board and take their stations

After commissioning, **sea trials** (a series of short cruises to check out the operation of the ship or submarine and its equipment) take place. Weapons are fired and calibrated, and all gear is checked out and tested. One of the last sea trials is a **shakedown cruise** to verify seaworthiness, speed, endurance, and maneuverability under simulated operational conditions. This may be followed by a training cruise of several weeks' duration. Upon successful completion of this cruise, the ship or submarine is ready to join the fleet.

Ship Names and Designations

The name of a new Navy ship, submarine, or larger service craft is chosen by the Secretary of the Navy under direction of the President upon recommendation of the Chief of Naval Operations (CNO), in accordance with rules prescribed by Congress. The names are mostly chosen according to a set of traditional rules that have evolved over time for each type of vessel, though exceptions are sometimes made. Attack submarines, for example, were once named for fish, then later for cities, and most recently for states; and cruisers were once named for cities, then later for states, and then for battles. State names were once given to battleships, then later to nuclear-powered cruisers and ballistic missile submarines, and are now being given to attack submarines. An exception occurred in 2009, when Secretary of the Navy Donald Winter announced that SSN 785 would be named for former Navy Secretary and senator John Warner.

All naval vessels also have a standardized **designation**, a group of letters and hull numbers that more completely identify

Dignitaries, guests, and well-wishers look on at the commissioning ceremony for the *Nimitz*-class aircraft carrier USS *Ronald Reagan* (CVN 76) at Norfolk Naval Station in Virginia, as members of the commissioning crew run up the brow to bring the ship to life. *Rusty Black*

them. The letters indicate the vessel's type and general use, and the hull numbers indicate the sequential number of that vessel within the type. These designations are used in correspondence, records, and plans, and appear on the bows of many surface ships, the islands of carriers, LHAs and LHDs, and on their boats. All Navy ships can be readily identified as to their type, mission, armament, propulsion, and building sequence number by their designator.

All ship designations have at least two letters. The first letter in a designation signifies the type and is a general classification. The current primary type designator letters are as follows:

A	auxiliary
B	battleship
C	cruiser
CV	carrier
D	destroyer
F	frigate
J	joint service craft
L	amphibious, littoral
M	mine warfare
P	patrol
S	submarine
T	Military Sealift Command
Y	yard and service craft

The designation CV for aircraft carrier is an exception, used to differentiate aircraft carriers from cruisers. There is no established explanation of why the letter V was chosen, although it is generally believed that it was in reference to the French word *volplane*.

The second letter signifies the subtype, if any. There are many letters used to indicate subtypes, too numerous to list here. Several Navy warship types do not have a subtype classification and simply repeat the first letter:

BB	battleships
DD	destroyers
FF	frigates
SS	submarines

As examples, the first two letters of a destroyer's designation might be DD, while the letters AK might designate a cargo ship, with the A standing for auxiliary and the K for cargo.

Other additional letters further identify mission, armament, and propulsion of the vessel. In combatant designations, for example, the additional letter G signifies that the ship or submarine carries guided missiles, and the letter N signifies nuclear propulsion. An example might be an SSGN, a nuclear-powered guided-missile submarine.

Traditionally, the first vessel of a given type receives the hull number 1, and successive vessels of that type are numbered in the sequence in which they were built. When a number of ships or submarines of a given type are built to the same design, they make up a **class**, which is named for the first vessel built in it. Vessels retain their class names even if the original vessel for which the class is named is altered or retired. Again, just as with names, exceptions are sometimes made. The first of the Navy's new fleet of advanced technology surface combatants, the guided-missile destroyer USS *Zumwalt*, for example, was assigned the hull number 1000 in 2006, even though it was not the thousandth destroyer to have been built.

Two examples of combatant ship designations are the USS *Ronald Reagan* (CVN 76) and USS *Ohio* (SSGN 726). The *Ronald Reagan* is a nuclear-powered aircraft carrier, CV meaning aircraft carrier and N meaning nuclear powered, and the 76th large-deck aircraft carrier built. The *Ohio* is a nuclear-powered guided-missile submarine, SS meaning submarine, G, guided missile, and N, nuclear-powered, and the 726th submarine built. The *Ohio* also happens to be the first of four converted guided-missile submarines currently in commission, and was also the first of the current class of fourteen ballistic missile submarines before its conversion. Thus, the four guided-missile submarines are called the *Ohio*-class SSGNs while the remaining fourteen ballistic missile submarines are called the *Ohio*-class SSBNs.

As we learned in the Naval Knowledge section of this book, many auxiliary-type Navy ships have been assigned to the Military Sealift Command and are crewed by contract civilians. These ships are identified by the letter T preceding their designator; for example, the auxiliary MSC cargo RoRo ship USNS *Benavidez* (T-AKR 306), pictured on page 19.

Critical Thinking

1. How does the construction of a naval warship differ from that of a typical dry cargo merchant ship? Why the differences?
2. Research some of the features incorporated into new naval warships built during the 1990s and beyond that make them more resistant to damage than ships built earlier. What provided the impetus for these changes?
3. Make a table listing common features of a building such as foundations, walls, doors, and so on, then list in the table the corresponding nautical features in a boat or ship.

Study Guide Questions

1. List the major factors considered in the construction of naval ships.
2. Provide the nautical terms for these civilian terms:
   A. Outer walls
   B. Inner walls
   C. Floors
   D. Ceilings
   E. Hallways
   F. Stairs
   G. Entrance hall
3. What nautical terms are used for these directions?
   A. Toward the front of a vessel
   B. Toward the back of a vessel
   C. Crosswise
   D. To the right
   E. To the left
   F. Off to the side
   G. Behind
   H. Downstairs
   I. Up masts or rigging
4. What names are given to these structural features of a ship?
   A. Main body
   B. Front end
   C. Back end
   D. Widest part
   E. Backbone of the hull
   F. Athwartships girders
   G. Watertight skin
   H. Empty spaces between inner and outer bottoms
   I. Top of the hull
   J. Intersection of the top of the hull with the sides
   K. Water level along the exterior hull
   L. Vertical distance from the keel to the waterline
5. A. What name is given to all structures above the main deck?
   B. What is the semienclosed compartment from which maneuvers are directed when underway?
   C. What is normally the highest structure above the main deck?
   D. Where is the national ensign flown from when the ship is underway?
6. A. How are decks above the main deck numbered?
   B. Below the main deck?
7. What structural components of a ship form spaces and compartments within it?
8. What nautical names are given to these spaces within a ship?
   A. Officers' dining room/lounge
   B. Officers' bedrooms
   C. Enlisted dining area
   D. Enlisted living quarters
   E. Kitchens
   F. Bathrooms
9. What is the collective term applied to officers' living quarters on board a Navy ship?
10. How are spaces within a Navy ship identified?
11. A. What term is given to the division of a ship's hull into a series of watertight compartments?
    B. What is the exceptionally strong watertight bulkhead at the after end of the forepeak called?
12. A. What is the main difference between a door and a hatch on a ship?
    B. What is a scuttle?
13. What is the name given to a watertight fitting through which piping or cables penetrate a watertight bulkhead?
14. What are the three main types of propulsion used by today's Navy ships?
15. What are the three component parts of a gas turbine engine (GTE)?
16. Briefly describe how a gas turbine engine works.
17. What device do gas turbine and steam engines use to transmit power between their high-speed turbines and the propeller shafts?
18. A. What advantages does a gas turbine engine have over a traditional steam propulsion plant?

B. What disadvantages does it have?

19. A. What are the main components of a conventional steam propulsion plant?
    B. What is the biggest difference between a steam and nuclear power plant?
20. How does propeller shaft speed control differ between a gas turbine engine and a steam engine?
21. What does the primary circulating water cycle in a nuclear power plant consist of?
22. A. What is the advantage of nuclear power for submarines?
    B. For aircraft carriers?
23. Which class of Navy ships uses diesel-electric engines as their means of propulsion?
24. What part of a conventional propulsion system actually drives a ship through the water?
25. How does a controllable-pitch propeller work?
26. A. What is cavitation?
    B. Why is it a problem especially for submarines?
27. A. What Navy vessels use water jets and pump jets for propulsion?
    B. How do water jets and pump jets differ from a conventional propulsion plant?
28. In what kind of shipyard facility are almost all large ships built?
29. In what four ways can a ship be launched?
30. A. Who selects the sponsor for a ship?
    B. What does the sponsor do to christen the ship?
31. What is the first order given after the new commanding officer assumes command of a newly commissioned ship?
32. A. Who chooses the name of a new Navy ship?
    B. How are the names chosen?
33. A. What comprises a ship's designation?
    B. What do the letters G and N in a ship's designator indicate?
    C. What does the letter T before a ship's designator mean?
34. What determines how a new class of naval ships is named?

New Vocabulary

protection (ship feature)
stability (ship feature)
endurance (ship feature)
seaworthiness
maneuverability
habitability (ship feature)
landlubber
overhead (ship feature)
Jacob's ladder
athwartships
abaft
fantail
quarter (ship)
pitch
keel
frames (ship feature)
voids (ship feature)
trimming (ship)
gunwale
waterline
freeboard
foremast
mizzenmast
pig-stick (mast)
jackstaff
half deck
poop deck
levels (superstructure)
bulwark (ship feature)
space (ship compartment)
wardroom
officers country
berthing compartment
head (ship compartment)
compartment number
list (lean)
collision bulkhead
scuttle
stuffing tube
compressor (engine)
turbine (engine)
rpm
HED system
superheater
nuclear reactor
cavitation
shaft alley
building dock
block construction
end-on launching
side launching
slipways
sea trials
designation (ship)
bulkhead
accommodation ladder
fore, aft
beam (ship)
forecastle
port, starboard
roll
yaw
stem and stern posts
bilges
peak tank
armor
bilge keel
draft (ship)
superstructure
mainmast
truck (mast)
gaff (mast)
stack
platform deck
well deck
weather decks
scupper
compartment
stateroom
mess deck
galley (ship feature)
hold (ship feature)
watertight integrity
trim
hatch
dogs (latches)
GTE
combustion chamber (engine)
reduction gears
propeller (screw)
boiler
water cycle
shielding (reactor)
water-jet/pump-jet propulser
dry dock (graving dock)
building ways
fitting out
float-off launching
roll launching
slideway
shakedown cruise
hull number

2

Damage Control and Firefighting

A ship's ability to do its job, and even to survive in an emergency situation, may one day depend on the crew's damage control abilities. **Damage control** (DC) is the measures taken to prevent or minimize damage caused by battle, fire, collision, grounding, explosion, flooding, or any other emergency condition, including defensive measures used to reduce the effects of weapons of mass destruction such as chemical, biological, and radiological (CBR) warfare. The duties and responsibilities of the ship's damage control organization are outlined in the ship's *Battle Bill* and covered in detail in the *Naval Ship's Technical Manual* (*NSTM*), *Repair Party Manual*, and in various other shipboard damage control manuals and ship's instructions. They include the proper setting of various material readiness conditions in port and at sea, and maintenance of damage control equipment and closures.

Preventive damage control on Navy ships is an all-hands responsibility. Drills and personal qualification training are part of the regular routine on all Navy ships, submarines, and shore stations to teach everyone damage control situational awareness and how to use DC equipment and perform many DC tasks. An important part of handling any emergency is to keep calm, remain alert, and work rapidly with the tools at hand. Unless the damage is very bad, there is much that DC teams can do to keep a surface ship afloat and a submarine watertight and ready for action.

This chapter describes the damage control organization, equipment, and features, and the various DC procedures used on Navy surface ships. As with other aspects of naval knowledge and skills discussed elsewhere in this book, much of this applies to submarines as well, although there are some major differences owing to the nature of submarines and qualifications of their crews.

Material Readiness Conditions

The success of damage control depends partly on maintaining watertight integrity. As was discussed in the last chapter, ships and submarines are divided into watertight compartments to control flooding, protect and strengthen the structure, and maintain buoyancy and stability. Watertight integrity may be reduced or severely compromised by enemy action, storms, collisions, or negligence.

Navy ships have three basic **material conditions of readiness**, each representing a different degree of "tightness" and protection: X-RAY (X), YOKE (Y), and ZEBRA (Z). The names are based on an older version of the phonetic alphabet that was replaced by the modern version in the mid-1950s. The material condition set is predicated on (based on) which overall *readiness condition* has been set for the ship, as described in chapter 25 in the Naval Knowledge section of this book.

As set forth below, all watertight and airtight fittings in the ship are marked with capital letters corresponding to the material readiness condition that governs when they are required to be secured. Certain fittings and closures (access openings in overheads, decks, and bulkheads) that may be opened for accessibility for a short time during each material readiness condition are identified by the use of a circle surrounding the appropriate letter. Circle X-RAY (Ⓧ) and circle YOKE (Ⓨ) fittings may be opened without special permission, but circle ZEBRA (Ⓩ) fittings may be opened only with the permission of the CO, given through the damage control assistant (DCA). When opened, circle ZEBRA fittings must be guarded so that they can be immediately closed after the requested access is completed.

Condition X-RAY offers the least protection and the greatest ease of access throughout the ship. It is set when the threat to the ship is minimal, such as when at anchor in a well-protected harbor or moored at home port during regular working hours and there is no threat of attack or bad weather. During this condition, only closures (doors, hatches, valves, deck access plates, and so on) marked with a black X or circle X (Ⓧ) are secured.

Condition YOKE provides more protection than X-RAY. YOKE is set and maintained whenever the ship is at sea. In port, it is maintained at all times during war, and outside of regular working hours during peacetime. When material condition YOKE is set, all closures marked with a black Y or circle Y (Ⓨ) plus all X-RAY fittings are secured.

Condition ZEBRA provides the highest level of watertight integrity possible without securing ventilation. It is the maximum state of readiness for the ship's survivability system. It is set immediately whenever general quarters stations are manned, when entering or leaving port during wartime, and in any emergency situation when it is deemed necessary to localize damage and control fire or flooding when not at GQ. When material condition ZEBRA is set, all closures marked with a red Z, circle Z (Ⓩ), or DOG-ZEBRA (🅉) are secured, in addition to all X-RAY and YOKE fittings. DOG-ZEBRA closures prevent interior lighting from showing to the outside; they are secured whenever condition ZEBRA is set or when "darken ship" is set for night steaming.

Fittings marked with a black W (WILLIAM) are vital seawater suctions for operating equipment, air supply valves for critical systems such as the ship's emergency diesel generators and weapons cooling systems, and other valves that must be open to maintain mobility and fire protection. They are never closed except as a last resort to control contamination or contain damage. Those marked with a circle WILLIAM (Ⓦ) are habitability ventilation features that draw air from outside the ship. They may be secured to limit air circulation into a space during a CBR attack.

The setting of material conditions on board ships is normally carried out by the division or department responsible for each compartment. In an emergency, the repair party

COMP'T NO. 2-108-I-L **NAME** Crews Berthing (LSD Wing Wall)

ITEM	FITTING	NUMBER	LOCATION AND PURPOSE	CLASSIFICATION	DIVISION RESPONSIBLE
	ACCESS				
1	WT DOOR	2-108-1	Access to: 2-96-1-L	Z	REPIII
2	WT DOOR	2-129-3	Access to: 2-120-1-L	X	REPIII
3	WT HATCH	2-108-1	Access to: 3-108-1-L	X	S
	MISCELLANEOUS CLOSURES				
4	ATC	2-108-1	In WITH 2-108-1 used to test: 3-108-1-L 3-103-3-A 3-115-1-A	X	E
5	ATC	2-108-1	In WTD 2-108-1 used to test: 2-95-1-L	X	E
	DRAINAGE				
6	DECK SOCKET (remote)	2-112-1	Bilge eductor overboard discharge valve 5-112-1	X	M
7	STC	2-118-1	Sound Ball 6-108-1-W	X	R
8	GAGGED SCUPPER	2-109-1	Plumbing drain from 1-110-1-L	Z	REPIII
	FIRE MAIN & SPRINKLING SYSTEM AND WASH DOWN				
9	FMCOV	2-109-1	Cut out to FP 1-109-1	W	REPIII
10	FMCOV	2-110-1	Cut out to Group IV magazine sprinkler	W	REPIII
	FUEL OIL				
11	STC	2-116-1	Sound F.O. & Ball. 6-108-3-F	X	B
	REMOTE OPERATION				
12	Remote start/stop switch	2-119-1	For exhaust blower 2-108-1	X	REPIII
	MISCELLANEOUS UNCLASSIFIED				
13	Loud speaker		General announcing 1 MC		
14	C.P. Riser Terminal	2-114-1	Casualty Power Outlet		
15	15 lb. CO_2	2-119-1	Portable fire extinguisher		
16	One OBA		In box at Fr. 110 stbd.		

A typical naval ship compartment checkoff list.

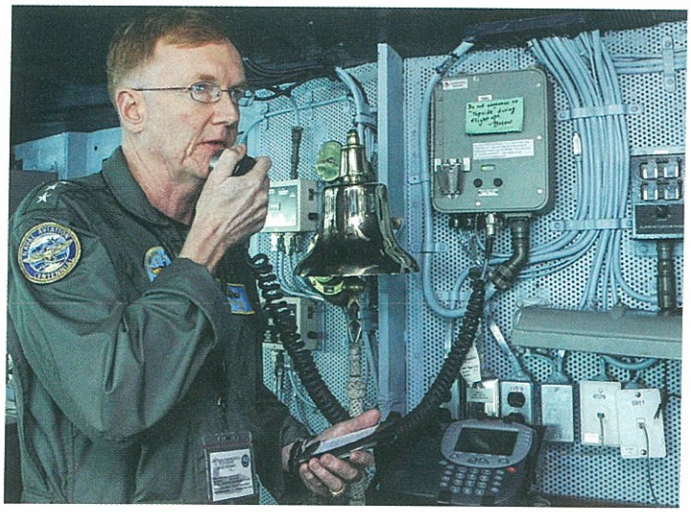
personnel responding to the casualty and any crewmembers in the area set the highest material condition necessary to restrict the spread of damage. To help ensure that all required deck and access fittings are secured, each compartment has prominently posted near its entrances a **compartment checkoff list** containing the name, location and purpose, material readiness condition classification, and division responsible for every marked fitting located in that compartment.

Once a material condition is set, no fitting marked with that or lower material condition symbols may be opened without permission from the CO, given through the DCA or OOD, with the exception of those marked with a circle, as noted above. It is the responsibility of all hands to maintain whatever material readiness condition has been set for the ship.

Emergency Communications Systems

Good communications among different parts of the damage control organization during shipboard emergencies are vital. There are three main communication systems used for this purpose: the general announcing system, sound-powered telephones, and messengers.

The *general announcing system*, or **1MC** as it is known on board ship, is not a primary means of transmitting damage control information, but it is a quick way of getting orders, information, and alarms spread throughout the ship. For DC purposes it is used to announce the setting of the various readiness conditions; to call away the rapid response or in-port emergency teams; to call away general quarters for a damage control emergency, in addition to the general alarm described below; and may be used to announce the location of any bomb or shell hit, fire, or collision. An emergency alarm system that is integrated with the 1MC overrides any input from microphone stations while the alarms are sounded.



An admiral addresses the crew over the 1MC public address system on a Navy ship. *Taylor Jackson*

The **emergency alarms** consist of various distinctive sound tones and patterns that can be activated from the bridge or quarterdeck and sounded over the 1MC to quickly inform all hands of an impending emergency. In order of precedence, the emergency alarms include the *collision alarm*, a repeated series of three high-pitched tone pulses with a short pause in between; the *chemical attack alarm*, a steady tone with the same pitch as the collision alarm; the *general alarm*, a series of gong tones; and the *flight crash alarm*, a continuous stepped or sinusoidal variable-pitched tone similar to a European emergency vehicle siren. Before and/or after any of these alarms sounds, a verbal announcement is usually made as to whether or not the alarm is to be or was sounded as part of a drill, or if not, the location and extent of any damage such as fire, flooding, or other damage that may have occurred.

The collision alarm is sounded when a collision with a pier or some other fixed object, another vessel, or running aground is imminent. The chemical attack alarm is sounded in the event of a CBR attack on or near the ship. The general alarm is sounded to call the crew to general quarters for battle or to deal with a serious emergency such as a large fire; it is generally followed by the verbal summons, "General quarters, general quarters, all hands man your battle stations!" especially if an attack is imminent. The flight crash alarm is sounded on ships having an aviation component to alert the crew to an impending or actual flight deck emergency such as a crash or fire. As a common practice, GQ battle stations are manned for all of the emergency alarms.

There are several Internet sites where audible recordings of the various Navy ship emergency alarms can be accessed. They can readily be found by doing a search with those key words.

The ship's battle circuits, including emergency damage control circuits, primarily use ***sound-powered telephones***. They are a principal means of communication throughout Navy ships, and the main one used by the DC battle organization. Each sound-powered phone set has a transducer in the microphone that converts sound pressure from a user's voice into minute electrical signals, which are then converted back to sound by transducers in the earpieces at the receiving end. Their advantage over other systems is that they require no external source of power other than the talker's voice. Each of the ship's **repair parties** (DC parties within the ship's DC battle organization) has its own sound-powered phone circuit connecting it to other repair party stations and the ship's damage control central (DCC), or on newer ships the central control station (CCS), the main damage control and coordination centers within the DC battle organization.

When other standard methods of communication fail, *messengers* must be used to relay orders and information.

Sailors standing bridge watch communicating via sound-powered phones. The phone circuit is always live, and the user simply pushes a button on the handset microphone to talk. Sound-powered phones are a mainstay of communications on board Navy ships. They are also used in the civilian world for such applications as powerless communications between stations on ski lifts and emergency communications in elevators. *J. C. Stokes*

Messengers must learn how to get around the ship to all the control and repair party stations and other areas. Messengers will often be given written messages for delivery, but they must also be able to deliver oral messages accurately.

The Damage Control Organization

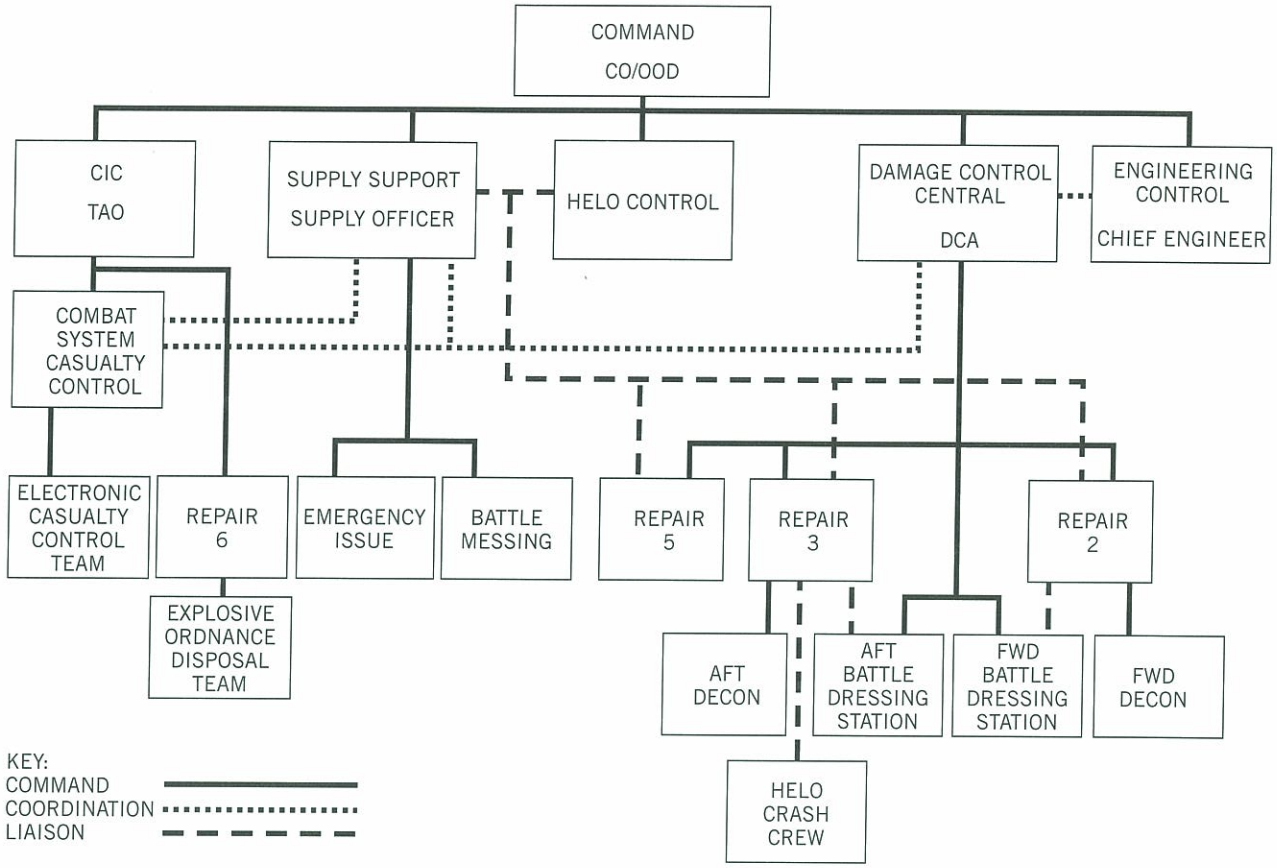
Like the general shipboard organization, the DC organization consists of an administrative organization and a battle organization. The administrative organization begins with the ship's CO and extends through the XO and engineering officer (chief engineer), who is designated the damage control officer, to the ship's **damage control assistant** (DCA), and from him or her to the ship's gas free engineer (the DCA or a senior petty officer), fire marshal, the DCC or CCS senior enlisted supervisor, and damage control division crew. The *gas free engineer* advises when it is safe to enter closed or poorly ventilated spaces, and the *fire marshal* (a designated senior petty officer) helps the DCA train personnel to prevent and fight fires, and makes daily fire prevention and fire safety equipment inspections throughout the ship. Each shipboard department also has damage control administrative and maintenance responsibilities, including routine maintenance of all damage control equipment located within the department. Each department has assigned *damage control petty officers* (DCPOs) in each division who carry out these responsibilities as collateral duties. They are trained by the DCA and report any discrepancies to him or her.

When a ship has been damaged, the ship's damage control battle organization is responsible for restoring the ship to as near normal operation as possible. The battle organization varies somewhat from one ship to another, depending on the ship's size, type, and mission; however, the same basic principles apply to all Navy shipboard DC battle organizations. The DC battle organization begins with the ship's CO, who may delegate some DC command and control functions to the general quarters OOD under battle conditions, and extends to the engineering central control station and the engineering officer, DCC/CCS and the DCA, the weapons department and weapons or combat systems officer, the CIC/SMC/CDC and TAO, air department and air officer on ships with aviation capability, and the supply department and supply officer.

Although the engineering officer is designated the ship's damage control officer, under battle conditions the DCA is responsible under him or her for all the ship's survivability systems, with coordination by the engineering officer. The DCA's specific responsibilities include control of damage; control of stability, list, and trim; restoration from damage; medical casualty response; and CBR countermeasures. The DCA is also responsible for fighting all shipboard fires except those in weapons and electronic combat systems and on the flight deck, hangar bay, and island of aviation ships, which are the responsibility of the TAO, weapons, operations, and air departments, respectively. The supply department under the supply officer is responsible for emergency repair parts issue and battle messing.

The battle station for the DCA is DCC or the CCS located at a centralized protected location within the ship. DCC and CCS are the control centers for the direction of the entire damage control organization of the ship. Under the direction of the DCA, their primary function is to collect, record, and evaluate damage reports from the various repair parties shown in the DC battle organization chart, and to direct, coordinate, and monitor the progress of any necessary DC actions. The CCS has the added capability of being able to control the closing of fire zone (FZ) doors and certain valves electronically, and can remotely activate installed firefighting systems.

As damage reports are received from the various repair parties, the DCA and his or her assistants make notations of the damage on various schematic damage control diagrams and status boards, and the DCA directs any necessary damage control actions to be done. For example, if reports of flooding come in, the location of the flooding is marked on the appropriate schematic diagram of the ship's compartmentation using standardized damage control symbology, and status boards showing the liquid distribution (fuel and water) before the damage occurred are updated. With this information, any negative effects on the stability and buoyancy of the ship can be determined, and the DCA can order any necessary corrective measures to keep the ship afloat on an even keel.



Typical damage control battle organization chart for a small to medium-sized Navy ship with helo detachment. Repair 2 is the forward repair party, and Repair 3 is the after repair party. Repair 5 is propulsion repair, and Repair 6 is ordnance. Larger ships have in addition a Repair 1 party (main deck repair), Repair 4 (amidships repair), Repair 7 (hangar bay and island structure), and Repair 8 (electronic casualty control).

Repair Parties

The primary DC battle organization units on a ship are the repair parties assigned to various sections of the ship and to other locations and functions such as propulsion repair, ordnance repair, and electronics repair. All general repair parties such as Repair 1, 2, and 3 come under the DCA. Other more specialized repair parties and casualty response teams such as ordnance disposal and aircraft crash and salvage come under the various departments of which they are a part. All naval vessels have at least one repair party. Most small ships have two or three, and larger ships have more. During GQ, all damage control stations, repair parties, and specialized casualty response teams are manned by designated crewmembers from all the various divisions of the ship.

All repair parties must be capable of:

- Evaluating and reporting correctly on the extent of damage in their areas
- Identifying, controlling, and extinguishing all kinds of fires
- Making repairs to communications circuits
- Giving first aid and transporting the injured to battle dressing stations
- Detecting, identifying, and measuring intensities of nuclear radiation; identifying chemical agents; sampling biological agents; and carrying out decontamination procedures

In addition to these requirements, general repair parties such as Repair 2 and 3 must also be capable of maintaining ship stability by repairing damage to structures, closures, or fittings that maintain watertight integrity; shoring, plugging, welding, and caulking bulkheads and decks as necessary to control flooding; controlling and removing floodwater (called *dewatering*); making emergency repairs to piping systems; rigging emergency power; and repairing primary and auxiliary methods of steering. The specialized departmental repair parties must in addition to the general requirements also be capable of performing the special duties assigned to them, such as propulsion, ordnance, and electronics repairs.

Sailors man damage control central on the aircraft carrier USS *Ronald Reagan* (CVN 76) under direction of the ship's DCA (center) during a general quarters drill. Note the protective gear worn by all and the schematic diagrams of the ship's decks on the bulkhead to the right.

A damage controlman plots on-scene damage reports on a diagram in a ship's DCC. *Diana Quinlan*

Each repair party has a designated **repair locker** within its area of responsibility that contains a wide variety of general damage control equipment such as axes, wrenches, hammers, and portable pumps, plus other types of specialized equipment pertinent to its responsibilities. Several *firefighting ensembles*, *proximity suits*, and self-contained breathing apparatuses (SCBAs) described below are stowed there, along with protective masks and suits and other gear used by topside investigators in CBR warfare. Wooden timbers that can be used for shoring (emergency bracing) and emergency power cables are stored at various locations throughout the ship.

Each repair party has an assigned **battle dressing station** to treat the injured. Battle dressing stations are first aid stations equipped to handle casualties and are manned by medical department personnel during GQ. There may be only one or two on smaller ships, and more on larger ones. Stretcher cases are brought directly to a station by repair party stretcher-bearers to remove them from further harm. Emergency supplies of medical equipment are also contained in first aid boxes placed at various locations throughout the ship.

Repair Party Personnel

Repair parties consist of teams of enlisted crewmembers trained to deal with any damage or casualties that might occur within their areas of responsibility. The ship's *Watch, Quarter, and Station Bill* assigns crewmembers from divisions throughout the ship to the various repair parties. The number and qualifications of personnel assigned to each repair party are determined by the location of its station, the size of the area to be covered, the skills required, and the total number

An investigator makes a report from the Repair 2 locker to damage control central via a sound-powered phone talker during a general quarters drill on board the dock landing ship USS *Tortuga* (LSD 46). *Gregory Harden*

of people available. On a submarine, virtually the entire crew constitutes a repair party in emergencies.

Each repair party will have an officer or senior petty officer in charge, a scene leader to supervise all on-scene activities, a sound-powered phone talker, and messengers. Other personnel are assigned to various teams within each repair party. For a general repair party such as Repair 2 or 3, these include investigation teams; hose teams; dewatering, plugging, and patching teams; shoring; piping repair; structural repair; casualty power; and interior communications repair. There are also designated CBR investigators and decontamination teams, who dress out in special protective suits.

Other specialized repair parties such as Repair 5 will have engineering personnel capable of making repairs to main propulsion and vital auxiliary equipment; Repair 6, ordnance repair personnel from the weapons department; and Repair 8, electronics repair personnel from the operations department. Specially trained air department personnel will constitute the aviation crash and salvage team, and other weapons department personnel, the ordnance disposal team.

In addition to repair parties and casualty response teams, each ship also has a designated *rapid response team* that proceeds directly to the scene under routine conditions both in port and under way when a fire or flooding is called away on the 1MC. The team consists of a half dozen or so designated repair party members supervised by the ship's fire marshal if at sea, or the duty-section fire marshal in port. If these first responders cannot handle the emergency within a set amount of time, GQ is normally called away, and full repair parties take over. In port, repair party functions are handled by an *in-port emergency team* (IET) made up of qualified DC personnel and the duty fire marshal. Should the IET require backup, the remaining crew on board is mustered to render assistance.

A repair party hose team dressed out in firefighting ensemble gear practices firefighting procedures during a damage control exercise. *Siobhana McEwen*

Flooding

Any rupture, break, or hole in the ship's outer hull plating below the waterline can let in seawater and cause flooding. Such damage can be sustained by collision; grounding; or the explosion of a mine, torpedo, plunging shell, bomb, or missile. Pressurized water or other liquid piping systems can be ruptured, possibly resulting in flooding of vital compartments. If such flooding is not controlled, the ship may be partially or totally incapacitated, or in extreme cases, may sink.

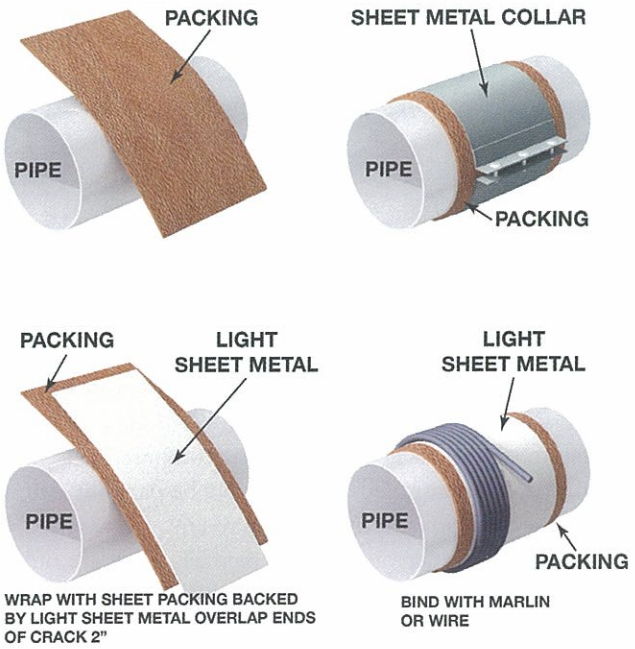
When the underwater hull is pierced, there are only two ways to control the resulting flooding. The first is to plug the hole(s); the second is to establish and maintain flood boundaries using the watertight compartmentation in the ship so the flooding will not spread. Small holes can be plugged by driving conical wooden plugs and wedges stored in damage control lockers into them. Medium-sized holes may be sealed by

clamping or welding a steel box patch over the inside of the hole, then securing it in place with shoring. Larger holes require the placement of some sort of large filler material such as mattresses backed by wooden slabs or metal plating, called a *strongback*, over the inside of the hole and then bracing the strongback with a telescoping steel rod or wooden shoring. Wooden timbers to be used for this purpose are typically stored near most repair lockers, and saws to cut them are a part of shoring kits located in the lockers, as are the telescoping steel shoring rods.

Leaks from ruptured pipes carrying water or other liquids at pressures less than 150 psi may be initially repaired by placing and tightening broad metal clamps lined by rubber sheet packing called *jubilee patches* over the holes, or by *soft patches* consisting of rubber sheeting backed by light sheet metal wrapped with marlin or wire, preferably after temporarily isolating the leaking pipe sections with built-in cutoff valves. Later, the affected sections may be wrapped with fast-setting woven fiberglass patching material to effect more permanent repairs. If the damaged pipe carries more than 150 psi, such patches will not hold. The only option is to isolate the damaged section until it can be replaced or bypassed.

Once the flow of incoming water has been stopped by the DC methods discussed above, it is necessary to remove any accumulated water resulting from flooding or firefighting so that the ship's stability will not be adversely affected. Such efforts are called **dewatering**. There are several methods by which this is accomplished. In a worst-case scenario, dewatering may be done manually by use of a bucket brigade manned by crewmembers, but the preferred method is to use natural drainage, or if this is not possible, any one of several pumping methods. In some cases, especially in engineering spaces, installed pumps can be used to remove any floodwater that may have accumulated in their bilges. Repair lockers are equipped with jet-type pumps having no moving parts called *eductors*, actuated solely by pressurized water from the fire main. An eductor removes floodwater by suction after being lowered into it. Some repair lockers are also equipped with electric submersible pumps that may be used if an electrical supply is available. Otherwise, portable gasoline engine–driven pumps may be used. Besides not requiring a power supply to operate, another advantage of eductors over these other types of pumps is that they are not as susceptible to being fouled by suspended material in the floodwater.

Two damage controlmen applying a fiberglass patch to a pipe section during a damage control exercise.

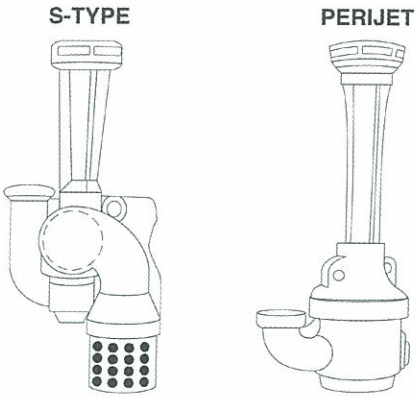


Jubilee patches (above) and soft patches (below) may be used to make temporary repairs to stop leaks from ruptured pipes.

Fire and Firefighting

Fire is a constant threat on a ship or submarine. All appropriate measures must be continually taken to prevent fires. Fires may start from *spontaneous combustion* (ignition caused by natural heat generated by rapid oxidation) or carelessness, or, like flooding, may result from collision, grounding, or hits by explosive enemy munitions. Any fire of significant size must be controlled quickly because it may otherwise cause extensive damage or loss of the vessel and much loss of life. There is nowhere to run from a fire on a vessel at sea.

In order for a fire to occur, three physical prerequisites must be met: there must be a burnable fuel; it must be heated enough to burn; and there must be enough oxygen to keep it



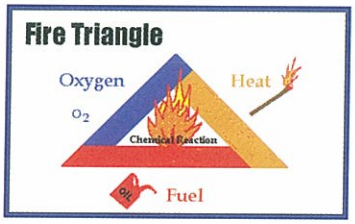
Two kinds of eductors carried on board Navy ships. To use them, fire hoses are connected to the inlets shown on the left, and larger discharge hoses to the tops, then the eductors are lowered into the floodwater and the fire hoses are activated. The water streaming through the eductors from the fire hoses creates a vacuum that sucks the floodwater in through the lower part of the eductors, then a mix of both it and the fire hose water is expelled into the discharge hoses.

burning. These three requirements form the **fire triangle**, whose sides consist of *fuel*, *heat*, and *oxygen*. Sometimes a forth requirement, an *uninhibited chain reaction*, is also added to form a four-sided geometric shape called the **fire tetrahedron**. Removing any side of the fire triangle or tetrahedron will result in extinguishing the fire (putting it out). Firefighters must determine the best way to put a fire out—in other words, which side of the triangle or tetrahedron to remove. This is not always an easy choice.

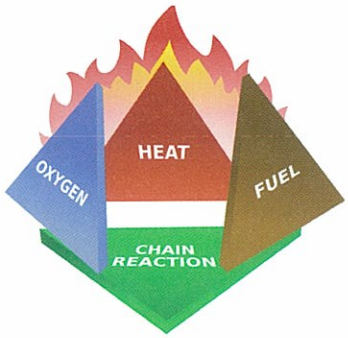
Removing the fuel is often not possible. It could be done, however, in instances such as when liquid fuel was being supplied to the fire by a pipeline. Closing the shutoff valves would cut the flow of the fuel, and the fire could then be brought under control. Sometimes combustible materials can be removed or soaked with water—another way of eliminating fuel.

Oxygen can be removed in two ways. In a closed space, carbon dioxide (CO_2) can be pumped in from an installed firefighting system to displace the oxygen and starve the fire. Another method is to smother the fire with CO_2 or dry powder fire extinguishers, or a blanket of foam or sand.

Removing the heat, or cooling the fire, is the most common method used to extinguish a fire, usually by the use of lots of water, both solid stream and fog (spray), to cool the burning surface rapidly.



The fire triangle.



A fire tetrahedron. Removing any side will extinguish a fire.

Removing the fourth side of the fire tetrahedron, the uninhibited chain reaction, is accomplished by the use of several types of dry firefighting chemicals that prohibit flames from forming on adjacent material involved in a fire that has been raised to its flash point or beyond.

Classes of Fires

There are four classes of fires, depending on the type of fuel or material burning and the methods required to extinguish them.

Class A (Alpha) fires involve solid combustible materials such as wood, cloth, or paper. They often leave ashes. Explosives are also in this category. Water is the usual means of putting out class A fires. CO_2 or dry powder extinguishers may be used on small fires, but not on explosives. The flames of a large fire are usually cooled down with water fog; then a solid stream of water is used to break up the material for further soaking and cooling.

Class B (Bravo) fires involve flammable liquids such as oil, gasoline, other fuels, cleaning agents, oil-based paints, and flammable gases. The preferred extinguishing agents are aqueous film-forming foam (AFFF—a mixture of water and certain chemicals), Halon or a substitute, or potassium bicarbonate (PKP); these are described in more detail below. Halon or Halon-substitute and PKP portable extinguishers are often located in proximity to stations where flammable liquids are present, and many Navy ships have firefighting systems installed in engineering spaces that dispense these agents automatically when activated either onsite or remotely. If foam or gaseous or powder extinguishing agents are not available, then water fog may be used. Solid stream water should not be used on class B fires because it will only scatter the fuel and spread the flames.

Class C (Charlie) fires are those burning in electrical or electronic equipment such as radios, radars, generators, electric control panels, wires, and cables. The usual firefighting procedure is to first secure the power supply to the fire site, and then extinguish the fire by use of CO_2, Halon gas or a substitute, or PKP extinguishers. Although water or other liquid extinguishing agents may be used once the power to the site has been secured, a gaseous or dry powder extinguisher is preferred because electricity can travel along wet decks and present an electrocution hazard. Water or other liquids will also damage valuable electrical and electronic equipment far more than will the use of other types of agents.

Class D (Delta) fires involve combustible materials such as magnesium, titanium, sodium, and in some cases aluminum. These elements, particularly aluminum, are used as structural material in some ships, especially older ones, and in aircraft, missiles, some weapons, and computers and other electronic gear. They are also used in many types of flares and munitions. A magnesium aircraft parachute flare, for instance, can burn at a temperature greater than 4,000° Fahrenheit, with a brilliancy of two trillion candlepower. Dry powder extinguishing agents containing sodium chloride granules or copper powder are preferred for this type of fire. Fire extinguishers containing this material are often installed in spaces that have contents that might be involved in a class D fire. Water fog can also be used, but it can excite these fires, cause explosions, and make them worse. Firefighters dealing with class D fires should wear welders' goggles with dark lenses to protect their eyes from the often-intense glare of this type of fire, and if using water, should be at a safe distance, preferably behind a shield.

AFFF, sometimes called *light water*, is a type of foam formed from a mixture of water and certain chemicals. It rapidly extinguishes hydrocarbon (class B) fuel fires. It has the additional property of forming an aqueous film on the fuel surface that prevents evaporation and hence reignition of the fuel once it has been extinguished by the foam. **Halon** is a liquefied, compressed gas that stops the spread of fire by chemically disrupting combustion. Halon 1211 (a liquid streaming agent) and Halon 1301 (a gaseous flooding agent) leave no residue and are safe for human exposure. In the 1990s Halon was determined to have harmful depletion effects on the Earth's ozone layer, so its manufacture was discontinued by international treaty. Nevertheless its use has continued on many Navy ships and aircraft until satisfactory substitutes can be found and produced, most likely in the form of inert gaseous compounds called *hydrofluorocarbons* (HFCs). **PKP**, or "Purple K," is a firefighting agent composed primarily of potassium bicarbonate powder. It is colored with a violet dye to distinguish it from other dry agents, hence the name. It floats on the surface of most liquids, thereby isolating them from the oxygen in air, is nonabrasive, and is compatible with most AFFF firefighting systems.

An AFFF test on the flight deck of the aircraft carrier USS *Nimitz* (CVN 68). AFFF is a type of foam used to fight hydrocarbon fuel fires.
Andrew Jandik

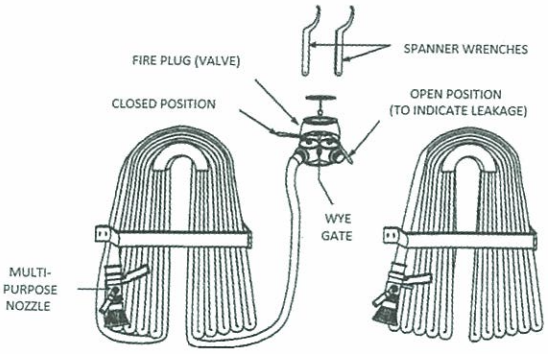
Firefighting Equipment

The ship's **fire main** (large seawater piping) system is designed to deliver seawater to fireplugs and sprinkler systems just like a city's fire main piping delivers fresh water under pressure to fire hydrants. It is supplied with seawater drawn from submerged fittings beneath the ship's hull and pumped at high pressure through the fire main system by one or more large fire pumps in the engineering spaces. The fire main extends throughout the interior of a ship, and branches are fitted with small fireplugs for DC purposes. Each fireplug has two fifty-foot lengths of fire hose fitted with all-purpose bronze nozzles on racks near it, with the combination called a *fire station*. Generally the hoses are one-and-a-half-inch diameter, but ships larger than destroyers have some that are two-and-a-half-inch diameter. Spanner wrenches are also provided in brackets at the stations to assist in making hose connections. Additional lengths of hose are rolled and stowed in repair lockers.

Sprinkler systems that squirt water fog are installed in magazines, ammunition-handling rooms, spaces where flammable materials are stored, and hangar bays on board ships that operate aircraft. Some systems are automatically triggered when the temperature in the protected compartment reaches a certain temperature, but most are operated manually by control valves.

Protective Fire Clothing and Breathing Apparatus

Any clothing such as Navy uniforms that cover the skin will offer some protection from flash burns and other short-duration



A typical fire station on board a Navy ship. One hose is left unconnected with the fireplug wye-gate water valve on that side left open so that any leakage can be easily spotted and repaired.

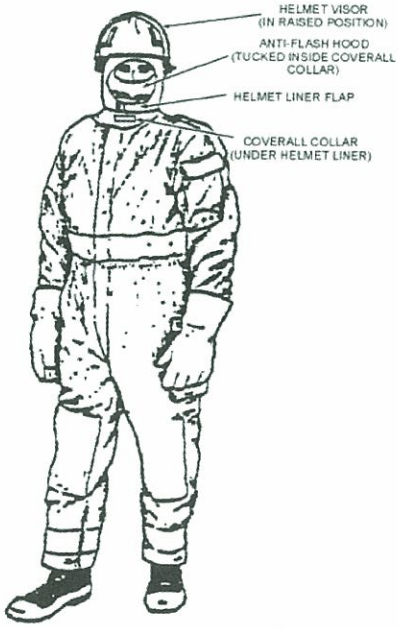
A flight deck crewman equipped with an SCBA breathing device practices handling an all-purpose nozzle on a fire hose during a firefighting drill in the hangar bay of the amphibious assault ship USS *Boxer* (LHD 4). *Brian Biller*

flames. For additional protection, all personnel serving on board Navy surface combatants are issued flame-retardant flash hoods and long gloves that are worn whenever warranted. When GQ is called away, crewmembers not wearing fatigues or coveralls adjust their uniforms to *battle dress mode*, with pant legs tucked into boots or socks, long shirt sleeves pulled down and buttoned, the top shirt button buttoned, and the flash hood and gloves on. All exposed skin is covered, and eyes are protected with antiflash goggles if available. In addition to their hoods, gloves, and goggles, when GQ or the at sea emergency response team or the in-port emergency team is called away, firefighting personnel are issued a **firefighting ensemble** consisting of a helmet, coveralls, boots, and rubber gloves, plus a breathing apparatus called a SCBA.

The **SCBA** (self-contained breathing apparatus) is worn by firefighting personnel and anyone else who must enter a confined space with a questionable oxygen supply, or one that contains smoke or other harmful vapors. The unit's main components consist of a harness, high-pressure rechargeable air cylinder, pressure regulator, full-face mask, and high- and low-pressure hoses. The air cylinders are filled with compressed air and then stored until needed.

All Navy personnel are trained in the use of the SCBA in boot camp and in fleet training schools, as well as on board ship during repair party training sessions.

The **proximity firefighting suit** (close-in suit) consists of aluminized coveralls, gloves, hood, and boots. The hood provides a protective cover for the SCBA breathing apparatus that is normally worn with it. It is lightweight and resists penetration of liquids. The suit allows crewmembers to enter overheated or steam-filled compartments and to make aviation crash fire rescues. The wearer is not expected to enter burning spaces or walk through flames, only to get close enough to rescue victims or assist in putting out the fire.



The parts of a firefighting ensemble.

Most fire casualties result from smoke and toxic fumes breathed in by those initially caught in the vicinity of the fire, and not from the fire itself. For this reason the **emergency escape breathing device** (EEBD) was developed for emergency escape from the site of a fire. It consists of an air canister that provides the wearer with about thirty minutes of breathable air and is worn until the individual can get topside when evacuating from below-deck spaces. With proper training, a crewmember should be able to activate and put on an EEBD in less than thirty seconds.

Fighting a Fire

A fire may gain considerable headway before smoke is detected, especially if it originated in an unattended space. The first sign may be smoke coming out of a ventilation outlet or seeping around a door or hatch cover. The smoke may have traveled some distance, so the first job of a responding rapid response, in-port emergency, or repair party firefighting

Two crewmembers on board the guided-missile cruiser USS *Vella Gulf* (CG 62) outfitted in proximity firefighting suits carry a simulated casualty to safety during a flight deck fire drill. *Jason Zalasky*

A Navy fireman uses an emergency escape breathing device (EEBD) as he climbs up an emergency escape trunk during a main engineering space fire drill. *Jeffrey Truett*

team is to locate the fire. This is done by team members called *investigators*, normally the first people to be sent out to respond to damage or fire.

As they proceed, the investigators check bulkheads, decks, and vents for heat to see if the fire is in an adjoining compartment. Doors and hatches are checked for heat and pressure behind them before their door dogs are fully opened. Often they will have with them an infrared thermal imaging device (heat detector) that can detect hot spots at a distance. They may have to follow a trail of smoke. Once the fire is located, they check adjoining compartments to be sure it has not spread to them, then they report its location and extent to their scene leader (person in charge) and begin isolating the fire.

An investigator uses an infrared thermal imaging device to detect hot spots during a shipboard fire drill. *Byron Linder*

As soon as the extent of the fire is determined, a full report is made to DCC or CCS. An upgraded material readiness condition, usually ZEBRA, is set around the entire area.

While the firefighting is under way, the firefighting team sets up ***fire boundaries*** to isolate the fire and keep it from spreading. Fire boundaries are set in several ways. Combustible materials in adjoining spaces are moved or soaked to prevent spread of fire by heat transmission. Since fire can blister and ignite paint on bulkheads in adjoining compartments, fog or sprinklers are used to cool the bulkheads, decks, and overheads in them. Ventilation systems in the area are secured to cut off the oxygen supply to the fire and to limit the spread of smoke and gases to other compartments. *Fire watches* (fire sentries) are posted in surrounding compartments.

In conjunction with isolating the fire, electrical circuits in the affected area are deenergized to protect against shock.

After the fire has been extinguished, the area must be *overhauled* (cleared) to prevent reflash of the fire. All smoldering or charred materials are saturated thoroughly and removed if possible. The compartments are checked for explosive vapors or liquids that might remain. Dewatering of any water accumulated during firefighting is then begun. At this time a full report is made to DCC or CCS on fire and smoke damage and any flooding that may have occurred. The final step in fighting the fire is to set a *reflash watch* (fire sentry) to be sure the fire does not start again from a smoldering fragment or through vapor ignition. Gases, especially from fuels, can be ignited by heat or sparks if allowed to concentrate in or near an area that has not been properly overhauled.

Fire Prevention

Any fire is certain to cause some damage. The most firefighters can do is to minimize the damage and keep the fire from spreading. A main objective, therefore, is to prevent fires from starting. The rules for preventing fires are generally the same everywhere, but special precautions must be taken on board naval vessels because of the concentration of flammable fuels and explosives.

The first rule is to keep things squared away—clean, in good order, and in their proper places. Flammable materials must be kept away from potential fire starters such as torches, cigarettes, and sparking equipment.

Firefighting equipment must be well maintained. If a fire starts, the appropriate gear must be immediately available and operating properly to prevent the fire from spreading.

One of the more common causes of class A fires is lighted cigarettes or matches thrown into trash cans. Smoking in bunks is strictly forbidden by regulations, but the regulations have been broken—with serious consequences. Through spontaneous combustion, piled-up oily rags and paper also commonly cause such fires.

Class B fires are very difficult to predict, especially if fumes leak in voids and tanks on board ship. Anything that causes a spark or open flame, such as welding torches, light switches, and even flashlights, can be sufficient to cause an explosion and fire with gasoline fumes. Grease fires in galleys are not uncommon if hot oil or grease spills onto burners. The "smoking lamp" (permission to smoke tobacco on deck or in authorized spaces) is out whenever fuels or explosives are handled on board a ship.

Paint and oils should be kept away from electrical wires. Frayed or worn wires and insulation must be repaired or replaced immediately. Dust and dirt should not be allowed to accumulate around electrical equipment. Unauthorized electrical appliances and overloaded circuits, extension cords, and plugs are an open invitation to overheating and subsequent class C fires.

If a person's clothing catches on fire, the person should not run; this will fan the flames. He or she should lie down and roll up in a blanket, coat, or anything that will smother the flames. If nothing like this is available, the person should roll over slowly, beating out the flames with his or her hands. If another person's clothing catches fire, he or she should be taken down and covered up (except the head) with a blanket or coat.

Critical Thinking

1. Explain why quick and effective response to damage such as fire or flooding is even more critical on board a ship than in the case of buildings ashore.
2. Summarize the qualities that make the various common types of extinguishing agents effective for the types of fires that they are used to combat.

Study Guide Questions

1. What does damage control include?
2. A. What are the three basic material conditions of readiness on board Navy ships?
   B. What is the extent of protection for the ship in each?
   C. Who normally sets the material readiness conditions on board ships?
3. What markings are used to identify fittings and closures that may be temporarily opened for accessibility during each readiness condition?
4. What is posted within compartments to help ensure the securing of all required deck and access fittings for each material readiness condition?
5. What are the three main communications systems used by the damage control organization during shipboard emergencies?
6. A. What are the four emergency alarms that can be sounded over a ship's 1MC system?
   B. When is each one sounded?
7. A. What is the main means of emergency communication used by the DC battle organization?
   B. What is the particular advantage of this system?
   C. When other standard methods of communication fail, what method is used to relay messages?
8. What are the damage control coordination centers on Navy ships called?
9. What is the administrative damage control organization on a ship?
10. A. What are the duties of the ship's gas free engineer?
    B. What are the duties of the ship's fire marshal?
11. A. What is the damage control battle organization?
    B. What are the responsibilities of the DCA under it?
12. A. What are the primary DC battle organization units of a ship?
    B. What must all repair parties be capable of doing?
13. A. What are battle dressing stations?
    B. Who brings stretcher cases to a battle dressing station?
14. A. What personnel are assigned to repair parties?
    B. What teams are they assigned to?
15. What is the rapid response team?
16. A. What are the two ways to control flooding resulting from a ship's underwater hull being pierced?
    B. How can leaks from holes in piping be patched?
17. A. What is dewatering?
    B. What equipment might be used to accomplish it?
18. A. What is the fire triangle?
    B. What is a fourth requirement sometimes added to form a fire tetrahedron?
    C. How can a fire be put out?
    D. What is the method most commonly used?
19. List the four classes of fires, fuels for each, and the best method of extinguishing each of them.
20. Why should water or other liquids not be used to put out fires in electrical or electronic equipment before it is completely deenergized?
21. A. What is AFFF?
    B. What is Halon, and why was its manufacture discontinued in the 1990s?
    C. What is Purple K?
22. What equipment is found at shipboard fire stations?
23. Where are shipboard sprinkler systems installed?
24. A. What protective gear is issued to shipboard personnel to protect against flash burns and other short-duration flames?
    B. What does a firefighting ensemble consist of?
25. A. What breathing apparatus is used by firefighting personnel on Navy ships?
    B. What emergency device helps personnel escape from shipboard fires?
26. How are fire boundaries set to limit the spread of a fire on a ship?
27. What is the first rule in shipboard fire prevention?
28. What should a person do if his or her clothes catch on fire?

New Vocabulary

damage control
compartment checkoff list
1MC
sound-powered telephones
CCS
DCPO
fire marshal
repair locker
dewatering
IET
eductor
fire triangle
CO_2
PKP
fire main
sprinkler system
firefighting ensemble
SCBA
thermal imaging device
investigators
fire watch
smoking lamp
material readiness conditions
closures
emergency alarm system
DCC
DCA
gas free engineer
repair parties
battle dressing station
rapid response team
jubilee patch
spontaneous combustion
fire tetrahedron
AFFF
Halon
fire station
battle dress
proximity suit
EEBD
scene leader
fire boundaries
reflash watch

Unit 2

Deck Seamanship

The first requirement of everyone who sails in the ships of the U.S. Navy is seamanship. Seamanship has three main components: the art and skill of handling a vessel, skill in the use of deck equipment, and *marlinspike seamanship*—the care and use of various kinds of line. On board ship, the people most concerned with seamanship every day are those in the deck department. Sailors who work in the ship's office, radio shack, engine room, or on the flight deck may not be called upon for much seamanship in their normal everyday duties. This does not mean, however, that seamanship is unimportant for them.

Seamanship is the skill that ties every member of the Navy together. Whether an admiral or a Sailor, a Navy person wears a uniform that says he or she is familiar with the art of seamanship. Regardless of what job specialty a Sailor selects, that Sailor first becomes a seaman, then a technician. The pride with which a person performs seamanship duties will carry over into the specialty ratings.

Many times, especially in smaller ships, everyone must help the deck force. Enlisted persons may have to carry stores on board, assist in replenishment, or help in mooring or unmooring the ship. Officers are expected to be able to supervise all such activities. In emergencies or general quarters, all hands may have to take part in all manner of seamanship evolutions ranging from anchoring and mooring and crewing boats to handling cargo during underway replenishment. All departments must keep their spaces (compartments) clean and painted, exercise good safety procedures, and do preventive maintenance of their equipment.

Skills used in the conduct of shipboard evolutions such as cargo handling, underway replenishment, and mooring that require the use of lines, anchoring gear, and other such equipment are collectively referred to as **deck seamanship**. Most of these deck seamanship evolutions are carried out by personnel of the deck department on board large ships, and by the deck division on smaller ships.

The **first lieutenant**, as we learned earlier in the Naval Knowledge section, is in charge of the deck department or division. The title goes back to the early days of British naval sailing ships when the captain was served by a number of lieutenants, each in charge of a division. The first lieutenant was the most senior and knowledgeable in the business of working and maneuvering a man-of-war under sail and was therefore the specialist in seamanship. This title has survived to this day. The first lieutenant, assisted by the ship's boatswain, is in charge of all deck seamanship evolutions as well as the care and maintenance of most of the ship's exterior.

Deck Personnel

The personnel under the first lieutenant who carry out most seamanship duties are members of one or more deck divisions, depending upon the size and type of the ship. Submarines do not have a deck division; destroyers and cruisers usually have one; and aircraft carriers, large auxiliaries, and amphibious ships have three that constitute a separate deck department. The first division on such ships has charge of the forward part of the ship; the second, the ship's boats and boat decks; and the third, the after part of the ship.

On ships having aviation facilities, nonaviation personnel, especially those in the deck department, are traditionally referred to as "blackshoes" while aviation personnel are collectively called "brownshoes." These nicknames refer to the shoe color of surface line officers, who wear black shoes, as opposed to naval aviators, who by custom wear brown shoes with their khaki uniforms.

Enlisted petty officers who serve in the deck department and deck divisions are called *boatswain's mates*. The senior boatswain's mate on a ship is referred to as the *ship's boatswain*. On large ships, he or she may be a warrant officer.

All Sailors in the general deck community reporting on board ship from boot camp (recruit training) are usually assigned to a deck division. These new personnel do the physical work that must be done by the deck force in any ship, including upkeep of ship's compartments, messing and berthing areas, decks, and external surfaces. They stand deck watches such as helmsman, lookout, and messenger under way and in port; and other special watches such as boat crew, sentry duty, and anchor watches. During general quarters they are members of gun crews and damage control parties. If the newly reported Sailor is a seaman apprentice of pay grade E-2, he or she must first satisfy the requirements for seaman before advancing to E-3. To qualify for this rate the E-2 must prove competence at marlinspike, deck, and boat seamanship.

3

Marlinspike Seamanship

A *marlinspike* is a tapered steel tool used for separating strands of rope. It is the basic tool of the seaman and the symbolic "tool of the trade."

Marlinspike seamanship involves the use and care of fiber line and wire rope used at sea. It includes every kind of knotting and splicing (weaving two lines together), as well as all fancywork done with rope, line, twine, and cord. It takes knowledge and skill to become proficient in marlinspike seamanship. A good seaman has a real appreciation for a sound piece of line or a good square knot or splice. One look at the way a person handles a line tells experienced people whether or not that person is a seaman. It is not a difficult art, but to learn it well takes time, patience, and practice. Knowledge of marlinspike seamanship is the real test for deck Sailors and is an important qualification for advancement.

The rest of this chapter deals with the types, care, makeup, and use of rope and line. Many NJROTC cadets will want to try their hand at tying knots, and some may even wish to do some fancy or ornamental work. It can be fun as well as useful.

A chief boatswain's mate instructs junior deck division personnel in marlinspike seamanship in the boatswain's locker on board the guided-missile destroyer USS *McCampbell* (DDG 85). *Declan Barnes*

Rope and Line

In civilian parlance, **rope** is a general term that can be applied to both fiber and wire. In the Navy, though, fiber rope is called rope only as long as it is still in its original coil. Once the rope has been uncoiled and cut for use it is called **line**. Rope made from wire is called wire rope, or just **wire**.

Line is made from either natural fibers of various plants (manila, sisal, hemp, cotton, and flax) or synthetic fibers such as nylon, polyester, and Kevlar. Of the natural fibers, *manila* is the one most often used for line. It is made from the fibers of the abaca, or wild banana plant, grown chiefly in the Philippines (hence the name manila). It is the strongest and most expensive of the natural line fibers. Natural fiber line will stretch very little, even under heavy strain. It will, however, lose about 30 percent of its strength over a two-year period even with normal careful use.

Up until the 1970s, almost all line used on Navy ships was made from manila. Over the course of the next thirty years, however, line made from nylon and later other synthetics replaced manila line for most applications on board ship. Although more expensive than manila, nylon is lighter and nearly three times as strong. It is less bulky, requires less stowage space, and is more flexible, making it easier to handle. Unlike manila, it does not rot over time when wet and resists marine fungus growth. For all these reasons, even though its initial cost was greater than manila, nylon became the line material of choice in the U.S. Navy for much of the last part of the twentieth century, and it is still used for many routine applications on Navy ships.

Nylon line, however, has one significant disadvantage that ultimately led the Navy to seek other alternatives—it tends to stretch by up to as much as 55 percent before breaking when under a heavy load, such as when used for mooring lines or anchor cables. This stretching tendency is not a bad thing when nylon line is used for anchor cabling because it helps to absorb stresses and strains when an anchored vessel is pushed around by heavy seas. When the stretching occurs when in use as a mooring line, however, the effect can be extremely hazardous

A Sailor handles a nylon mooring line on a destroyer. *Daniel Barker*

if the line parts under high tension. The parted line will recoil back like a rubber band at nearly the speed of sound, injuring, perhaps even killing, anyone in its path. During the years from 1970 to 1982 when the use of nylon line became widespread, the Navy recorded more than three hundred injuries, including nine fatalities, resulting from parted nylon mooring lines. Because of nylon's tendency to stretch greatly under load, for many years the Navy continued to mandate that all personnel highline transfers be done using manila line.

This hazard spurred the Navy to develop alternative synthetic fibers to nylon for use in line for marine applications. Today, polyester and Kevlar line has replaced nylon and manila for almost all shipboard applications in the Navy.

Polyester line was the first lower-stretch alternative to nylon line. It has about 90 percent of the strength of nylon line but much less stretch—a maximum of 30 percent at the breaking point—less wet-strength loss, and a higher amount of friction than nylon, which makes it better for use with winches and as mooring lines. It is generally more expensive than nylon line, but not as expensive as Kevlar. Polyester line, particularly double braids, has become the standard against which all other kinds of line are measured. In the early 2000s polyester line replaced manila line as the mandated line for use in personnel highline transfers in the U.S. Navy.

Kevlar fiber line is made from a group of synthetic materials called aramids, and is used on some ships as an alternative to nylon or polyester line or wire rope in applications requiring high strength such as mooring lines. Better known for its use in sheet form in body armor, Kevlar line is five times stronger than manila and stretches much less than polyester line under load, to a maximum of only about 6 percent at the breaking point. It is, however, very expensive, has poor flex capabilities and resistance to fatigue, and can be weakened by certain kinds of knots.

Even though polyester and Kevlar mooring lines will not stretch nearly as much as nylon line under heavy strain, they still present a significant recoil hazard to anyone directly behind or near them if they part, so safety precautions similar to those for nylon line in similar circumstances still have to be observed. These include never standing directly in line with or near any line being pulled or under tension, with line handlers always being positioned at a right angle to the direction of the tensioned line. Also because of a lower coefficient of friction of synthetic as opposed to manila line, extreme care should be taken whenever a synthetic line under tension is being paid or eased out from around securing devices such as bitts, cleats, or drums on capstans and gypsy heads (winches), as the line can unexpectedly slip and rapidly pay out.

Deck division personnel take in a polyester mooring line as their ship gets under way.

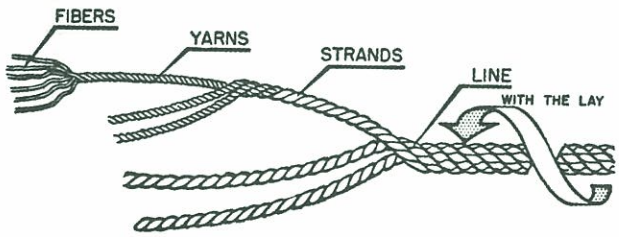
A seaman makes repairs to a Kevlar mooring line. Note that each strand is braided (woven), and three strands are twisted together to form the line. *Casey Kyhl*

Although wire rope has not been in general use for mooring lines for many years, some ships still use it for situations that require extra strength, such as when storms or high winds are expected. The main use of wire rope in the Navy today is for span wires during underway replenishment operations. Because such rope tends to form spurs or burrs on the surface over time, people handling it should always wear heavy leather work gloves. Handlers should take care not to rub against it, because the sharp burrs can easily pierce light clothing and inflict severe cuts.

Line Construction

Regardless of the material from which it is made, almost all general-purpose fiber line is formed in basically the same way. The natural or synthetic fibers are twisted together in one direction to form *yarns* or *threads*. These yarns or threads are then either twisted together in the opposite direction or braided (woven) to form *strands*. Traditional three-strand twisted line, called *plain-laid line*, is formed from three of these strands, either braided or unbraided.

Most large line currently used in the U.S. Navy is three-strand synthetic plain-laid line with a right-hand twist, or lay, called *right-laid* line, with each of the strands braided. All Navy line larger than one and three-quarters inches in circumference is required to be right-laid in order to avoid confusion on board ship. Such line must always be coiled down right-handed, or clockwise, to avoid kinks or unraveling.



The construction of plain- right-laid three-strand twisted line. Successive twists of the fiber, yarns, and strands are always opposed.

Nylon, polyester, and Kevlar lines also come in *single-*, *solid-*, and *double-braided* forms—as opposed to three-strand twisted plain-laid form—for use as dock and mooring lines, sailboat running rigging, and other specialized applications requiring high strength and flexibility and small line size. Braided line will not kink or unlay (unravel) as plain-laid line will tend to do when it is free to rotate, and is stronger than plain-laid line of comparable size. Single-braided line consists of a single strand of either eight or twelve yarns braided into a circular twill pattern with half of the yarns going clockwise and the other half counterclockwise around a void in the center. In solid-braided line all the yarns forming the strand travel in the same direction and alternate between forming the outside of the line and the interior, with no central void. Both of these are rarely more than one inch in diameter. Double-braided line is constructed with a braided core within a braided cover, with each carrying an equal percentage of the total load applied to the line. It ranges in circumference up to sixteen inches or sometimes even more.

Modern-day synthetic line used for high-strength applications in the Navy, such as mooring lines for ships and towing hawsers, usually is either three-strand solid braided Kevlar line, or three-stranded solid-braid or double-braided nylon or polyester line. Some larger ships like carriers use large-circumference double-braided or four-strand Kevlar line for mooring. The latter has three right-laid mixed Kevlar and polyester strands surrounding a Kevlar core strand. Any such line with an equivalent strength and circumference rating equal to or greater than five-inch nylon line that is generally used for towing or mooring is called a **hawser**.

In addition to the kinds of line described above, a wide variety of other synthetic materials and braiding techniques are in use, each with its own advantages for many specialized applications. In the not-too-distant future it is probable that synthetic fiber line will replace wire as the material of choice for underway replenishment transfers in the Navy, and for many other high-strength applications that now require the use of wire rope.

Line Measurements

Length of line is normally measured in fathoms, feet, or meters (one fathom equals six feet), but the *size* of a line is either its circumference or diameter, measured in inches or sometimes millimeters. By convention, the size of any line larger than one and three-quarters inches in circumference is stated in terms of inches of its *circumference*, while the size of line less than one and three-quarters inches in circumference, called **small stuff**, is stated in terms of its *diameter* in inches or millimeters or by its thread count. The size of wire rope is always its diameter, measured in inches or millimeters across the widest part.

Twenty-four thread, with a diameter of about nine-sixteenths inch, is the largest small stuff. Other sizes of small stuff are twenty-one thread (one-half inch), fifteen-thread (seven-sixteenths inch), twelve thread (three-eighths inch), nine-thread (five-sixteenths inch), and six-thread (one-fourth inch). Any small stuff less than six-thread is called by name rather than by the number of threads.

Marline is the most common small stuff referred to by name. It is made of two-stranded, left-laid, tarred hemp and is not much larger than ordinary household wrapping cord. It is most often used for *serving*, or covering a larger line for protection from abrasion. *Seizing stuff* is similar to marline, though stronger because it is three-stranded and right-laid, and is also

mostly used for serving. *Small white line* is made from cotton or flax and is used in braided form for lead lines (line with a weight on the end used for depth measurements), lightweight halyards (line used to hoist something), and the like. It is like household "clothes line."

Handling Fiber Line

When preparing to use any line larger than small stuff, it is usually a good idea to lay it out on deck in one of several established ways. Doing so will help both in handling the line and in avoiding kinks in plain-laid line as it is run out. It also contributes to the shipshape and seamanlike appearance of the ship or boat.

Coiling down a line means to lay it in overlapping circles on the deck, roughly one coil or circle on top of the other, with a space in the center. Right-laid line is always coiled down in a clockwise direction, and left-laid line in a counterclockwise direction. Coiling down in the wrong direction results in annoying and possibly dangerous kinks and twists. When a line is coiled down, the end on top is ready for running. Coiling is the fastest way of making up line or wire, and the most common.

Faking down a line is to lay it out in long, flat, straight rows on the deck, one alongside the other, with overlapping loops called *bights* at each end. The main advantage of working with line that is properly faked down is that it runs off with little chance of fouling or kinking. Mooring lines are commonly made ready by faking them down before coming in to a pier.

A third method used for laying down short lengths of line is *flemishing*. To flemish down a line is to lay it down in a flat helical coil on the deck, somewhat like a wound clock spring, with the *bitter end* (end of the line) in the center. The line is laid down loosely and wound tight to form a "mat" by placing the hands flat on the line and twisting in the direction the line is laid.

Sailors fake down a large mooring line on the fantail of the aircraft carrier *Dwight D. Eisenhower* (CVN 69). *Theodore Quintana*

Most rope and line on board ship is stowed in the *boatswain's locker*. This is a storage compartment, usually in the forward part of the ship, that holds all the line, wire, and tools used by the deck force.

Coils of line are stored on shelves or platforms clear of the deck so they will stay dry. They should not be covered, but should be open to the air, because fiber line is apt to mildew and lose strength if damp for long periods, and wire rope will rust. Small stuff is stored on a shelf in order of size, with the starting end of the line out for easy reach.

The bitter end of a line should always be *whipped* to prevent it from unlaying, or fraying. A good seaman cannot stand to see a good piece of line frazzled out. To prevent such fraying, temporary plain whipping can be put on with a piece of small stuff. The whipping line is laid down along the line and bound down with a couple of turns. Then the other end of the whipping should be laid on the opposite way and bound a couple of turns from the bight of the whipping and pulled tight.

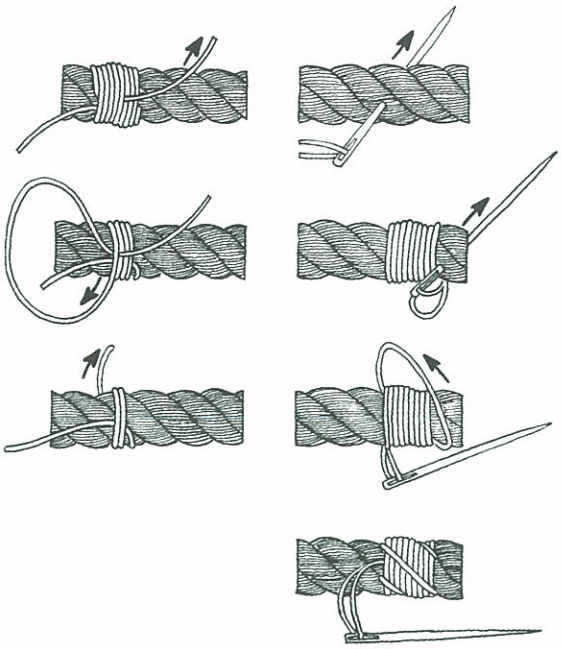
A permanent whipping is put on with a palm and needle. A *palm* is a tough piece of leather that fits into the palm of the seaman's hand and serves somewhat the same purpose as a thimble. This is rarely done to line or rope smaller than one and three-quarters inches, but normally is always done with larger lines.

The bitter end of a nylon line and some other synthetics can be secured by taping the end of each strand and then taping all the strands together, then fusing the end of the line with a hot iron or torch. The heat will melt and fuse the line together.

A good rule to remember with any line is that all loose ends must be cut or tucked in order for the ship or other vessel to maintain a smart, shipshape appearance. Attention to such detail is important; the ship that takes care of such details usually performs well.

Wet fiber lines and wire should be dried thoroughly before stowing. If this cannot be done, the line should be faked out on

Flemishing down a line. The bitter end is in the center.



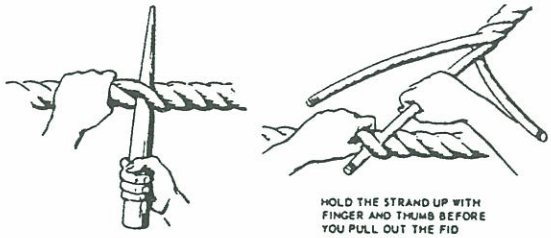
Whipping lines. The bitter end of a line should always be whipped (wrapped) to prevent it from unraveling. Whipping is done with a palm and needle.

gratings under cover so it can dry as quickly as possible. Many fiber lines shrink when wet and stretch again when dried out. For this reason, wet fiber lines in use that have this tendency should be slackened when the weather becomes damp or lines become wet with rain.

A line with a kink (irregular curl, bend, or twist) should never be placed under strain. A heavy strain on a kinked or twisted line will cause permanent distortion or damage, seriously weakening the line. When a kink has been forced into each strand, it is impossible to work it out, especially in the interior of braided line.

Many kinds of fiber line will weaken with use and exposure. Nylon line will gradually change its color from yellowish white to gray. It is necessary to inspect the inner part of such line to determine its real condition, though. In the case of plain-laid line, the strands are unlaid either by hand or with a *fid*, a pointed, round, tapered wooden or metal tool designed for splicing fiber lines. If weakened, the yarns will show bristles and a decrease in diameter. The interior of braided lines cannot be inspected, but if they are flattened in places or seriously abraded due to wear, or more than two strands visible on the surface are broken, lines in such weakened condition should not be used—certainly never for supporting people aloft or over the side.

Natural fiber line under heavy strain will make cracking noises as the strands work against the strain. When such noises



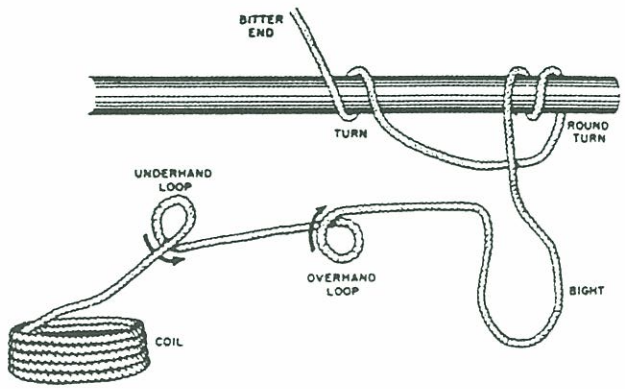
Using a fid to separate and splice lines.

increase in intensity, this is a warning sign that the line may part (break). A visible sign of such strain will appear in the form of a steamlike vapor over a weakening area if the line is wet. Nylon may not emit such noises unless against a cleat or bitt, but it will stretch and eject the vapor. Other types of synthetic line may show few if any warning signs before they part under load.

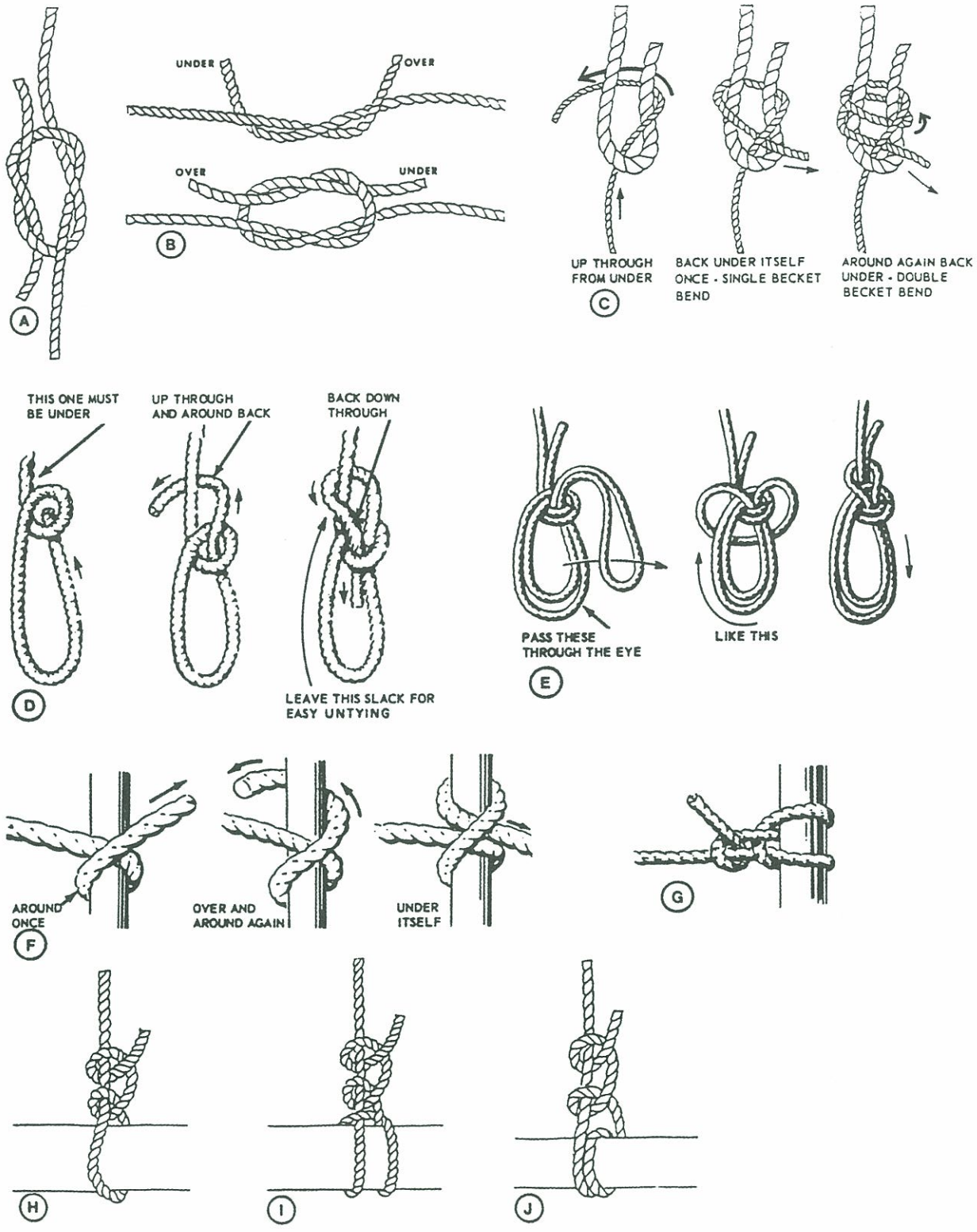
Knots, Bends, and Hitches

The term ***knot*** is often used as an all-inclusive term, but experienced seamen distinguish between knots, bends, and hitches. *Knots* are used to form *eyes* (secure loops) or to secure a cord or line around an object such as a package. Generally they are intended to be permanent, so they are hard to untie. *Hitches* are used to fasten a line to or around an object such as a ring or stanchion (a metal or wooden pole) or another piece of line. *Bends* are used to join lines together.

Most Navy men and women are expected to know how to tie the square knot, the bowline, single and double becket bends, and the round turn and two half hitches. Most also should know the clove hitch. These knots are explained and illustrated here to give you some guidelines to go by in your own seamanship practice. Besides that, it's fun!



Terms associated with tying knots, bends, and hitches.



Diagrams of various knots, bends, and hitches. A—Granny knot. B—Square knot. C—Becket bends, single and double. D—Bowline. E—Bowline on a bight. F—Clove hitch. G—Clove hitch and single half hitch. H—Two half hitches. I—Clove hitch with two half hitches. J—Round turn with two half hitches.

The *square knot,* also called the reef knot, is the best-known knot for bending two lines together. It can also be made to secure small stuff around a package. It can sometimes slip and can jam under strain. It can be loosened by pulling first one end and then the other.

A landlubber trying to tie a square knot often comes out with a *granny knot.* For a square knot, both parts of the line must be under the same bight (half loop).

Here is the proper way to tie a square knot: Take the end in your right hand and pass it over and under the part in your left hand. With your right hand, take the end that was in your left and pass it under and over the part in your left hand.

The *bowline* is one of the most useful knots. It has many variations. The chief use of the bowline is to form an eye at the end of a line, but it also can be used to secure a line to a ring or padeye (a deck fitting resembling a vertical steel plate rounded on the top and welded to the deck along the bottom, with a hole near the top), to form a loop around a stanchion or other object, or to bend two lines together. The bowline neither slips nor jams, and it ties and unties easily. It is the best knot to use for forming an eye in the end of a mooring line or bending a heaving line or messenger to the eye of a hawser or cable, because it is quick to tie and easy to untie.

The method of tying a bowline is as follows: Form a small horizontal loop in the line about where you want the eye to be formed, with the standing part (long side) of the line underneath. Pass the bitter end up through the loop, around behind the standing part, and back down through the loop (i.e., up, around, and down). Tighten the knot by applying some strain to the eye with the standing part of the line.

The chief value of the *becket bend* is to bend together two lines of different sizes. If there is a great difference in sizes or the strain on the line is to be great, a *double becket bend* should be used. A becket bend is as good as a square knot and much easier to untie after strain.

To fashion a single becket bend, make a bight on one line and run the bitter end of the other line up through it. Pass the bitter end around behind both parts of the bight and back under itself. The third step, to make a double becket, is made by taking another turn around the bight.

The *clove hitch* is the best all-around knot for bending a line to a ring, spar, or anything else that is round or nearly round. The clove hitch can be easily tied, and it will hold as long as there is a strain on it. Once the strain is taken off, however, the hitch must be checked and tightened to prevent the bitter end from pulling out when the strain is reapplied. For that reason it is a good idea to put a half hitch on the end of it.

To tie this hitch, take a turn around the object with the bitter end, pass the end across the standing part, and take another turn. (Notice that both turns go around in the same direction.) Then pass the bitter end under itself alongside the standing part, and the hitch is complete.

Another way to make the clove hitch is to form two underhand loops. Lay the second loop on top of the first. This method is often used to form the hitch when it can be slipped over the end of the object to which the line is to be secured.

Since the clove hitch may slide along a slippery object, the *round turn with two half hitches* is often used instead. The chief advantage of the round turn and two half hitches is that it will not slip along the object to which it is secured. If the angle of pull is acute (less than 90 degrees), this hitch should be used. The round turn and two half hitches is especially useful on a spar (pole) because it grips tightly and holds its position.

This hitch is made by taking a round turn around the object and then making two half hitches around the standing part. (The two half hitches actually consist of a clove hitch formed around the standing part of the line.)

Securing for Sea

Knots, bends, and hitches are necessary to ensure the safety of people working, for many seamanship evolutions, and for securing equipment to prevent damage during rough seas. You can never underestimate the force of the sea!

Lines must be in good shape and strong enough to hold the gear and people who depend on them. For heavy weather, all objects must be lashed tightly against something solid. The lines should be taut so the object will not "work" with the pitch and roll of the ship. **Chafing gear**, consisting of a marline wrap or canvas sleeve, should be placed around lines to prevent wearing on sharp corners and rough surfaces. Lines should never be tied to electric cables, small piping, or other movable objects.

Safety first is always the rule when working with lines and wire rope.

Critical Thinking

1. Demonstrate your knowledge of at least four of the various types of knots, bends, and hitches described in this chapter.

Study Guide Questions

1. A. What is deck seamanship?
   B. Which shipboard department is concerned with seamanship as its primary duty?
2. Which officer is in charge of the deck department or division?
3. What is the traditional name given to deck personnel on ships having aviation facilities?
4. What must a seaman apprentice accomplish in order to advance to pay grade E-3?
5. What is marlinspike seamanship?
6. A. What is the distinction between line and rope in the Navy?
   B. What materials is line made from?
7. A. What is the strongest of the natural fibers from which line is made?
   B. From what synthetic materials is most of the line now used in the Navy made?
8. What is a major disadvantage of nylon line that made the Navy seek other alternatives?
9. A. For what purpose is wire rope used?
   B. What special safety precautions should be observed when handling wire rope?
10. A. What term is applied to traditional three-strand general-purpose line to describe how it is built up?
    B. What term is applied to line having a right-hand twist or lay?
11. A. How is the length of a line measured?
    B. How is the size of line denoted?
12. What is the name given to line larger than five inches in circumference?
13. What is line under one and three-quarters inches in circumference called?
14. What is marline, and what is it used for?
15. What is seizing stuff?
16. What are three methods of laying out a line on deck?
17. What is the bitter end of a line?
18. Where is most rope and line stowed in a ship?
19. What is the purpose of whipping the bitter ends of a line?
20. A. What is a fid?
    B. What is it used for?
21. What are the warning signs that a fiber or nylon line under strain is about to part?
22. What are the differences between a knot, a bend, and a hitch?
23. What is the best knot for securing small stuff around a package?
24. What is a bowline knot used for?
25. What is the best knot for bending together two lines of different sizes?
26. What is a clove hitch used for?
27. What is chafing gear?
28. What is always the rule when working with lines and wire rope?

New Vocabulary

deck seamanship
splicing
line
manila
nylon line
Kevlar line
strand
right-laid line
solid-braided line
hawser
marline
seizing stuff
halyard
faking down
bitter end (line)
whipping (line)
kink (line)
knot (line)
hitches
square knot
bight
bowline
chafing gear
marlinspike
rope
wire rope
line
polyester line
yarn
plain-laid line
single-braided line
double-braided line
small stuff
serving (line)
lead line
coiling down
flemishing
boatswain's locker
palm (hand gear)
fid
eye (line)
bend (line)
granny knot
padeye
standing part (line)

4

Anchoring, Mooring, and Underway Replenishment

In addition to the marlinspike seamanship discussed in the last chapter, another very important aspect of deck seamanship that applies to nearly all naval surface ships is major deck seamanship evolutions such as anchoring, mooring, and underway replenishment. Towing and cargo handling are also a part of deck seamanship, but they are most often done by more specialized kinds of ships. All these evolutions are conducted mainly by deck department and deck division personnel, although in many cases the rest of the crew has supporting roles as well. Submarines also engage in some of these evolutions such as anchoring and mooring, but they have specialized procedures for them that are beyond the scope of this text and so will not be discussed here.

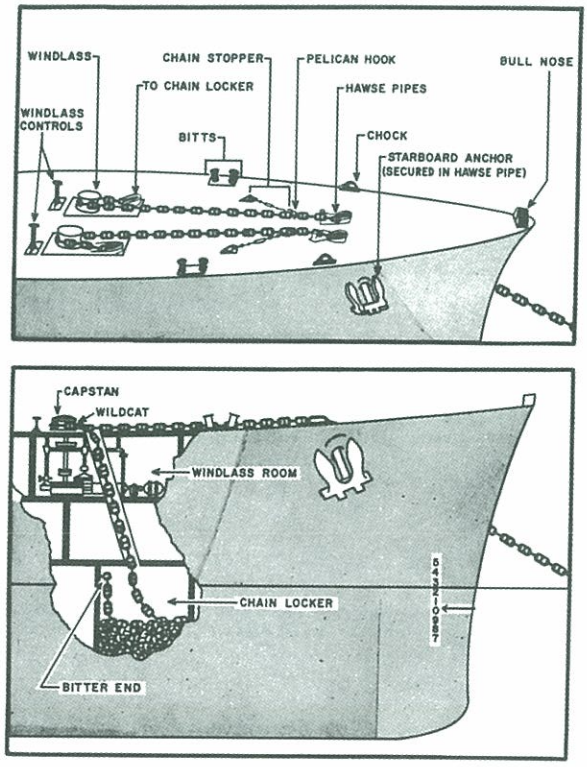
There is much specialized deck equipment associated with all these deck seamanship evolutions. The anchors and chains and all other equipment associated with anchoring are fundamental to the business of deck seamanship; it is called **ground tackle**. Other deck equipment has to do with mooring the ship, including the deck fittings that facilitate line handling and to which lines are made fast. A third major group of deck equipment is booms and their associated rigging, which is used to handle cargo both pier-side and during underway replenishment while connected to another ship alongside.

This chapter discusses the basics of the three major deck seamanship evolutions alluded to above, along with a brief overview of towing and general cargo handling, so that you will gain an understanding of the basic concepts involved and the equipment used to carry them out. The exact procedures for each will vary with different types of ships, but the general features are common to all.

Ground Tackle

Ground tackle is the equipment used in anchoring and mooring with anchors. It includes anchors; anchor cables and chains; and all chain cable parts such as chain stoppers, shackles, detachable chain links, and mooring swivels, and the tools used to work with them. It also includes the *anchor windlass*, the machinery used to hoist, or *weigh*, the anchor and its cable.

Before the development of anchor chain, anchors were raised and lowered by fiber rope and wire hawsers. This is how the *hawsepipe*—the large pipe through which the anchor cable passes from the deck to the ship's side—received its name. The hawsepipe is not to be confused with the *chain pipe* through which the chain runs from the windlass down into the *chain locker.*



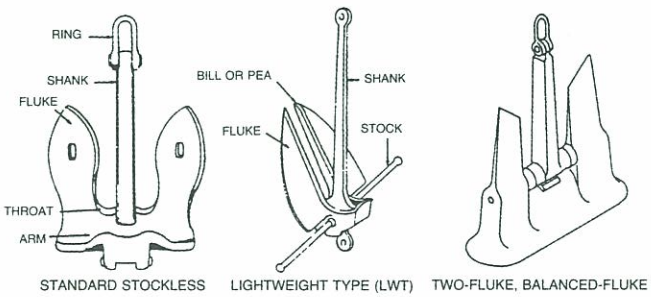
The ground tackle in the forecastle of a typical ship.

The starboard anchor chain swivel shot, chain stopper with pelican hook, and chain and hawse pipes are all clearly visible in this view of the forecastle of the USS *Gunston Hall* (LSD 44) taken during a line-handling evolution. Note also the faked-down mooring line and line-handling capstan. *Jonathon Sunderman*

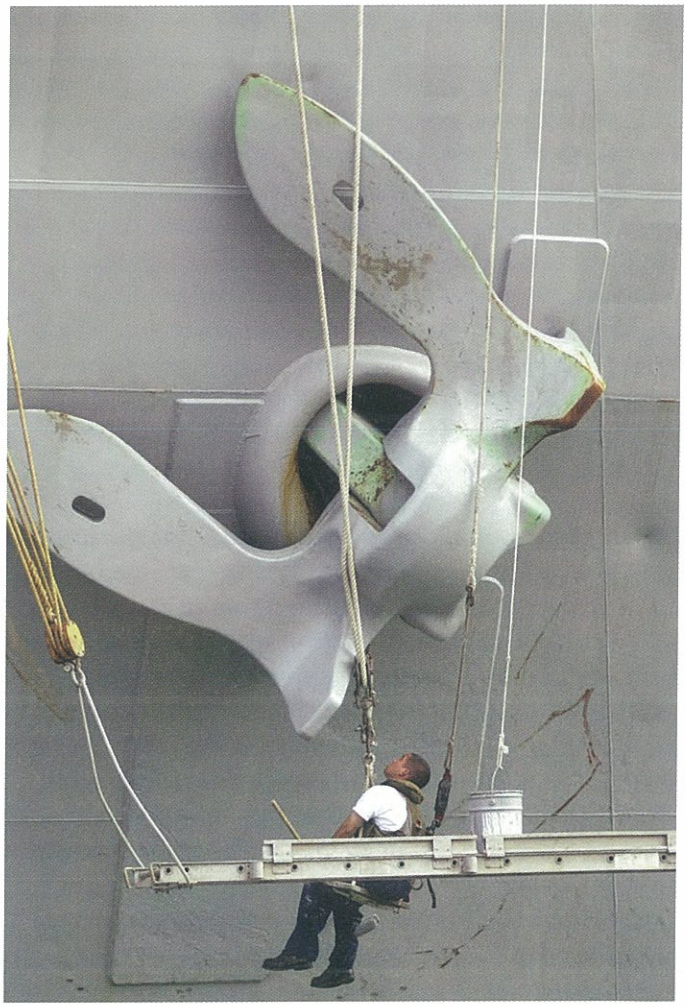
Anchors

Anchors currently used by Navy surface ships and craft are grouped into three types: the patent or stockless anchors; the lightweight anchors; and the two-fluke, balanced-fluke anchor.

Most Navy ships have *patent* or *stockless anchors* because they are easy to stow and handle, and have excellent holding characteristics. They have been the standard type of anchor used on Navy ships the size of destroyers and larger for most of the past century. They can be raised directly into the hawsepipe because there is no long stock. Stockless anchors are also called *bower anchors* because they are carried on, and let go and hauled up from, the bow. The arms, or *flukes*, of this kind of anchor can swing back and forth to permit the anchor to dig into the sea bottom. The largest stockless anchors weigh thirty tons and are used on aircraft carriers. Most Navy ships have two of these, one on each side of the bow, but some destroyers have only one that is stowed and dropped from the forward part of the bow, in order to avoid the sonar dome beneath.



The three major types of anchors used by U.S. Navy ships and service craft.



A seaman paints a huge fifteen-ton stockless anchor of an LSD. *Spike Call*

Lightweight-type (*LWT*) anchors, sometimes called Danforth anchors after their inventor, were developed in the 1940s for landing craft. They were used mostly by small craft until recent years when some new destroyers and the *Independence*-class LCSs were fitted with them as single bower anchors. The LWT anchor has a short stock, which makes it easy to stow in the hawsepipe. The LWT anchor tends to bury itself deep in most muddy bottoms when under strain and has about the same holding power as a stockless anchor twice its size. This makes the cost of the anchor and the gear to handle it much lower. A disadvantage of this type anchor is that it does not burrow well into sandy or shelly bottoms.

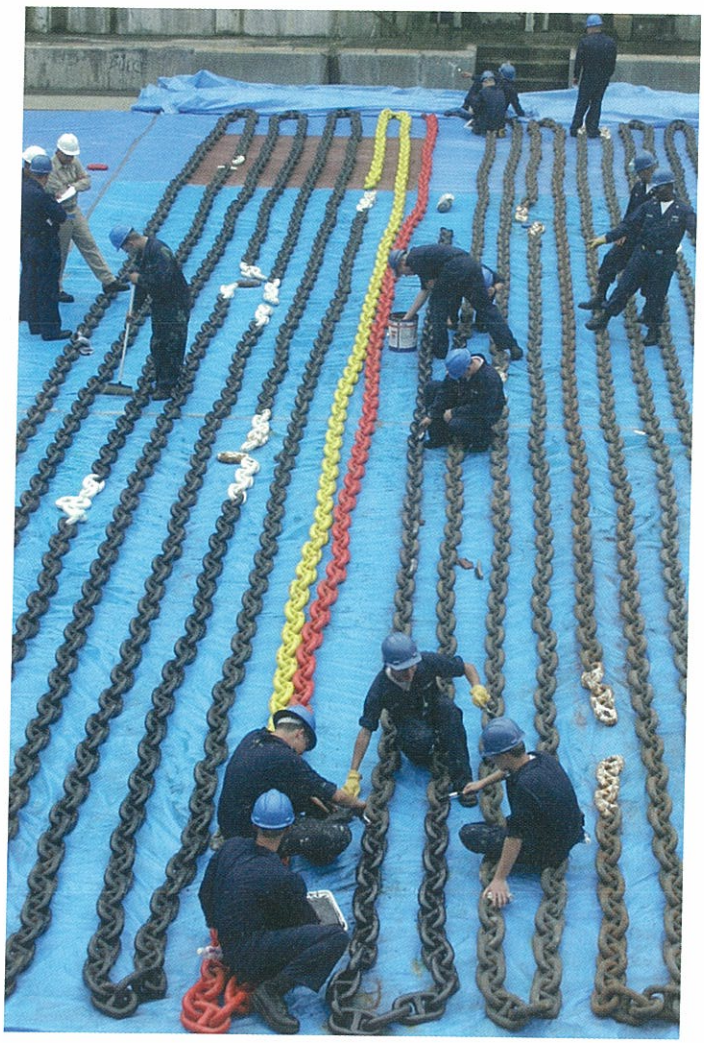
The two-fluke, *balanced-fluke anchor* is housed in the bottom of a vessel. It is used on board some surface ships in place of bower anchors in order to prevent interference with the ship's sonar dome.

Anchor Chains

Even though it is made up of links, an anchor chain is often called an **anchor cable** by custom. Modern naval anchor chain is made of high-strength steel links. The size of chain varies according to the size of the ship and its anchors. All of the links are *studded*; that is, a solid piece is welded in the center of the link to prevent chain kinking.

To give you some idea of the weight of a large anchor chain, a single link of a large aircraft carrier chain weighs about 350 pounds! Most Navy ships the size of destroyers and larger are equipped with two anchors and two chains.

The lengths of chain that make up the ship's anchor cable are called *shots*. A standard shot is fifteen fathoms (ninety feet) long. Large ships have a dozen shots in each anchor cable, and smaller ships somewhat fewer. A typical shot of an aircraft carrier's anchor chain contains 57 links, weighing a total of almost 20,000 pounds per shot!



A destroyer's anchor chains are laid out for painting while the ship is in dry dock for repairs. Note the red-painted final chain shot, and the yellow-painted next-to-last one immediately preceding it. Some of the white shot markers are also visible. *Danny Ewing*

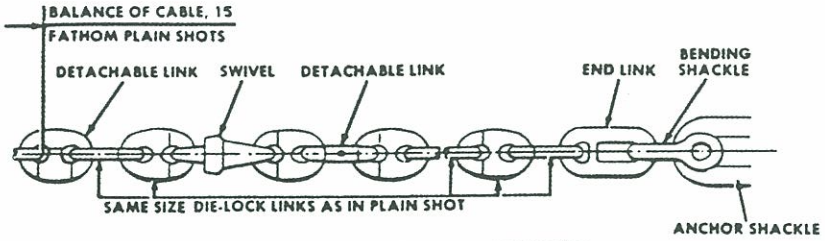
Shots are connected by *detachable links* painted in a repeating red, white, and blue sequence, with the links adjacent to each detachable link painted white to indicate the shot number. The first shot has one adjacent white link on each side of a red detachable link; the second shot has two white links on each side of a white detachable link; the third, three on each side of a blue detachable link; and so on. Each link of the next-to-last shot is painted yellow, and the entire last shot is painted red. This color scheme lets the anchor detail know how much chain is veered (paid) out and warns them when the chain is nearing its bitter end. The last link of the chain is normally shackled to a ring welded to a bulkhead in the chain locker to prevent the whole chain from being inadvertently veered out and lost. Nevertheless, this can happen if the huge momentum generated by the rapidly moving chain when an anchor is let go (dropped) in deep water breaks the shackle or attachment fitting before the anchor detail can apply the wildcat brake (see below).

On most ships, standard short *swivel shots* called "bending shots" attach the anchor chain to the anchor (see illustration next page) and allow the anchor to twist and turn. These swivel shots consist of detachable links, regular chain links, a swivel, an end link, and a *bending shackle* that is attached to the anchor shackle.

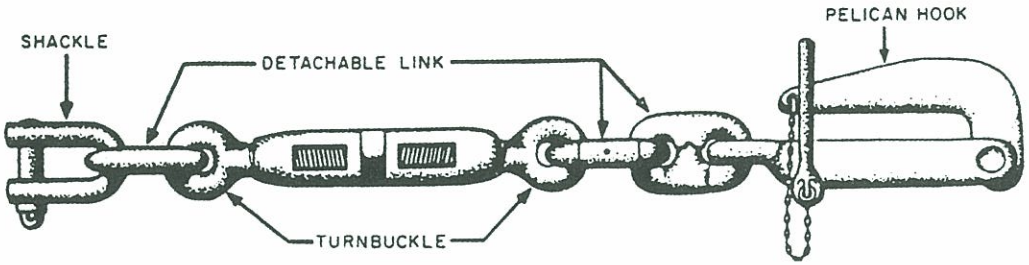
Chain stoppers (see illustration) are made up of a *turnbuckle* inserted in a short section of chain. A *pelican hook* is attached to one end of the chain stopper, and a shackle is at the other end. Chain stoppers are used for relieving stress on the windlass when anchored, holding the anchor taut in the hawsepipe or at short stay (a dangling position), or for holding an anchor and its swivel shot when they are disconnected from the chain for any reason.

Anchor Windlass

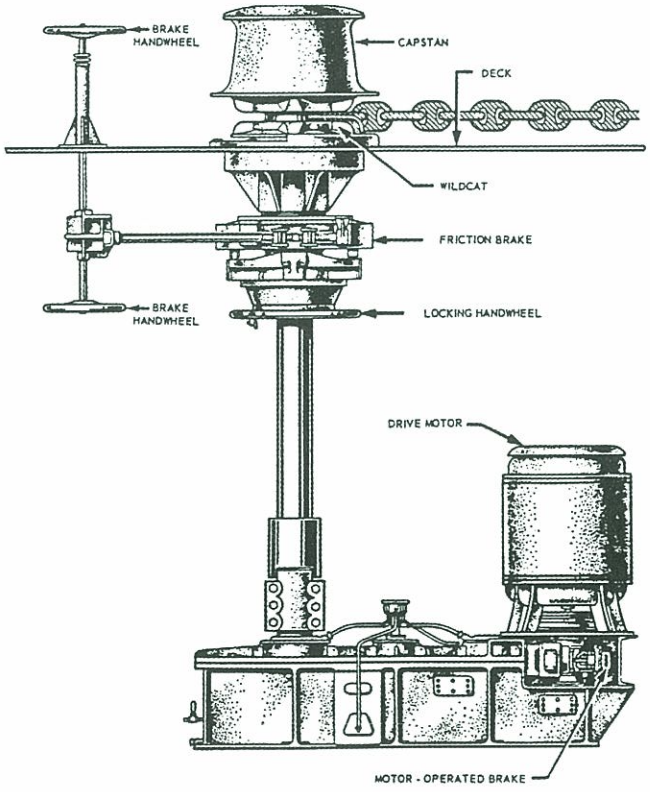
The *anchor windlass* is the machine used to hoist a bower anchor. A ship with a stern anchor has a stern-anchor winch to hoist it. On combatant ships the anchor windlass is a vertical-type winch with a *wildcat* (a large horizontal gear that has teeth called *whelps* that engage the anchor chain and prevent it from slipping) above deck and an electric motor and hydraulic drive for the wildcat shaft below deck (see illustration next page). On some ships there is also a *capstan* (rotating drum to assist line handling) above the wildcat on the same shaft (see illustration). It can be decoupled from the wildcat by a clutch for line handling. The wildcat is fitted with a friction brake to slow or stop the wildcat shaft from rotating, and thus regulate how much chain is let out; it is controlled by a handwheel as shown in the illustration. Some auxiliary and merchant ships have a horizontal windlass that is above deck, with two wildcats, one for each anchor.



STANDARD OUTBOARD SWIVEL SHOT & METHOD OF ASSEMBLING



The swivel or bending shot (top) is used to attach the anchor chain to the anchor. The chain stopper (bottom) with a pelican hook on the end is used to hold the anchor in the hawsepipe when secured for sea or when disconnected from the chain for any reason, and to hold the chain to relieve stress on the windlass when anchored.



The anchor windlass is the machine used to hoist a bow anchor. The wildcat under the line-handling capstan at the top above deck has teeth (whelps) that engage the links of the anchor chain. The brake handwheel controls a friction brake attached to the wildcat to slow or stop it from rotating, thus controlling how much chain is veered out when anchoring.

Anchoring

When a ship is to anchor or weigh anchor after having been at anchor, a special maneuvering, navigation, and anchoring team called the **special sea and anchor detail** is called away and posted on the bridge, in the engineering spaces, and on the forecastle. The ship's captain often takes the conn on the bridge, the XO or navigator supervises the navigation plot, and the first lieutenant takes charge of the *anchor detail* on the forecastle. Either the ship's boatswain or a senior boatswain's mate assists the first lieutenant. A machinist mate from the auxiliary machinery division and an electrician, both from the engineering department, take station in the anchor windlass room to handle any problems that might arise with that equipment. The first lieutenant is in direct contact with the bridge via a sound-powered telephone talker.

Letting Go

In preparing to anchor, all but one of the chain stoppers are removed and the wildcat brake is released so the anchor in the hawsepipe is restrained only by the remaining stopper. Sometimes the anchor may be walked out (slowly lowered) to a position just above the water surface by the windlass before the restraining stopper is attached. This is often done as a safety precaution when maneuvering in restricted waters. While these activities are being accomplished, the ship slowly approaches the desired anchorage location, guided by the navigator, and comes to a stop when the bow is over the intended position for the anchor.

On the forecastle, with all in readiness, just before letting go the first lieutenant orders all hands to stand clear, with the exception of a Sailor wearing a safety harness with a safety line

Action shot of the anchor detail on the forecastle of the amphibious transport dock ship USS *Denver* (LPD 9) after the starboard anchor has been let go. Note the Sailors manning the brake handwheel at back left, the empty chain stoppers on deck, and the letting-go sledgehammer-man in the safety harness at back right. *Casey Kyhl*

attached and equipped with a sledgehammer to release the last chain stopper. These are necessary safety precautions because nothing will stand in the way of the rapidly moving chain once the stopper is released until the anchor hits bottom. On the order "Let go!" relayed from the bridge, the pelican hook is knocked open with the sledgehammer, the Sailor jumps clear, and the anchor and chain plunge with a roar through the hawsepipe down into the water.

Once it is apparent from the motion of the chain that the anchor has hit bottom, the anchor detail applies the wildcat brake to temporarily stop any further chain from running out so that it will not pile up on top of the anchor. On the bridge the navigator plots the exact position of the anchor on a harbor chart. Then the ship begins to slowly back down as the wildcat brake is slacked off, allowing more chain to be slowly veered out while the flukes of the anchor begin to dig into the bottom. During this time reports are continually made to the bridge from the forecastle of the amount of chain veered out, angle relative to the bow, and strain. For example: "Thirty fathoms on deck; chain tending at twelve o'clock; moderate strain!" The word *tend* indicates the direction of the chain relative to the bow, given in terms of clock direction (e.g., twelve o'clock would be tending forward, nine o'clock would be tending 270 degrees to port, etc.). Strain on the chain may be reported as light, moderate, heavy, or no strain.

Scope of Chain

As additional chain is let out, it begins to hang in a slight catenary (downward curve). The amount of chain out at any given time is called the **scope**. Usually a ship anchors in water less than twenty fathoms deep. Under favorable sea conditions, the common practice is to continue veering chain until its scope is five to seven times the depth of the water, with six times the depth being a common rule of thumb. More chain than that may be veered out if rough weather is expected. When the proper scope of chain has been veered, the wildcat brake is fully engaged, a chain stopper is attached, and the ship continues to back down until the anchor has been fully imbedded into the bottom, indicated by a moderate to heavy strain on the chain and a halting of the backward motion of the ship. At this point the anchor is declared to have been "set." The ship's engines are stopped and shut down, and the chain is secured by the placement of another chain stopper on it.

If too little chain has been let out, the flukes will not dig well into the bottom and the anchor is apt to come loose and drag. Loud rumbles will be heard if the anchor drags on a rocky bottom, and a series of vibrations may be felt if it is dragging on a mud bottom. If this occurs, more chain may be veered out to try to set the anchor. In severe cases, especially if the anchor has been dragged an unacceptable distance from the desired anchorage, the ship may stop, weigh anchor, and move to a different location to try again.

Weighing Anchor

When the ship is to **weigh** (hoist) **anchor**, the special sea and anchor detail is set and the windlass engine is tested. Then the wildcat is engaged, the brake is released, a slight strain is taken on the chain, and the chain stoppers are cast loose. When the ship is ready to get under way, permission is requested to bring the anchor chain to *short stay*, a condition in which the chain is nearly vertical in the water with just enough chain out to keep the anchor from breaking loose from the bottom. Only the captain, or OOD with permission from the captain, may order heaving (taking in chain) to short stay.

As the anchor chain is heaved in by the windlass, the anchor digs its way out of the bottom. Status reports are made to the bridge from time to time, usually when the various shot markers become visible at the water's edge. (Example: "Fifteen fathoms at the water's edge; chain tending at one o'clock; moderate strain!") Additional reports are made when the anchor is at short stay, aweigh (broken loose from the bottom), in sight, and secured for sea or ready for letting go again if circumstances require.

As the chain comes in, it is hosed off by the anchor detail to remove mud, as is the anchor itself when it approaches the hawsepipe. Often, the shot markings are touched up with paint as they cross the deck. Some links of each shot are tested by striking them with a hammer. More links are tested if the chain had been subjected to a heavy strain. If a link rings, it is all right; if it sounds flat, it may be damaged; in this event it is marked for later inspection and possible replacement.

Two boatswain's mates hose down an anchor chain as it comes up the hawsepipe while weighing anchor. *Joshua Wahl*

Mooring

When a ship has one anchor down, it is *anchored*. When it has two anchors down and swings from a mooring swivel connected to both, it is *moored*. A ship secured to a pier or to another ship with lines, or to a mooring buoy or between two mooring buoys, is also considered moored. In a type of mooring common in Mediterranean ports called a *Med moor*, a ship is moored perpendicular to the pier, with the stern tied up to it and anchors out on each side of the bow.

Mooring a ship to a pier, buoy, or another ship, and unmooring, are some of the most basic jobs of the deck department. These tasks require skillful use of mooring lines and deck winches. Deck fittings such as cleats, bitts, chocks, and padeyes (a type of deck fixture incorporating a hole for fastening lines) are used in all these evolutions (see illustration below). Quick, efficient line handling when mooring to a pier or another ship or getting under way is one of the marks of a smart ship.

The guided-missile destroyer USS *Stetham* (DDG 63) being positioned for a Med-type moor. *Nardelito Gervacio*

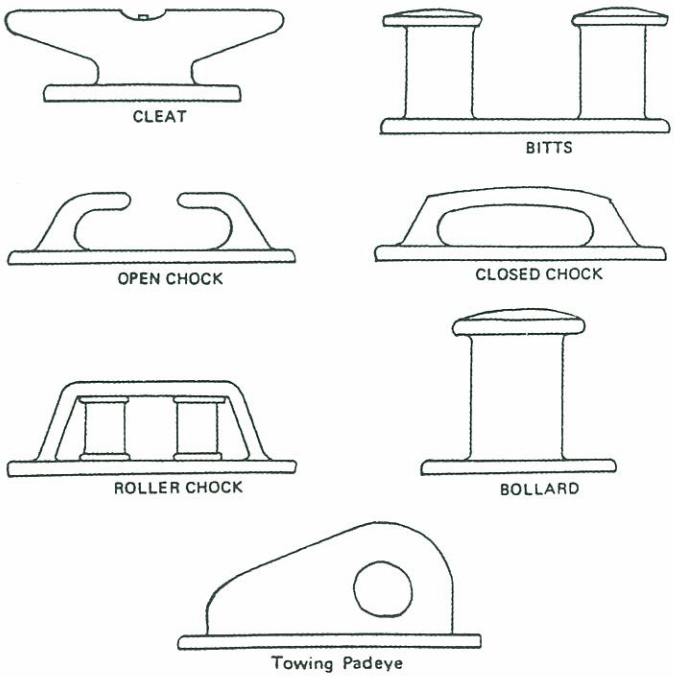
Deck and Pier Fittings

A number of different deck and pier fittings are used to facilitate line handling during deck evolutions such as mooring, unmooring, and towing. Sailors must know when and how to use these fittings to do a smart job of line handling.

A *cleat* is a device welded to the deck that looks like a pair of projecting horns. It is used for fastening or slowly paying out a line or wire.

Bitts are large, cylindrical fittings made of steel welded onto the deck. They are arranged in pairs, each pair mounted on a separate footing. Usually there is a set of bitts in the vicinity of each mooring chock for use in securing mooring lines.

A *mooring chock* is a heavy fitting on the deck edge with smooth, rounded surfaces through which mooring lines are led. Mooring lines are run from bitts on the deck through chocks to bollards on the pier when a ship is moored. Chocks are of three kinds: (1) *open chock*, a mooring chock open at the top; (2) *closed chock*, a mooring chock closed by an arch of metal across its top; and (3) *roller chock*, a mooring chock that contains a set of rollers for reducing friction.



Fittings used for handling lines. All the fittings shown are common on ships and boats except for the bollard, which is a pier fitting. The towing padeye is used as the attachment point for a towing hawser.

Deck department Sailors handle a large mooring line on the fantail of the aircraft carrier USS *Carl Vinson* (CVN 7) with the help of a pair of bitts as other crewmembers look on. Note the abrasion marks on one of the bitts caused by past strain on a mooring line that was secured to the bitts. *Iain Stratton*

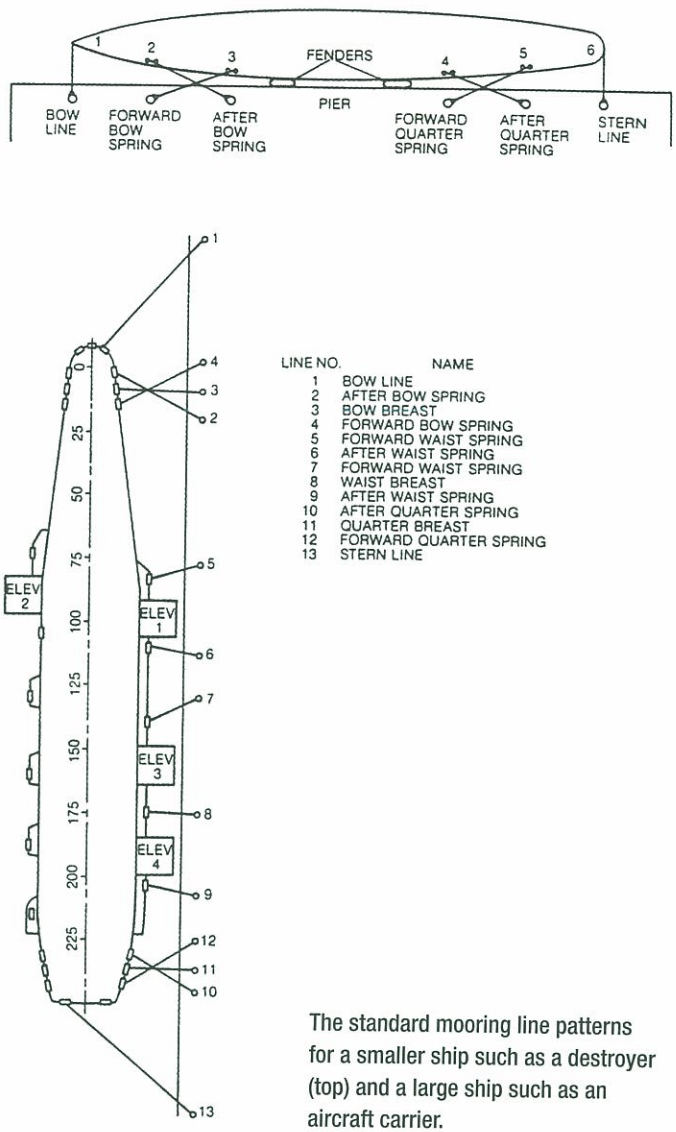
A *bollard* is a strong cylindrical, often toe-shaped upright fitting on a pier, around which the eye or bight of a ship's mooring line is placed.

A *padeye* is a fitting consisting of a steel plate welded to a deck or bulkhead with a circular hole in it to allow a line or shackle to be fastened to it for some purpose. A *towing padeye* is a large padeye of extra strength usually located at a centerline position on the fantail deck above the stern that is used in towing operations to secure a towing line.

Mooring to a Pier

Ships are moored to piers, wharves, or other ships with **mooring lines**. In general they are as light as possible for ease of handling, while also strong enough to take a big strain during mooring and to hold a ship in place when secured. In the Navy they are usually the equivalent of 5-inch 3-strand nylon line with a breaking strength of 60,000 pounds or better. Normally in today's Navy either polyester or preferably Kevlar line is used for mooring line, with an equivalent size of about four and one-half inches or more (three and one-half inches for four-strand Kevlar line). Very large ships like aircraft carriers use larger line. The Navy standard is that the maximum applied load on any mooring line should not exceed its breaking strength divided by a factor of 2.5.

Mooring lines are numbered from forward to aft in the order that they are run out from the ship. Many ships are normally moored with six lines, though large ships may use seven or eight, aircraft carriers thirteen, and small ships as few as four. The lines are grouped according to their use as bow, spring, breast, or stern lines.



The standard mooring line patterns for a smaller ship such as a destroyer (top) and a large ship such as an aircraft carrier.

The *bow line*, line one, is the mooring line that runs through the *bull nose* (a closed chock at the bow) or chock nearest the bow of the ship. For larger ships this line is led to a bollard well up the pier to stop the ship from moving aft; similarly the last line, the *stern line*, is led aft to stop any forward motion of the ship. For smaller ships, however, the bow and stern lines lead directly to the pier to serve as breast lines (explained below). *Spring lines* lead fore and aft at an angle and control the fore-and-aft movement of the ship. They are often placed in pairs and may be located at the bow, midships portion, and stern, depending on the size of the vessel.

Breast lines are at a right angle to the ship and control the distance from the pier to that part of the ship. Breast lines are designated bow, waist, or quarter breast lines.

When the ship is secured, and is to remain moored for any extended length of time, mooring lines are normally *doubled*

A boatswain's mate places the eye of a second bow line from a Navy destroyer over a bollard on a pier in order to double up the line. Note the chafing gear in the eyes of the two lines and the stockless bower anchor dangling from the hawsepipe at short stay, ready to be let go if the ship had encountered any difficulty while maneuvering into its berth. *Douglas Morrison*

up. Traditionally, to double up a line, an additional bight (loop) of it is passed around the fitting on the pier to which the line is attached. Then slack is taken out until the two parts of the bight are alongside the original part of the line. Thus, three parts of the line absorb the strain rather than just one. Nowadays, however, with the extensive use of stronger synthetic mooring lines, doubling up is often done by placing the eye of a second line of the same type and size on the fitting to which the first line is attached, then taking out the slack until the two lines are alongside one another with equal strain on both. Often after a line is doubled up the parts are bound together with small stuff, and a flat or conical **rat guard** is placed about midway up the line, with the open end facing the pier, so that rats and mice cannot crawl up the line onto the ship.

Often, particularly with small ships and boats, large buffers called *fenders* are suspended from the side on which the mooring will take place, so that it will not come into contact with the pier and be damaged. These fenders are usually either large pneumatic black rubber cylinders with line attached on both ends, or large coiled or woven fiber buffers made of old line. Alternatively, long, low, and narrow floating wooden platforms called *camels* are placed between a ship and a pier to serve the same purpose. They also facilitate doing maintenance on the side of the vessel when necessary.

Mooring to a Ship

Sometimes, particularly when deployed and visiting a foreign port in company with other ships of the same type, Navy ships the size of destroyers and smaller will tie up together, either when at anchor in a confined anchorage or alongside a pier when there is not much pier space available.

If at anchor, typically only one ship will put down an anchor, and another will tie up alongside. Usually only two ships will anchor together in this manner to avoid undue strain on the anchor cable, unless they are small. If alongside a pier, either a single ship or sometimes several ships may tie up alongside one another outboard of a ship moored to the pier. To go ashore, the crews of the outboard ships then have to cross over the intervening ships to get to the brow of the innermost one in order to disembark.

In either situation, the ships are usually moored parallel to each other head-to-head and stern-to-stern, with the same pattern of mooring lines as used for mooring to a pier as described above. Fenders or camels are usually placed between the ships to keep them from coming into contact and damaging each other.

Rat guard on a doubled-up mooring line. *Michael Russell*

Navy mine countermeasures ships moored together in a modified Med moor at a stateside naval station preparing to ride out a storm. *Michael Antoine*

Underway Replenishment

In addition to anchoring and mooring, one of the more frequent deck seamanship evolutions deck personnel of naval surface ships perform is **underway replenishment (UnRep)** while alongside another ship, called **connected replenishment (ConRep)**. Such operations may involve the transfer of fuel, cargo, ordnance, or personnel, mostly by the use of STREAM (standard tensioned replenishment alongside method) transfer rigs, or sometimes just personnel by what is called the **synthetic highline transfer** method.

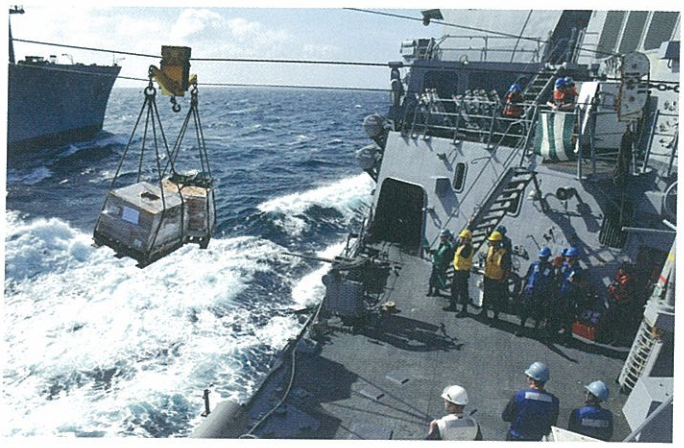
Normally in ConRep operations, the ship receiving the transfer has the responsibility to maneuver alongside the supplying ship, called the delivery ship, and then maintain station there, usually at a distance of eighty to two hundred feet away, depending on the size of the ships. Maintaining the proper distance apart is important, because if the ships get too close, suction effects will cause the two ships to be inexorably drawn together until they collide. Most replenishment operations are carried out at a steady speed of about twelve knots.

Once the receiving ship is steadied alongside, either light heaving lines are thrown or thin shot lines are fired across from the delivery ship. Heaving lines are light lines called *bolos* with a weighted plastic sphere or weighted knot called a *monkey's fist* in the bitter end, and shot lines are thin, orange braided lines attached to plastic cylinders that are shot across by means of smooth-bore shoulder-fired rifles. If the receiving ship is an aircraft carrier or aviation-capable amphibious ship, then it furnishes the bolos or shot lines to avoid possible damage to any aircraft on deck. Once the heaving or shot lines are exchanged, the delivery ship attaches heavier *messenger lines* to them, and these are passed back to the receiving ship, along with a sound-powered bridge-to-bridge phone line called the *phone and distance line*. It has distance markers every twenty feet so that when strung across it helps the receiving ship's conning officer maintain the proper distance between the ships. Sometimes station-to-station phone lines are also passed between the replenishment stations on the delivery and receiving ships.

A Sailor heaves a bolo with a plastic weight on the bitter end to a ship alongside.

The messenger lines are in turn connected to thick wires called *span wires*, or in some cases to a four-inch polyester *highline* for a personnel transfer via the synthetic highline transfer method. These are pulled over to the replenishment stations on the receiving ship, and in the case of span wires, attached to appropriate fittings. Slack is removed from the span wires by

A gunner's mate fires a shot line across to a replenishment ship to commence an underway replenishment.



A STREAM (standard tensioned replenishment alongside method) transfer rig conveys pallets of supplies from a replenishment ship during a ConRep.

Sailors tend a phone and distance line strung between replenishment and receiving ships during an underway replenishment. The line has markers every twenty feet to help the receiving ship's conning officer maintain the proper distance between the ships.

A refueling probe suspended from a span wire about to connect with a receiver on board a receiving ship during an underway replenishment.
Alan Baribeau

A Sailor is transferred between two ships in a boatswain's chair suspended from a highline. He may get wet on the way over by the look of the seas beneath.

winches on the delivery ship, or from the polyester highline, if one is being used, by lines of Sailors on both the delivery and receiving ships until they are taut, whereupon the transfer operations are ready to begin. Sufficient tension is maintained in the span wires by the winches and polyester highline by the Sailor line-tenders to keep them taut throughout the replenishment or personnel transfer operations. Alternatively, personnel transfers may also be done via STREAM span wires.

For fuel transfer, large, black fuel hoses with big metal probes on the end are slid across on wheeled trolleys beneath the span wires from the delivery ship until the probes are seated within conical receivers on the receiving ship. For cargo or ordnance transfer, pallets suspended from trolleys are sent back and forth across the wires. For personnel transfers, a **boatswain's chair** is suspended from a trolley beneath either the synthetic polyester highline or span wire and pulled across.

Upon completion of the replenishment and/or personnel transfer operations, all suspended transfer gear is retrieved, then the span wires, the polyester highline, and the phone and distance and any station-to-station phone lines are detached and retrieved, and the receiving ship maneuvers away from the delivery ship.

Vertical replenishment by helicopters (VertRep) often takes place simultaneously with ConRep, or sometimes independently, especially in the case of ships having helo or flight decks. Cargo, ordnance, and personnel may be transferred by

Vertical replenishment (VertRep) is often done simultaneously with connected replenishment (ConRep), as shown here with a Seahawk helicopter and a STREAM cargo transfer rig both delivering cargo from the combat support ship USS *Camden* (AOE 2). *Tyler Clements*

this method. Except for ships not having an air detachment, deck personnel are not normally much involved with this because that is the province of the air department personnel.

Towing

Most routine towing in the Navy is handled by harbor and fleet tugs, salvage vessels, and submarine rescue vessels that are especially fitted for this task. All naval ships, however, must be able to tow or be towed in an emergency.

As previously mentioned, most Navy ships have a towing padeye located on the fantail. To tow another ship, a towing assembly consisting of a pelican hook attached to a length of chain extending aft through a centerline mooring chock is shackled to the padeye. The towing hawser is connected to the end of the chain with a detachable link, and the hawser is passed to the towed ship. The hawser is attached to one of the towed ship's anchor chains, which is let out through the bull nose and veered to about twenty fathoms.

The length of the towline—hawser and chain—is adjusted to hang in a deep catenary about 500-600 feet in length. This catenary helps to relieve surges caused by movements of the two ships. Proper towing technique requires that the towline be of such length that the two craft are "in step." Both must reach the wave crests at the same time, or the towline will be whipped out of the water under terrific strain. Once properly rigged, the towing vessel barely gets under way as the towed vessel begins to move. A sharp start may part the towing hawser. Speed is gradually increased to about six to eight knots for the duration of the tow.

Cargo Handling

With the exception of amphibious ships and aircraft carriers having a small plane-hoisting crane, most warships are not outfitted with gear suitable for hoisting heavy cargo, so most cargo handling on them is limited to small hand trucks and forklifts. When in port, cargo is loaded or unloaded mainly by dockside winches and floating cranes. Mobile logistic ships, however, are fitted with heavy-lift cargo systems. In such ships, deck seamanship is mainly concerned with heavy-cargo handling. Sailors in these ships need to know about all the parts of cargo handling gear and the various "rigs" for handling cargo.

Rigging. The term *rigging* is used for all wires, ropes, and chains supporting masts or kingposts (vertical poles to which booms are attached) and operating booms and cargo hooks. *Standing rigging* includes all lines that support masts or kingposts but do not move, called stays and shrouds. *Running rigging* includes all movable lines that run through blocks, such as lifts, cargo whips, and vangs (described below).

Booms. A *cargo boom* is a long pole built of steel. The lower end is fitted with a *gooseneck*, a bracket attached to the kingpost that supports the boom. The free end is raised or lowered and held in position by a cable called a *topping lift*. These booms range in capacity from about five to seventy-five tons.

Cargo booms are moved into position, and cargo is moved into and out of holds by running rigging. Topping lifts move the free end of the boom vertically and hold it at the proper height. Inboard and outboard guys, or *vangs*, move the boom horizontally or hold it in working position over a hatch or dock. The cargo hook is raised or lowered by *cargo whips* running from winches.

Several booms and their rigging are shown in this view of the MSC replenishment oiler USNS *Yukon* (T-AO 202). *Rebecca Moat*

Critical Thinking

1. Describe the complete sequence of anchoring a vessel from initial preparation through setting the anchor.
2. Describe the complete sequence of raising an anchor from a mooring until it is in final position in the hawsepipe.

Study Guide Questions

1. What is the equipment associated with anchoring called?
2. What is the machinery used to weigh the anchor and its cable called?
3. What is the large pipe through which the anchor cable passes from the deck to the ship's side called?
4. What are the three types of anchors used by the Navy?
5. Describe a Mediterranean moor.
6. What is the most common anchor in use in the Navy today?
7. What are anchors carried on the ship's bow called?
8. What are the advantages of LWT anchors?
9. A. How many fathoms and feet are in a shot of anchor chain?
   B. How are chain shots connected to each other?
10. What is the identifying color scheme of detachable links and anchor chain shots?
11. A. How is strain on the anchor chain reported to the bridge?
    B. What is the common reference used to describe the direction in which an anchor chain tends?
12. What is the common rule of thumb used to determine the proper amount of anchor chain to be veered out when anchoring?
13. What does it mean to "heave in the anchor to short stay"?
14. Describe the process of heaving in an anchor and the various status reports that are made.
15. When is a ship considered to be moored as opposed to anchored?
16. Describe the following fittings:
    A. Cleat
    B. Bitts
    C. Chock
    D. Bollard
    E. Padeye
17. A. What is the purpose of spring lines when a ship is moored to a pier?
    B. Breast lines?
18. What are names of the mooring lines for a standard six-line moor of a destroyer-sized ship?
19. What is connected underway replenishment (ConRep)?
20. Describe the STREAM method used for underway replenishment of fuel oil.
21. What are three methods by which personnel may be transferred from ship to ship during underway replenishment operations?
22. Why must all naval ships be prepared to tow or be towed?
23. With respect to cargo handling, what does the term *rigging* include?

New Vocabulary

ground tackle
hawsepipe
Med moor
bower anchor
mushroom anchor
balanced fluke anchor
chain shot
swivel shot
turnbuckle
anchor windlass
capstan
letting go (anchor)
scope (of chain)
short stay (anchor)
bitt (fitting)
bollard
mooring lines
bull nose
double up (mooring lines)
fender (buffer)
ConRep
VertRep
boatswain's chair
running rigging
gooseneck
vang
weigh anchor
chain locker
stockless anchor
fluke (anchor)
LWT anchor
anchor cable
detachable link
chain stopper
pelican hook
wildcat
anchor detail
veer (chain)
catenary
cleat (fitting)
mooring chock
padeye
bow line
breast line
rat guard
camel (platform)
STREAM (replenishment rig)
highline transfer
standing rigging
boom (rigging)
topping lift
cargo whip

5

Small Boat Seamanship

At some time or another during unit visits to naval bases and ships or in recreational activities you will be concerned with another aspect of deck seamanship: small boat seamanship. This chapter discusses the particular characteristics of small boats, including nomenclature (vocabulary), boat handling, and boat etiquette. Most of the discussion of boat handling will be concerned with powerboats as opposed to sailboats, because that is the type of boat with which most NJROTC cadets will come into contact during their training visits to Navy ships and shore stations.

Boat Nomenclature

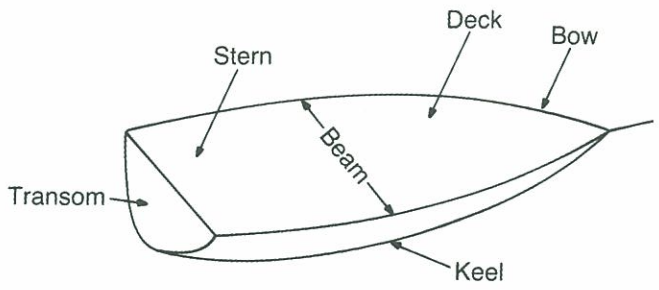
The first thing anyone who will be in or around a small boat needs to know is the nomenclature that applies to it. There are two basic kinds of small boats with which we will be concerned: powerboats and sailboats. A **powerboat** is any vessel that is propelled through the water by some type of motor or engine. A **sailboat** is a vessel that is propelled mainly by the wind through the use of some type of sail, though most have small engines for use in restricted waters or when making a landing. **Motor sailers** are designed to be propelled by both power and sail at the same time. They typically have a powerboat hull and a sailboat's upperworks, with engines comparable to those in low-speed powerboats.

A powerboat, like this captain's gig being made ready alongside the USS *Boxer* (LHD 4), is any vessel propelled by some type of motor or engine.

The Hull and Its Parts

The hull is the largest part of a boat and is the structure that floats in the water. There are two basic hull forms:

Sailboats, like the ones shown here being sailed by NJROTC cadets in a regatta, have low upperworks to allow for free movement of the sails. All except the very smallest usually have some sort of auxiliary engine for propulsion when the sails are down. *Mike Miller*



The principal parts of a small boat hull.

- the *displacement* type, which displaces water and plows through it, and
- the *planing* type, which skims on the surface

Most sailboats, motor sailers, and many powerboats have a displacement hull; high-speed powerboats usually have a planing hull. But regardless of the type of hull, the basic nomenclature is the same for both sailboats and powerboats.

The pointed forward portion of the hull is the *bow*, and the opposite rear portion is the *stern*. The extreme back end of the stern, usually fairly flat in a powerboat, is the *transom*. At the bottom of the hull is the *keel*. The keel is usually fairly deep in a sailboat and relatively shallow in a powerboat, with a motor sailer's somewhere in between. On the top of the hull is the *deck*. The depth to which the hull sinks in the water is the *draft* of the hull, and its maximum width is the *beam*. The line the water makes with the hull is the *waterline*.

Boats that have two fairly shallow-draft V-shaped hulls connected together by the boat's upperworks are called *catamarans*, and those having three such hulls are *trimarans*.

Upperworks

Structures placed on the hull of a boat, corresponding to the superstructure of a ship, are called *cabins*. As in a ship, vertical access openings in the cabin are called *doors*, and horizontal access openings in the cabin and deck are *hatches*. Windows, especially in a sailboat, are called *ports*. The forward window or sets of windows that shield the cockpit in a powerboat are the *windshield*.

Larger boats have a kitchen, or *galley*, and one or more bathrooms, called *heads*. Bedrooms on a boat are *staterooms*.

The steering gear (wheel or tiller) for the boat, which may be inside or outside the cabin, or in some cases both, is the *helm*. In many sailboats and some powerboats the helm is located in the *cockpit*, a depressed area aft of the cabin, or, in some cases, amidships between two cabins. The edge of the deck, called the *gunwale* on a powerboat and a *rail* on a sailboat, usually has vertical metal stanchions that support one or more rows of *lifelines*. In front of the bow and extending from it on most sailboats and many powerboats is the *pulpit*, a platform enclosed by lifelines that provides room to handle the forward sail and anchor. It may be supported underneath by the *bowsprit*, a beam that extends from the bow beneath the platform. Some powerboats have an auxiliary helm and engine controls on a platform elevated for better visibility called a *flying bridge*.

Sailboats and motor sailers have one or more tall masts used to support their sails, collectively called the boats' *rig*. A powerboat may have a short, stubby mast for the radar and radio antennas, and on some types called *trawlers* these may even be high enough to carry a steadying sail. If a sailboat or motor sailer has two or more masts, the tallest one is the *mainmast* and the other is the *foremast* (if forward of the mainmast) or *mizzen* (if aft of the mainmast). The position of the mainmast may vary according to the type of rig the boat has. Metal wires, rods, or lines used to support the masts are the *standing rigging*, and the various lines used to support and control the sails are the *running rigging*. Horizontal supports near the top of the masts that support the standing rigging are the *spreaders*, and horizontal poles near the base of the masts used to support the bottom of the sails are *booms*.

There is a great deal of other nomenclature peculiar to sailboats that is not included here. Any basic text on sailing will usually have a section on sailboat nomenclature that can be referred to if the need arises.

Propulsion and the Rudder

The propulsion machinery of powerboats is called the *engine*, and on sailboats so equipped, the *auxiliary*. Boat engines may be either gasoline or diesel fueled. They transmit their power to the propeller or screw under the stern via the *propeller shaft*, which corresponds to a drive shaft on a car. Most powerboat propellers are three-bladed; some sailboats have a two-bladed propeller that can be aligned with the back of the keel to reduce drag through the water while operating on sail alone. All powerboats have at least one engine. If permanently installed within the hull they are called *inboard* engines, and if portable and mounted on the stern, they are called *outboard* engines. Most Navy small boats have inboard engines. Near the propeller is the *rudder* (in some cases two rudders) that controls the direction of travel of the boat.

Types of Boats

There are hundreds of different types of sailboats and powerboats, collectively called *pleasure boats* or *pleasure craft* if they are operated mainly by civilians as leisure-time activities. In the Navy, all small boats are called *small craft*. The main types of small craft with which NJROTC cadets will come into contact

are small sailboats and powerboats such as amphibious craft, utility boats, officers' boats, and inflatables.

Amphibious craft include landing craft that are equipped with bow ramps that can be lowered to discharge troops or cargo when the boats reach shore, as well as various types of control boats that look like traditional powerboats and other specialized types of craft such as hovercraft and tracked amphibians that can swim ashore and then climb the beach to discharge their troops and cargo inland.

Utility boats are essentially open powerboats ranging in length from about 25 feet to about 75 feet, designed for hauling personnel and light cargo between ships and fleet landings ashore. Most have a single screw and rudder.

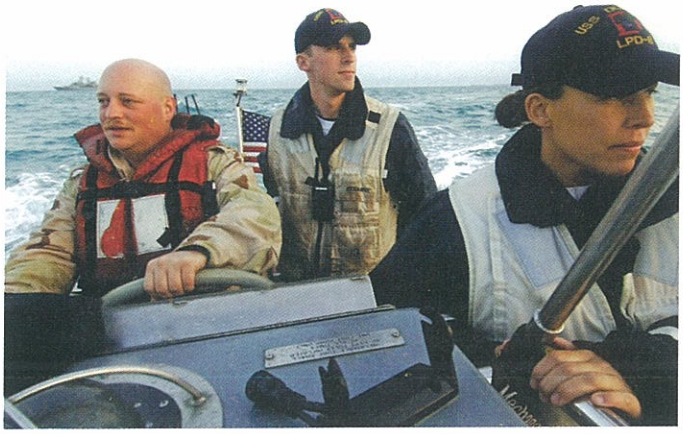
Officers' boats are smaller, traditional-looking powerboats with cabins intended to carry senior officers and other ship's officers. They are usually of less capacity than comparably sized utility boats. Most ships have only one or two of these, reserved for use primarily by the ship's captain or higher-ranking officers who may be embarked on the ship. Any boat used by the captain is called a *gig*. A boat used by an officer of higher rank than the ship's captain is called a *barge*.

Modern *inflatables* come in many shapes and sizes. The traditional double-ended fiberglass whaleboats of years past have largely been replaced by *rigid hull inflatable boats* (RHIBs) to fill the small-boating needs of most Navy ships. Most of them are water-jet propelled, eliminating the need for a propeller and rudder.

A landing craft utility (LCU) makes ready to unload a group of Marines.
Geronimo Aquino

Large utility boats like the one shown here capable of carrying eighty passengers are used for transporting personnel and light equipment.
Michael Cole

Rigid hull inflatable boats (RHIBs) have become the workhorses among the small craft of the fleet, doing duty as lifeboats, personnel boats, patrol craft, and utility boats.



A boatswain's mate coxswain of a RHIB (left) and his boat officer (center) make a boat run with another officer (right). *Kitt Amaritnant*

Coxswain

The person in charge of a civilian boat, regardless of its size or type, is customarily called the boat's captain. This tradition is followed almost universally in both commercial and pleasure boating. In the Navy, the person in charge of a sailboat is also called the captain, but in the case of powerboats of all sizes and types, the person in charge of the boat, its crew, and any passengers is called the *coxswain* (pronounced *coc*-sun). The coxswain is responsible for the maneuvering and safety of the boat under all circumstances except when a commissioned line officer is embarked as either a boat officer or passenger; these officers may then give directions under certain circumstances to the coxswain.

Boat Handling

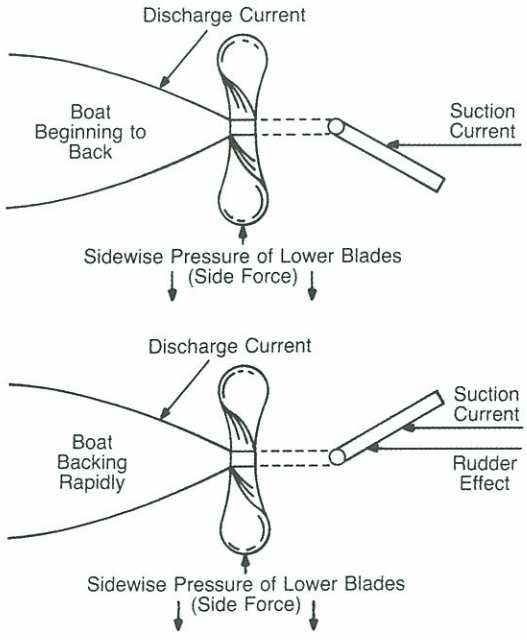
Generally speaking, a boat is moved by forces resulting from pressure differences. In order to become a good boat handler, a person must understand the forces that act on the boat, how they are generated, and how they cause it to move in one way or another. These forces can be broadly classified into two types: those that are controllable by the boat handler, such as the propeller force and rudder pressure, and those that are uncontrollable, such as wind and current. It is the interplay of all these forces acting simultaneously that determines how a boat will react in any given situation.

Propeller Forces

For all practical purposes, water is incompressible. Therefore, when a propeller or screw rotates, high- and low-pressure areas are created on opposite sides of the propeller blades. This force, called **propeller thrust**, is transmitted from the high-pressure area toward the low-pressure area. When a right-handed propeller, the type normally used on a single-screw boat, is rotating clockwise as viewed from astern, the low-pressure area is on the forward face of the propeller blades, resulting in forward movement of the boat. When the propeller rotates counterclockwise an opposite effect occurs, and the boat backs.

Next in importance to propeller thrust is **side force**, which tends to move the boat's stern sideways in the direction of propeller rotation. The upper blades exert a force opposite to that of the lower blades, but the lower blades are moving in water of greater pressure. Consequently, the force of the lower blades is greater. It is as though the lower blades were touching the bottom and pushing the stern to the side. When going ahead, therefore, the stern tends to starboard, and when backing, to port. Side force is greatest when the boat begins moving from a stationary position or nearly so, and decreases rapidly as the boat's speed increases. Side force is greater when backing than when going ahead. This side force is the reason why most single-screw powerboats, and even many larger vessels, tend to back much more easily to port than to starboard, especially when maneuvering in tight quarters in shallow water near a pier.

Screw current, caused by the action of a rotating propeller, consists of two parts. The portion flowing into the propeller is the suction current, and the portion flowing away from the propeller is the discharge current. Suction current is a relatively minor force in boat handling. Discharge current is a major force in two main respects: it is a strong force acting on the rudder



The screw (discharge) current, side force, and rudder forces all combine to determine how a boat will respond, as in the backing situation depicted here.

with the screw going ahead, and it is a strong component of side force when the screw is backing because of the discharge current acting against the boat's hull.

Single-screw ships and boats have a single rudder mounted directly behind the propeller. Twin-screw ships and boats usually have a rudder mounted directly behind each propeller, but some have a single rudder mounted between and just behind the propellers. Basically, a rudder is used to attain or maintain a desired heading. The force necessary to do this is created by dynamic pressure against the surface of the rudder. The magnitude of this force and the direction in which it is applied produce the rudder effect that controls stern movement and, through it, the boat's heading. Factors having a bearing on rudder effect include rudder size, rudder angle, rudder location, boat's speed, direction of propeller rotation, headway, sternway, suction current, discharge current, and side force. The diverse effects of all of these factors can be lumped together under a single term, *resultant force*, which indicates the direction and amount of net force exerted on a boat's stern.

A single-screw vessel is most difficult to maneuver at very low speeds when rudder effect is minimal while at the same time propeller side force is greatest.

As mentioned above, one of the most notable characteristics of a single-screw boat or ship is its tendency to back to port. Four distinct controllable forces affect a boat's steering when backing:

- The screw (discharge) current from the propeller (which tends to throw the stern to port)
- The suction current caused by the propeller drawing in water from astern (which adds to the steering effect of the rudder, although not by any great amount)
- The sidewise pressure of the blades (which forces the stern to port)
- The normal steering effect of the rudder

In addition, the uncontrollable forces of wind and current can also have a major effect on how a boat backs.

Typical Situations

Let us examine the effect of the forces just described in a few typical situations. We will assume there is no wind, tide, or current, except in certain instances where it is so stated.

Boat and screw going ahead. When a boat is dead in the water, with right rudder on, and the screw starts turning over, the screw current hits the rudder and forces the stern to port. With left rudder on, the stern moves to starboard. As the boat gathers headway (forward motion), the effect of the screw current diminishes and the normal steering effect of the rudder controls the boat's head.

When the boat is proceeding ahead in the normal manner and the rudder is put right, the boat first falls off to port. If the rudder is put left, the boat first falls off to starboard. The entire boat is thrown slightly (almost imperceptibly) to the side, but the stern gives way to a greater extent. The boat advances two or three boat lengths along the line of the original course before it commences to gain ground in the desired direction. At higher speeds, this advance is slightly less than at lower speeds and turns are executed more quickly. Because of the advance, trying to execute a turn to avoid an obstacle only a short distance ahead can result in disaster.

Boat and screw backing. When backing down, as set forth above, four distinct forces are involved in steering: discharge current, side force, suction current, and rudder effect. The combination of these forces is such that it is almost impossible to back a single-screw boat in a straight line.

Because discharge current (from the propeller) and side force tend to throw the stern to port, most single-screw boats tend to back easiest in that direction. The relatively weak suction current acts to throw the stern to the side on which the rudder is, but suction current is negligible at slow speeds, so the rudder tends to be ineffective. As the boat gathers sternway (backward motion), the water through which the boat is moving acts on the rudder and increases the effect of suction current, so the rudder becomes more effective. This usually slows, but does not necessarily stop, the stern's swing to port. When backing long distances, it usually is necessary to occasionally reverse the rotation of the screw and shift the rudder long enough to straighten out the boat. Until you discover differently, assume that a boat will always naturally back to port.

Strong winds affect backing ships and boats. Most ships and many boats with high superstructures forward will tend to back into strong winds because their upperworks act as weathervanes.

Boat going ahead, screw backing. A boat going ahead with the screw backing is an important illustrative case because it is the usual condition when danger is discovered close ahead or close aboard. One might assume that the rudder would have its usual effect in such a situation, *but this is not true.* As soon as the propeller starts backing, the forces discussed earlier combine and begin to cancel rudder effect.

If the rudder is left amidships (centered), the head falls off to starboard and the boat gains ground to the right as it loses way. This is because both side force and discharge current force the stern to port.

If the rudder is put hard right at the instant the screw starts to back, the boat changes course to starboard. The stern continues to swing to port until, as the boat gathers sternway, the rudder effect becomes great enough to overcome the inertia to port.

If the rudder is put hard left at the instant the propeller backs, the boat's head goes to port at first, and as the speed decreases, the head usually falls off to starboard. Some boats

and ships, however, back stern to starboard for a while if there was a distinct change in course to port before the screw started backing.

Boat going astern, screw ahead. With the boat going astern, the screw going ahead, and the rudder amidships, side force and screw current are the strongest forces. They oppose each other; hence the resultant effect is difficult to determine. You must try it on each boat to obtain the answer. If the rudder is put hard right, the discharge current greatly exceeds the side force and the normal steering effect of the rudder, and the stern swings rapidly to port. Throwing the rudder hard left causes the stern to fall off to starboard.

Making a Landing

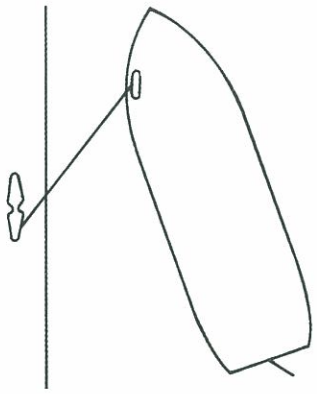
Many books on boat handling tell the beginner to make a landing heading into the wind, if possible, or to make it on the side of the pier where wind or current will set the boat down on the pier. This is good advice, but any Navy Sailor knows that a coxswain often has few opportunities to select the optimum landing. Consequently, the coxswain must learn the effects of the elements on each boat and how to control the boat under any condition. The coxswain will be then able to get under way or make a landing when and where necessary in a smart, seamanlike manner. With experience, the coxswain eventually will be able to adjust to any circumstances and handle the boat correctly as almost second nature.

The techniques that follow, plus a firm understanding of the preceding section, will assist a person learning the basics of boat handling. A boat handler should remember, though, that boats do not always respond exactly as theory predicts and there is no substitute for actual experience.

Throughout this section we assume that the boat handler knows how far the boat, going at various speeds, will travel before a reversing screw stops the boat or changes its direction. We also assume that the boat handler knows how far the boat will fetch (glide) with the screw in neutral.

Making a landing usually involves backing down. For this reason, procedures for landing port-side-to differ from those for a starboard-side-to landing. Let us first consider a port-side-to landing.

Port-side-to landing. Making a port-side-to-the-pier landing is easier than making a starboard-side-to landing because of the factors previously discussed. With no wind or current with which to contend, the approach normally should be at an angle of about 20° with the pier. The boat should be headed for a spot slightly forward of where you intend to stop. Several feet from that point (to allow for advance) put your rudder to starboard to bring your boat parallel to the pier and simultaneously commence backing. Quickly throw the bow painter (bow line) over. Then, with the painter around a cleat to hold the bow in, you can back down until the stern is forced in against the pier.



Making a landing can be simplified with the proper use of lines in conjunction with any current. This diagram shows a port-side-to landing using a spring line.

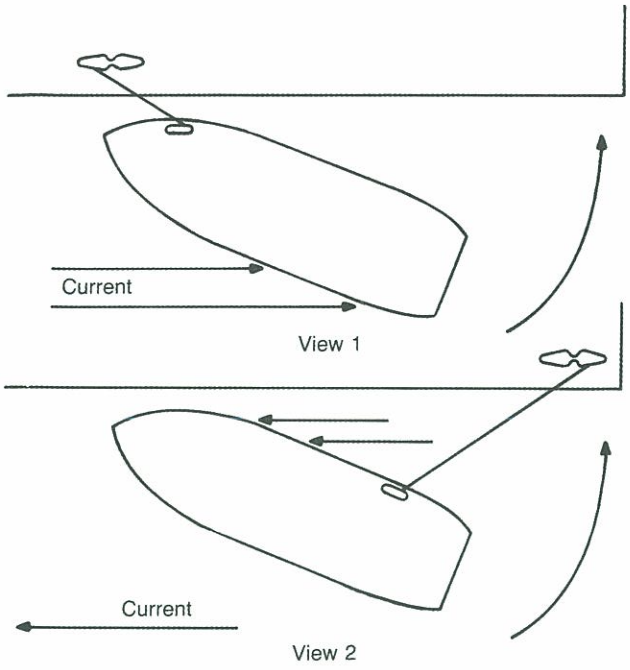
If wind and current are setting the boat off the pier, make the approach at a greater angle and speed. The turn is made closer to the pier. In this situation it is easier to get the stern alongside by using hard right rudder, kicking ahead, and using the bow line as a spring line. To allow the stern to swing in to the pier, the bow line must not be snubbed too short.

If wind or current is setting the boat down on the pier, make the approach at about the same angle as when being set off the pier. Speed should be about the same as or slightly less than when there is no wind or current. The turn must begin farther from the pier because the advance is greater. In this circumstance, the stern can be brought alongside by either of the methods described above, or the boat can be brought parallel to the pier and allowed to drift down alongside.

Starboard-side-to landing. Making a starboard-side-to landing is a bit more difficult than a landing to port. The angle of approach always should approximate that of a port-side-to landing, that is, about 20° with respect to the pier in nominal wind and current conditions. Speed, however, should be slower to avoid having to back down fast to kill headway, with the resultant swing of the stern to port. A spring line should be used when working the stern in alongside the pier. Get the line over, use hard left rudder, and kick ahead.

If you cannot use a spring line (as when approaching a gangway), time your turn so that, when alongside the spot where you intend to swing, your bow is swinging out and your stern is swinging in. When it looks as though the stern will make contact, back down; as you lose way, shift to hard right rudder.

Making use of the current and wind. If there is a fairly strong current from ahead, get the bow line to the pier and the current will bring the boat alongside. If the current is from aft, the same



A starboard-side-to landing in a current using a spring line.

result can be achieved by putting over a stern line first. Take care during the approach because a following current decreases rudder efficiency and steering may be slightly erratic.

Wind can also have a major effect on how a boat handles when making a landing or maneuvering in open water. The more freeboard and the bigger its cabin, the more the vessel will be affected by the wind. Boats with a high profile are more affected than boats with a low profile. As previously mentioned, all boats will tend to turn into the wind because of the weathervane effect, higher-profile boats more so. Winds from the side will also tend to push a boat sideways either toward or away from a pier, depending on their direction. Winds will tend either to amplify the effects of the controllable forces and the current or to nullify them, depending on their strength and direction.

Twin-Screw Boats

On twin-screw boats, when going forward the starboard screw is usually right-handed (clockwise) and the port screw is left-handed (counterclockwise). When backing, the directions of rotation are reversed. The lateral (sidewise) forces produced by one screw cancel those of the other when both are going ahead or astern. When one is going ahead and the other is going astern, however, the forces complement each other and the side force effect is doubled, thus doubling the turning force on the boat. For this reason, maneuvering a twin-screw boat is considerably easier than maneuvering a single-screw boat. You need not worry about the separate forces or their combined effect; think of it as a lever with a force (screw) at each end and the load (boat) in the middle. Thus, you can readily see how much more quickly a particular maneuver may be accomplished by using the correct propeller combinations along with the appropriate rudder angle. For example, to turn your boat 180° to starboard from a dead stop, use right full rudder, port engine ahead, and starboard engine astern. The boat will make the turn in little more than its own length, whereas most single-screw boats would require considerably more space to complete the same turn. It is also much easier to get into a short berth or other confined space with a twin-propeller boat.

Almost all the maneuvers required of a boat can be accomplished by varying the direction and speed of the engines and without using the rudders. An experienced coxswain also can maintain a fair course just by varying the number of turns of the propellers and keeping the rudder amidships.

Boat Etiquette

In the Navy the observance of proper **boat etiquette** is second in importance only to safe boat handling when it comes to judging the competence of a boat's coxswain and crew. Boat etiquette is concerned with customs, honors, and ceremonies observed by the boat coxswain and crew. Most of these are traditions that have been passed down through the years since the founding of the Navy more than two hundred years ago.

These customs promote the smooth loading of passengers, help govern boat traffic, and expedite the movement of boats at gangways and piers. Proper boat etiquette is a sign of good seamanship. It also makes a lasting impression on all who observe it. Clean boats and sharp, courteous crews draw favorable attention and comments. Dirty boats and sloppy boat handling and etiquette draw the opposite.

The following rules of boat etiquette, established by custom and regulations, should serve as a guide to proper conduct when in boats. Passengers in a boat should observe them closely and insist that others do likewise.

Rendering Honors

Hand salutes are rendered to boats carrying officers and officials in much the same way as salutes would be made when passing such individuals while walking on land. Junior boats salute the senior first, and the senior returns the salute. It is not the size or type of boat but the rank of the officer on board that determines a boat's seniority. Thus, a small boat carrying an O-5 commander is senior to a large boat carrying an O-3 lieutenant. Usually it is possible to tell which boat is senior by the officer's uniform or by the flag flown, if any. When in doubt, however, it is best to go ahead and salute.

Boat salutes are rendered by a boat's coxswain and by the senior officer embarked, if any. The engine of the junior boat should be idled during the salute. After the return of the salute, speed may be resumed. Coxswains always rise to salute unless it is dangerous or impractical to do so. Officers generally do not rise to salute but do so from a seated position if visible to the other boat.

During morning or evening colors, a boat's engine should be idled or stopped and the clutch disengaged. The boat officer (if assigned) and the coxswain stand at attention and salute in the direction of the ceremony if it is possible to do so without losing control of the boat.

A coxswain in charge of a boat salutes when officers enter or leave the boat if the situation allows. For example, when a boat is alongside a ship's accommodation ladder, the coxswain oftentimes is too busy maintaining control of the boat to salute.

Finally, personnel working in a boat or working on the ship's side from a boat do not salute unless "Attention" is sounded.

Courtesy on Board Boats

Through the years, the crews and passengers of Navy boats have come to practice certain courtesies. The basic rule in Navy manners, as in civilian life, is to make way for a senior quickly, quietly, and without confusion.

The procedure for boarding and leaving boats is as follows: juniors board boats first and leave after seniors, unless the senior officer gives orders to the contrary. The idea is that the senior officer should not have to wait in a boat for anyone. The senior gets out first because normally his or her business is more important and pressing than that of personnel of lower rank. Generally, seniors take the seats farthest aft; in boats with no officers embarked, the after part of the boat (the stern sheets) is usually reserved for chief petty officers.

Subject to the requirements of the rules for preventing collisions, junior boats must avoid embarrassing (hindering) senior boats. At landings and gangways, juniors should give way to seniors. Juniors should show deference to their seniors at all times by refraining from crossing the bows of their boats or ignoring their presence.

Under ordinary circumstances, enlisted personnel maintain silence when they are passengers in boats with officers on board.

Boat Flag Etiquette

The national ensign and personal flags and pennants of officers are properly displayed from small boats as described below.

National ensign. The national ensign is displayed from Navy boats at the following times:

- When underway during daylight in a foreign port
- When ships are required to be dressed or full dressed
- When going alongside a foreign vessel
- When an officer or official is embarked on an official occasion
- When, in uniform, a flag or general officer, a unit commander, a commanding officer, or a chief of staff is embarked in a boat of his or her command or in one assigned to his or her personal use
- At such other times as may be prescribed by the senior officer present

Personal flags and pennants. When embarked in a boat of the naval service on official occasions, an officer in command, or a chief of staff when acting for him or her, displays from the bow of the boat his or her personal flag or command pennant or, if not entitled to either, a commission pennant.

Critical Thinking

1. In what ways is handling a small boat the same as handling a larger vessel in a seaway? In what ways is it different?

Study Guide Questions

1. With what types of boats will most NJROTC cadets come into contact while on training visits to Navy ships and shore stations?
2. What is
   A. A powerboat
   B. A sailboat
   C. A motor sailer
3. What are the two basic hull forms of boats?
4. Identify the following boat parts:
   A. Transom
   B. Pulpit
   C. Port
5. Explain what differentiates the following sailboat masts:
   A. Foremast
   B. Mainmast
   C. Mizzen
6. What are the two types of fuel used by boat engines?
7. A. What is the generic name given to all small boats in the Navy?
   B. What types of boats does this include?
8. What is the difference between a utility boat and a gig?
9. What is an RHIB?
10. What is the person in charge of a powerboat in the Navy called?
11. What two broad types of forces determine how a boat will handle in any given circumstance?
12. What is the effect of propeller side force on a vessel's stern?
13. When is it most difficult to maneuver a single-screw boat?
14. In what direction will a single-screw boat be easiest to turn when backing?
15. What forces does a coxswain have to reckon with when backing a boat?
16. When a boat is proceeding ahead and the rudder is put over to one side, what happens to the stern initially?
17. What effects does wind have on a boat while under way?
18. When making a landing under nominal conditions, at what angle should the boat approach the pier?
19. On twin-screw boats, in which directions do the two screws turn when going forward?
20. How does a twin-screw boat handle as compared with a single-screw boat?
21. With what is boat etiquette concerned?
22. By whom are boat salutes rendered on board a boat?
23. What is the custom for embarking officers and enlisted personnel on a boat?
24. When should the national ensign be displayed from boats?

New Vocabulary

powerboat
motor sailer
planing hull
catamaran
ports (boat windows)
rail (sailboat)
bowsprit
trawler
auxiliary (sailboat engine)
outboard motors
side force (propeller)
suction current (propeller)
headway
bow painter (line)
sailboat
displacement hull
transom
trimaran
cockpit
pulpit
flying bridge
spreaders (sailboat)
inboard motors
pleasure boat
screw current
discharge current (propeller)
sternway
boat etiquette

Unit 3

Navigation

Navigation is the art and science by which mariners find a vessel's position and guide it safely from one point to another. Most of you would know how to guide yourself, or a boat or ship, by following a magnetic compass needle. The problem is finding your location in the first place. This is the navigator's first job: to locate the ship exactly on the Earth. The navigator can then recommend a course to be steered in order to arrive safely at the destination.

To find out where we are now, we must locate ourselves in relation to something else. For instance: your desk is twenty feet from the back door and directly in front of the teacher's desk. Or your house is on the corner of Elm Street and Western Avenue. Using a road map, we can say that the town of Jefferson is on Highway 26, fifteen miles south of Watertown.

We have now used a tool that is important in locating places: a map. This unit discusses maps of the Earth, in particular maps that show on a flat surface the locations of places important to the maritime nations of the world. The maps used to navigate on the water are called *nautical charts*; they are in essence "pictures of the navigable waters of the Earth." Charts are what the navigator uses when plotting courses and finding the ship's position. The navigator cannot refer to a highway, a crossroads, or towns. There has to be a way of locating the ship on the featureless ocean. The following chapters describe how this is done.

6

Introduction to Navigation

A knowledge of nautical charts and how to use them is basic to operating on water. This chapter discusses the features of nautical charts and the procedures, techniques, and tools used to navigate with them.

The Terrestrial Sphere

Before we can discuss navigation and nautical charts we must first understand how locations and directions are specified on the Earth. In navigation, the Earth is called the *globe* or *terrestrial sphere* (the latter term comes from the Latin word *terra*, which means "earth"). For most practical purposes in navigation, the Earth is considered to be a perfect sphere, although it is actually somewhat flattened at the poles.

On any sphere, any point on its surface is similar to every other point, and all points are equidistant from its center. In order to designate locations on the surface, therefore, there has to be some point or set of points designated as a reference or references to which all other points can be related. Since the Earth spins, two such reference points are the points at which its spin axis pierces its surface: the **North Pole** and the **South Pole**. Imaginary lines that would be formed at the Earth's surface by the intersection of planes passing through the poles are called **meridians of longitude**. They divide the surface of the Earth into sections, much as you might cut an orange into for easy peeling.

The imaginary line formed on the Earth's surface by the intersection of a plane perpendicular to its axis that passes through the center of the Earth, cutting every meridian in half and dividing the Earth into top and bottom halves, is called the **equator**. The word *equator* implies "equal parts." It lies exactly halfway between the two poles. The top half of the globe bisected by the equator is called the **Northern Hemisphere** ("half-sphere"), and the lower half is the **Southern Hemisphere**.

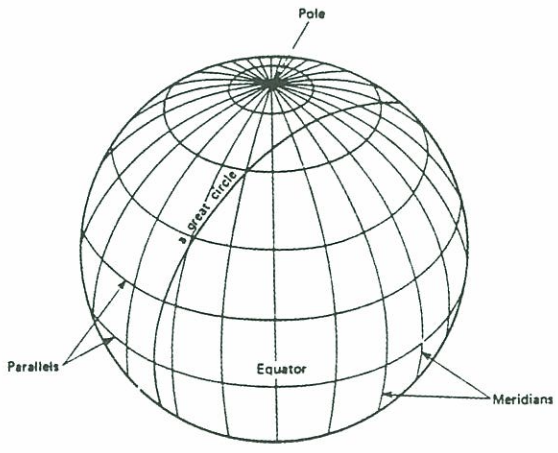
Other imaginary lines formed on the Earth's surface by passing planes through the Earth parallel to and north and south of the plane of the equator are called **parallels of latitude** because they are parallel to the equator. They are all smaller circles than the equator. Of the parallels, only the equator cuts the globe into two hemispheres.

Great Circles

The meridians, the equator, and any other circle formed on the Earth's surface by the intersection of any plane passing through its center so as to divide the globe into two equal hemispheres are called **great circles**.

A look at the globe will show that all meridians of longitude going north and south through the poles are great circles. Of all the circles of latitude going around the globe in an east-west direction, however, only the equator is a great circle. You can also see that a great circle does not have to be a meridian or the equatorial parallel. A great circle is *any* circle whose plane passes through the Earth's center, no matter in what direction.

What is the significance of the great circle in navigation? Just this: the shortest distance between two points on the Earth



The globe with meridians of longitude and parallels of latitude and a great circle. A great circle is any line formed on the Earth's surface by the intersection of a plane passing through its center so as to divide the globe into two equal halves. In addition to the one shown, the other great circles in this drawing are the meridians and the equator.

(or any sphere) lies along the path of a great circle passing through those two points. This path, or segment of a great circle, is an arc on the Earth's rounded surface. It has to be an arc, because a straight line between two points would go under the surface!

Circular Measurement

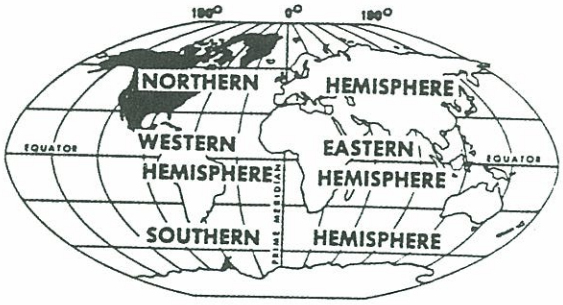
You have learned in your math classes that a circle's *circumference* (its perimeter) contains 360 degrees (°). Regardless of the size of the circle, whether it is the size of a ping-pong ball or of the globe, the circumference has 360°. Each degree contains 60 minutes of arc (symbolized by ′), and each minute contains 60 seconds of arc (symbolized by ″). Therefore, measurements of a segment of a great circle on the circumference of the globe—or in other words, on the Earth's surface—can be expressed in terms of how many degrees, minutes, and seconds of arc the segment subtends. The linear distance measured along the same segment on the Earth's surface can also, of course, be expressed in terms of standard distance units, such as feet, yards, meters, miles, and kilometers. This means that there is a definite relationship between the degrees of arc and the corresponding distance units as measured along the arc of a great circle on the Earth's surface. As we will see in more detail later, each degree of arc along a great circle on Earth's surface subtends sixty miles of distance, and each minute of arc subtends a mile.

Measurements along the circular meridians of longitude or parallels of latitude are routinely expressed in terms of these same degrees, minutes, and seconds of arc—and sometimes, in the case of meridians of longitude, also in terms of these same distance units, since they are great circles.

Meridians

Just as an infinite number of planes can be passed through the Earth's poles, an infinite number of meridians of longitude run from pole to pole. Rarely, however, are they drawn on a globe more often than for every five or ten degrees of longitude. On charts or maps, though, depending on the scale, they may be drawn for every degree of longitude, or even for every ten minutes within a degree. The starting or reference place for numbering these meridians of longitude is the meridian on which the Royal Observatory at Greenwich, England, is located. The Greenwich meridian, therefore, is numbered 0, or 0°, and is called the **prime meridian**.

Halfway around the globe from the prime meridian is the 180th meridian. The 180th meridian is the other half of the 0 meridian; together they make a great circle that divides the globe into the **Eastern Hemisphere** and **Western Hemisphere**. The Eastern Hemisphere is that portion of the globe between 0° and 180° east of the prime meridian, and the Western Hemisphere is that part between 0° and 180° west of the prime meridian. The 180th meridian is called the **International Date Line** (discussed further in chapter 9 of this unit). Meridians of longitude between the prime meridian and the date line are numbered from 0° to 180° east (E) or west (W), depending on how far east or west they are from the prime meridian. For example, a location in the Western Hemisphere might be at 70° W longitude, while one in the Eastern Hemisphere might be at 120° E longitude.



A projection of the globe showing the four hemispheres, divided by the equator, the prime meridian, and the International Date Line.

Parallels

Similar to the case for meridians, an infinite number of planes can be passed through the Earth parallel to the equator, so there is an infinite number of parallels of latitude. Like meridians, on a globe parallels of latitude are typically drawn for about every five or ten degrees of latitude, and on charts and maps, they may be drawn for every degree or every ten minutes within a degree, depending on the scale. The starting place for numbering these parallels of latitude is the equator, the 0° parallel. Parallels are numbered from 0° at the equator to 90° north (N) at the North Pole, and from 0° to 90° south (S) at the South Pole. A place in the Northern Hemisphere, for example, might be located at 35° N latitude, while one in the Southern Hemisphere might be at 50° S latitude.

Latitude and Longitude

From the discussions above we have seen that a network of parallels of latitude and meridians of longitude extends all over the globe. Thus, the location of every spot on the Earth can be specified in terms of its latitude and longitude. *Latitude* is the arc distance north (N) or south (S) of the equator. It is expressed in degrees, minutes, and seconds, measured along the meridian of the place. *Longitude* is the arc distance in degrees, minutes, and seconds east (E) or west (W) of the prime meridian,

measured along the parallel of latitude. Let's state it again: latitude is always measured north or south from 0° through 90°, and longitude is always measured east or west from 0° through 180°. By convention, when specifying the location of a place on the Earth's surface, the latitude is always stated first, and then the longitude.

For example, the position of Washington, D.C., is 38° 58′ N latitude, 77° 01′ W longitude. This is spoken as thirty-eight degrees, fifty-eight minutes north; seventy-seven degrees, one minute west. Seconds are used only if very exact locations are required. Every spot on the Earth can be located precisely by this method. You should become very familiar with locating places on the globe this way.

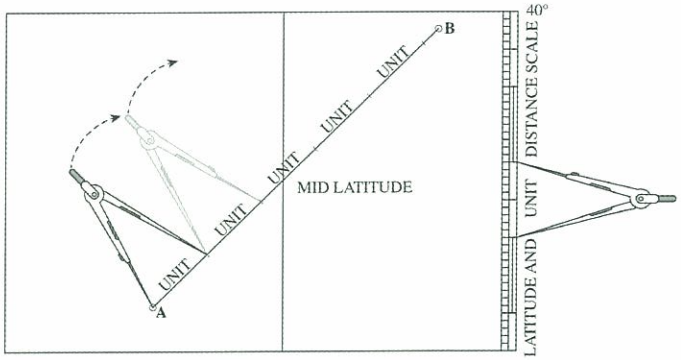
Nautical Measurements

Distance

In talking earlier about degrees of arc in relation to the Earth's surface, we were also indirectly talking about nautical distance, or distances at sea, because if you divide the Earth's circumference, 21,600 nautical miles, by the number of minutes of arc in 360°, you get 1 nautical mile per minute of arc along any great circle. A **nautical mile** is about 1.15 (one and one-seventh) statute or land miles, or about 6,076 feet. For most applications in the Navy and marine navigation, this is rounded to 2,000 yards; a statute mile by comparison is 5,280 feet, or 1,760 yards.

Since meridians of longitude are great circles, they can be used as convenient distance scales. Because of the way they are projected onto Mercator charts, the most common chart type used in marine navigation, meridians appear as straight vertical lines on a chart running north and south, parallel to and equidistant from one another. Parallels of latitude appear as horizontal lines on the chart running east and west.

The meridians that form the sides of large-scale charts are typically graduated in minutes of latitude between the printed latitude lines, each of which corresponds to one nautical mile of distance, or two thousand yards. Because of increasing distortion in this type of chart as the distance from the equator increases, the space between parallels on a chart—and the length of the minute graduations within them—increases with increasing latitude. The distance represented by each minute of latitude, however, always remains the same: one nautical mile, regardless of this expansion. Thus, when distance measurements are made on such a chart using instruments called **dividers** (see the illustration), it is important to always take the dividers to the middle of the latitude scale on the side of the chart adjacent to where the distance is being measured to obtain the distance reading, especially on a chart depicting a large area. Distance bar scales printed on the chart represent the average distance between minutes and degrees of latitude



When measuring distance on a chart using dividers with the latitude scale, as in the example shown here, it is important to always take the dividers to the middle of the latitude scale adjacent to where the distance is being measured (i.e., the *mid-latitude*). Once the dividers are set, the distance on the line between points A and B is determined by "walking" the dividers along the line as indicated.

over the area depicted on the chart, so on smaller-scale charts depicting large areas it is usually more accurate to make distance measurements along the appropriate latitude scale rather than to use the bar scales. On large-scale charts depicting smaller areas, however, the difference between the two distances as determined by use of the latitude scale as opposed to the chart bar scale is negligible.

Speed

The unit of speed in the marine environment is the **knot**, a nautical term meaning "nautical miles per hour." It is incorrect to say "knots per hour" except when referring to increases or decreases in speed (i.e., accelerations). The term comes from old sailing days when ships determined their speed through the water by running out a line knotted at fractions of a nautical mile. The line was attached to a flat piece of wood called a *chip log*. The amount of line (number of knots) that ran out in two or three minutes gave an estimate of the ship's speed, from which the number of nautical miles covered per hour could be calculated.

Nowadays a vessel's speed through the water is usually determined by use of a *speed log* (like a speedometer), either mechanical or electronic. One very commonly used type of *mechanical speed log*, especially on small craft, has a small propeller that extends down beneath a vessel's hull. The water streaming past the hull rotates the propeller, and the vessel's speed is proportional to the speed of rotation. Another type commonly found on larger vessels uses a *pitot tube* that measures the speed of the water stream by pressure differences. *Electronic speed logs* measure vessel's speed electronically, either by use of GPS (Global Positioning System) or by projecting sound beams down into the water.

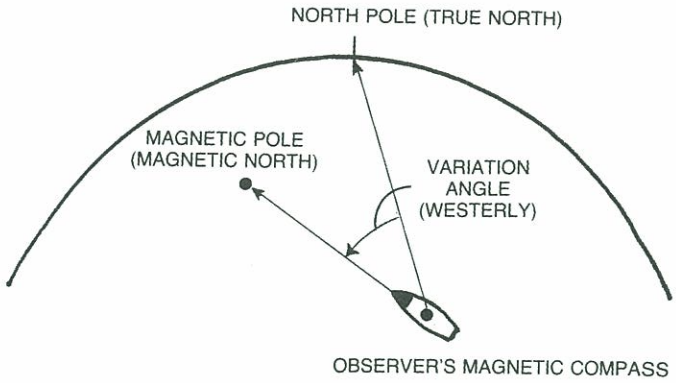
Direction

Nautical directions, like directions on land, are customarily measured with reference to true north (the North Pole) as located on a globe. Such directions are called **true directions**. In olden days directions were expressed in terms of sixteen *points* on the compass, such as north, north-northeast, northeast, east-southeast, and so on. Today navigators use a system of horizontal angular measurement using 360° of arc, which is more precise and convenient. A **compass card** (circular card in a magnetic compass and in gyrocompass repeaters) shows the readings of degrees of arc. As will be described in chapter 8 of this unit, the four *cardinal points* (north, 000°; east, 090°; south, 180°; and west, 270°) are still used to describe the top-marks used on *cardinal buoys* in foreign waters.

A nautical direction is always expressed using three figures, regardless of whether three digits are necessary. In other words, it is not 45° (forty-five degrees), but 045° (spoken "zero four five degrees").

Most naval ships, submarines, and aircraft are fitted with an instrument called a **gyrocompass** that always points toward true north with little if any error. When available, it is used as the reference for all true direction and course measurements. To make its use practical, remote *gyrocompass repeaters* with rotating compass cards in them are installed in the cockpit of an aircraft or the bridge of a vessel for use in steering and, in the case of a vessel, wherever else necessary to obtain directions to other vessels, navigation aids, and landmarks.

A gyrocompass, however, is expensive, bulky, and needs a power supply to operate. Smaller ships, boats, aircraft, and many ground vehicles therefore use relatively inexpensive **magnetic compasses** similar to those you may have used in Scouting or in a science class as a directional reference. Magnetic compasses do not require power, are simple in construction, are highly portable, and can be easily installed almost anywhere. Like gyrocompass repeaters, magnetic compasses used for marine navigation incorporate a rotating compass card graduated in 360 degrees, with a magnetized 0° reference that points like a compass needle in the direction of the Earth's **magnetic north pole**, which is currently situated in northern Canada. Directions obtained using a magnetic compass are called *magnetic* or *compass* directions, depending on whether or not they are compensated for any **deviation** (a potential compass error caused by the presence of nearby iron metal that can deflect a magnetic compass). Compensated directions obtained with a magnetic compass are called *magnetic directions*, labeled °M (e.g., 085° M). Uncompensated directions are called *compass directions* and labeled °C (e.g., 085° C). If the deviation is significant (i.e., more than a half degree or so of deflection), a correction for the resulting compass error (CE) will have to be made to all directions obtained with that compass. Most magnetic compasses used on board naval vessels and aircraft are precompensated for any deviation that may occur at their location, so they have no compass error.



The relationship between true north and magnetic north. The angle between the two directions is called the *variation angle*. Here, the variation angle is westerly, since at the observer's location the magnetic compass needle points to the west of true north.

Because the Earth's magnetic north pole is some distance away from the geographic (true) North Pole, there is usually an angle between magnetic and true north at all locations on Earth. This angle is called the **variation angle**. If the magnetic compass points east of true north, the variation angle is labeled *east*. If the magnetic compass points west of true north, the variation angle is labeled *west*. The size and direction of the variation angle at any location on the Earth's oceans are printed within a graphic called a *compass rose* on nautical charts of the area; it will be described in more detail below. Because the Earth's magnetic north pole wanders from year to year, the amount of resulting yearly change in the variation angle is also given.

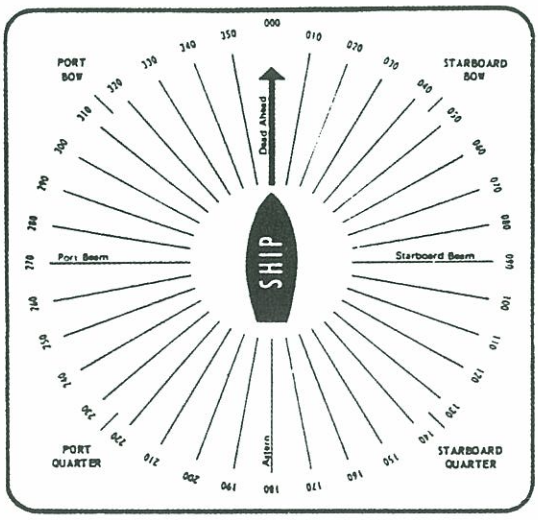
Magnetic and true directions can be converted back and forth very simply. To convert from magnetic to true, just add or subtract the variation at your location to the magnetic bearing. Easterly variations are added, and westerly variations are subtracted. For example, if your vessel were heading 090° M in an area where the variation was 10° East, the true heading would be 090° + 10°, or 100° true. To convert from true to magnetic, do the reverse. For example, if you wanted to proceed on course 270° true in the same area, you would steer 270° – 10°, or 260° M. To avoid confusion, true directions are sometimes labeled with a T; magnetic directions are always labeled with an M. If a direction is unlabeled, it is assumed that it is a true direction.

It is important to be able to make these kinds of conversions because nautical charts and land maps are drawn up based on true directions, but small vessels, aircraft, and land vehicles are often fitted with magnetic compasses, necessitating frequent conversions back and forth between these two types of direction during navigation.

The direction in which a vessel is facing at any moment is its **heading**. The direction that a vessel is steered through the water is its **course**. Because they are directions, headings and courses are always expressed in three digits. There is usually some difference between the two when underway as a vessel tosses and turns because of wind and wave and current action and the like.

A **bearing** is the direction of an object from an observer, measured clockwise from one of three references. A *true bearing* is the direction of an object measured clockwise from true north, usually by use of a gyrocompass repeater; a *magnetic bearing* is the direction of an object measured clockwise from magnetic north by use of a magnetic compass; and a *relative bearing* is the direction of an object measured clockwise from a vessel's bow. Once obtained, bearings observed by one method can easily be converted to other types of bearings by the procedure described above for converting between true and magnetic directions, or in the case of a relative bearing, by adding the relative bearing of the object sighted to the vessel's heading.

To facilitate bearing observations, gyrocompass repeaters are fitted on the top with a rotatable ring called a *bearing* or *azimuth circle* incorporating sighting vanes, analogous to sights on a rifle or target-shooting pistol. A bearing circle has only one pair of sight vanes on it to take surface bearings, and an azimuth circle has an additional pair of sights designed for taking the bearing (azimuth) to celestial bodies. The far sight vanes of both pairs of sights have a small mirror in them that puts the compass card beneath into the field of vision so bearings can be easily read. A *telescopic alidade* is a similar device fitted with a telescope to facilitate observing surface bearings to more distant objects.



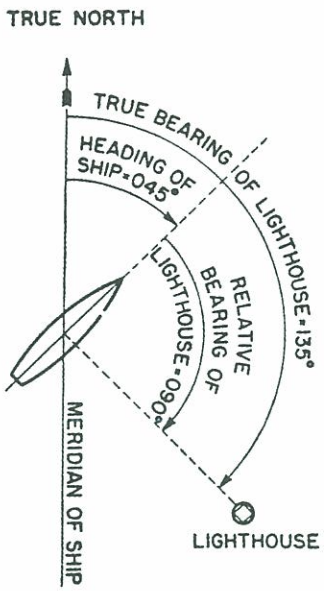
Relative bearing card showing numerical and descriptive relative bearings from a ship.

Bearings, like other nautical directions, are always written or spoken using three digits. When recording or saying a bearing, it is assumed to be a true bearing unless followed by the letter M or R, or the spoken words "magnetic" or "relative." For example, 030° M means 30° to the right of magnetic north, spoken "zero three zero degrees magnetic," while 030° R means 30° off the starboard bow, spoken "zero three zero degrees relative." Objects seen by lookouts are reported in terms of relative bearing by degrees. Note the following relative bearings: dead ahead, or bow, 000° R; starboard beam, 090° R; dead astern, 180° R; and port beam, 270° R.

As stated above, to go from a relative to a true or magnetic bearing, just add the relative bearing of the object sighted to the vessel's heading. If the sum is less than 360°, that sum is the

A quartermaster takes a bearing to the sun on an aircraft carrier using an azimuth circle. Tall sight vanes for use in taking a surface bearing are also plainly visible. A bearing circle would have only the surface bearing sights on it. *Anthony Riddle*

A quartermaster takes a bearing using a telescopic alidade. *Taylor Elberg*



A comparison of true and relative bearings showing the relationship between them.

true or magnetic bearing of the object. If the sum is more than 360°, subtract 360 from the sum. If going from true or magnetic to relative (not often done in practice), the reverse procedure is followed.

Nautical Charts

A globe like those in a classroom is a spherical, three-dimensional (length, width, and height) object that depicts the Earth's surface. But even if it were large enough for navigation, it is not practical to do navigational work such as charting courses or intended tracks from one place to another on a round surface like that of a globe. It is therefore necessary to convert the round surface of the small globe to an expanded one that is flat and two-dimensional (having only length and width).

Such conversions are done by **cartographers** using techniques called **projections**, wherein a portion of the surface of the globe is mathematically projected onto the surface of a flat sheet of paper to produce a *map* or *chart*. These techniques make it possible to create maps and charts that depict greatly expanded portions of the Earth's surface while preserving the true shapes and directions of land and water features, although their relative size may be increasingly distorted as the distance from the equator increases.

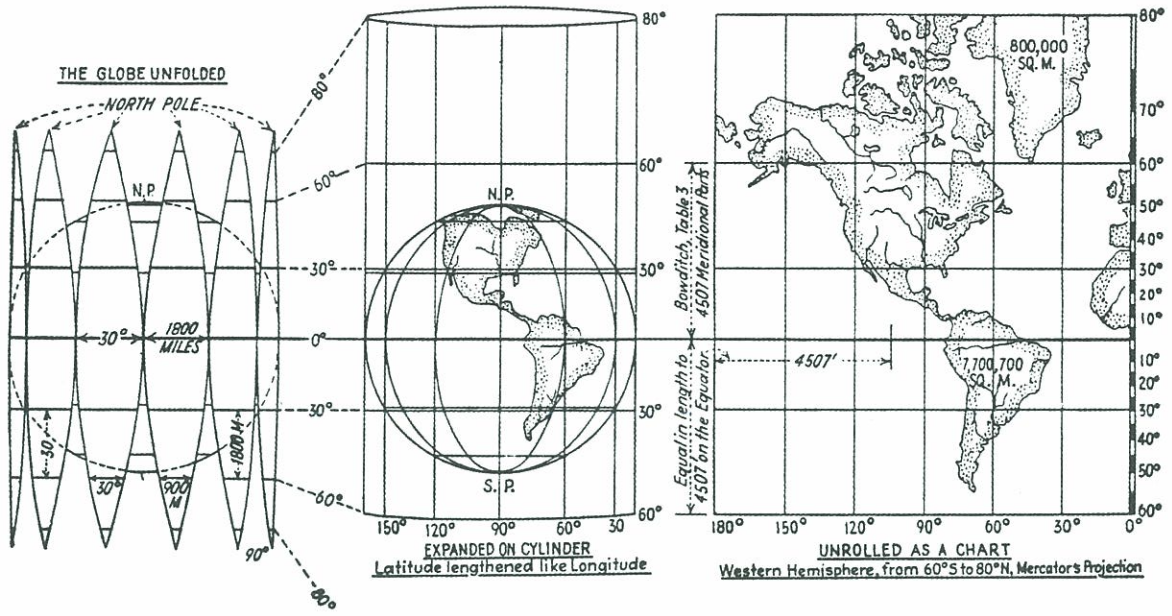
There is a difference between a map and a chart. A **map** is a representation of a land area on the Earth's surface. It shows political subdivisions, physical topography, cities and towns, roads, and other geographic information. A **nautical chart**, on the other hand, is primarily concerned with depicting navigable water areas. It depicts nearby land outlines and features only to the extent necessary to help a ship's navigator find his or her way at sea. Nautical charts convey a great deal of **hydrographic information** about the water areas they cover. They have shading and soundings (depth measurements) throughout water areas to indicate different water depths and depth contours. They depict bottom composition, channels, and obstructions; and they have symbols representing navigational aids such as buoys, lights, and beacons (discussed in chapter 8 of this unit).

In the United States, paper nautical charts are produced jointly by the National Geospatial-Intelligence Agency (NGA) and by the National Oceanic and Atmospheric Administration (NOAA), and are available for purchase from several Internet vendors and nautical supply stores in most coastal cities and towns throughout the United States. In addition to these traditional paper nautical charts, the NGA produces **electronic navigational charts** (ENCs) that can be used in computers and various types of electronic plotters. These are available free of charge directly from NOAA and for purchase from a number of private Internet vendors and nautical supply stores.

Chart Projections

The best-known and most widely used map and nautical chart projection is the **Mercator projection**. It is the one teachers generally use to locate geographic places when they display maps in the classroom. It is the projection used for road maps on land, and for most nautical charts used at sea. The Mercator projection was developed by a Dutch cartographer, Gerardus Mercator, in the 1500s. In this projection, the surface features of the spherical globe are projected onto a cylindrical piece of paper, wrapped around, or *tangent* to, the globe at the equator. Then the paper is cut at convenient meridians and spread flat. A Mercator projection of the world, for instance, is usually cut vertically near the International Date Line so the continental land areas are shown almost unbroken.

Because of the method of projection, increasing distortion occurs the farther the area depicted on a Mercator chart is from the equator, with the greatest distortion occurring in the polar regions. However, cartographers make this distortion uniform, or *conformal*, in both latitude and longitude so that any straight line drawn on it, called a **rhumb line**, is a line of true bearing that makes the same angle with all meridians it crosses, even at high latitudes, and the true shape of land features is preserved. A disadvantage, however, is that great circles appear as *curves* on a Mercator projection, with the amount of curvature increasing with the size of the area depicted and its distance from the equator. The large amount of distortion at high latitudes makes the island of Greenland in the Northern Hemisphere appear much larger than South America on a Mercator projection, as does Antarctica in the Southern Hemisphere,



A Mercator chart is made by projecting the spherical globe onto a cylindrical piece of paper tangent at the equator. In effect this cuts the globe up much like an orange might be sliced into sections. Distortion is minimal near the equator but increases rapidly as the poles are approached.

when the reverse is actually true. The closer a surface feature depicted on a Mercator map or chart is to the equator, the more its relative size approaches what it would be on a globe of similar scale. Since the poles are at infinity in this type of projection, Mercator charts of the world are nominally cut off at about 82° north and south latitude.

Depending on the scale of the chart, commonly used Mercator nautical charts can depict the whole world or an entire mid-ocean area; an approach area adjacent to a coast; or all or part of an inland harbor, bay, or navigable river.

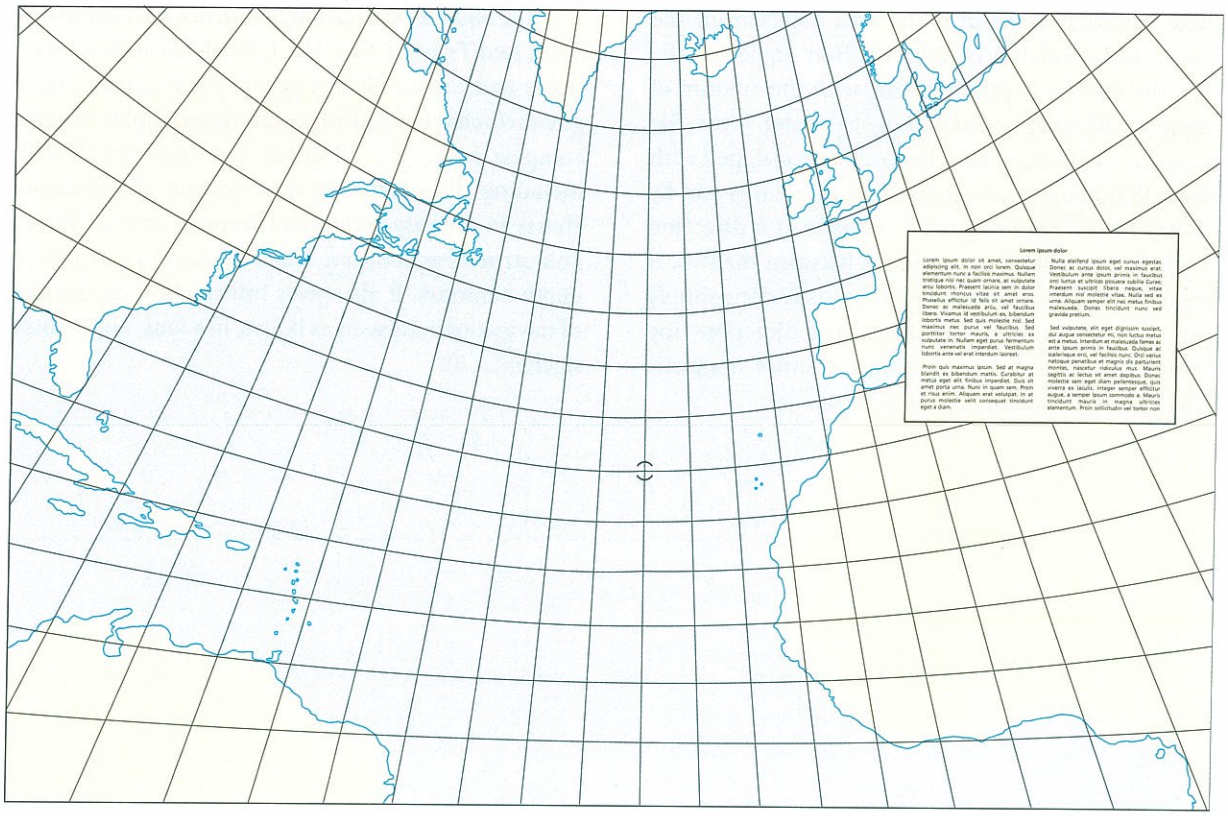
In addition to the Mercator projection charts, there are two other projection techniques used for more specialized charts. A **gnomonic projection** is a geometrical projection in which the surface features and reference lines of the globe are projected outward from its center onto a flat surface tangent to the globe in the center of the area depicted. This type of chart mainly depicts large ocean areas and polar regions that Mercator charts cannot depict. Its main advantage is that it shows great circles as straight lines rather than as curves, as they appear to be on small-scale Mercator charts of the same area. A navigator planning a voyage can plot a desired great circle route as a straight line on a gnomonic chart, then transfer a series of waypoints along the route onto the corresponding Mercator charts. Lines connecting the waypoints on the Mercator navigational charts will then be rhumb lines indicating the various course legs a vessel should steer as it makes its transit along the great circle route. The course legs will then approximate the arc of the great circle route, which as we learned above represents the shortest distance between two points on the globe.

The third type of projection, called a **Lambert conformal conic projection** after its inventor in the late 1700s, is made by projecting a portion of the surface of the globe onto a tangent cone. It also depicts great circle distances as straight lines. With the exception of a series of charts depicting the Great Lakes, this type of projection is most extensively used in aviation.

Chart Scales

The **scale** of a chart refers to a measurement of distance. It is a comparison of an actual geographical distance or size of a feature with that shown on the chart. The scale of a chart is normally printed near its *legend* (chart label) in the form of a *ratio*, such as 1:5,000 (meaning that the feature shown is actually five thousand times larger than its size on the chart). Said in another way, an inch or centimeter or other measurement on the chart represents five thousand identical units on the real Earth's surface. The smaller the ratio, the smaller the scale of the chart. A chart with a scale of 1:5,000 is on a much larger scale than one whose scale is 1:150,000, for example. Small scales are used to depict large areas on a chart, and large scales are used to depict small areas.

Remember, the larger the scale, the smaller the area depicted on a given chart or map. Large-scale charts show areas in greater detail. Features that appear on a large-scale chart may not show up at all on a small-scale chart of the same area.

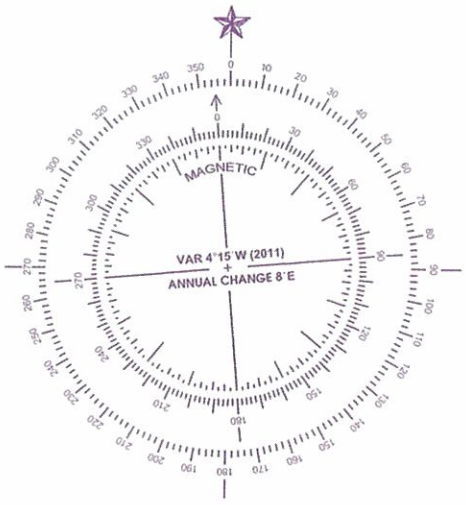


A gnomonic chart of the North Atlantic.

Chart Features

Scattered all over water areas of any but the smallest-scale nautical chart are many tiny numbers called **soundings**, each representing the depth of water in that particular place. Depths may be given in feet, fathoms (one fathom equals six feet), or meters. A notation under the title of the chart gives the depth key; for example, "Soundings in meters [or feet or fathoms] at mean low water." Soundings expressed in feet or fathoms are printed using vertical numbers, and those expressed in meters are slanted. Most charts also have dotted lines called **depth contours** delineating the limits of areas of certain depths and shoal waters, like ten meters or fifty feet. Most modern charts give water depth, heights of lights and bridges, and land contours all in meters, although some older ones still use feet for heights, or fathoms or feet for depths. They show standardized symbols for navigation aids such as buoys, lights, and beacons, with their light characteristics and markings printed in abbreviated form nearby.

Also printed on every Mercator chart is at least one graphic, and usually more, called a **compass rose**, consisting of a magenta-colored outer circle of true directions graduated clockwise from 0 to 360°, and a similar inner circle of magnetic directions rotated from the true direction circle by the amount



A compass rose on a nautical chart. Note the variation for the area of the chart for the year 2011 in the center, by which amount the magnetic compass graduations in the inner circle are rotated from true north. If the exact variation for, say, 2020 were desired, it would be necessary to subtract 9 × 8 minutes (the stated annual easterly increase), to get 3° 03′ W. *NOAA*

of the average variation angle over the area depicted on the chart. The size and direction of the variation angle for the year in which the chart was printed along with the amount of annual increase or decrease are stated in the center. Thus, the same chart can be readily used both by mariners equipped with a gyrocompass that allows them to use true directions and by others who may have only a magnetic compass as a direction reference, with no necessity for conversion between the two. If such conversion is desired, however, it can be easily done simply by observing what direction on the outer true direction ring corresponds with the same direction on the inner magnetic direction ring directly beneath it, or vice versa.

The NOAA publication *Nautical Chart Symbols, Abbreviations, and Terms, Chart No. 1*, available at most marine supply stores and on the NOAA website (**www.nauticalcharts.noaa.gov/mcd/chartno1.htm**), contains examples of chart legends, compass roses, and all other chart features described above, including the numerous symbols and abbreviations used on charts to identify prominent features of coastlines, buildings and structures, bottom features, hazards to navigation, and depth contours. It also gives information on the identification of navigation aids such as buoys, beacons, and lights (described in chapter 8).

Critical Thinking

1. In what ways are navigating on the water and navigating on land the same? In what ways are they different?
2. Draw a globe and show the following on it: longitude lines, parallels of latitude, the equator, the spin axis, North and South Poles, and the prime meridian. Then draw a corresponding two-dimensional map of the Earth showing the same features on it (except for the spin axis and poles).

Study Guide Questions

1. What is navigation?
2. What is the terrestrial sphere?
3. What are the points at which the Earth's spin axis penetrates its surface called?
4. What are the imaginary lines formed on the Earth's surface by the intersection of planes passing through the poles?
5. What name is given to the imaginary line formed by a horizontal plane passing through the center of the Earth, cutting every meridian in half?
6. What are the hemispheres on each side of the equator called?
7. What are the imaginary lines formed on the Earth's surface by planes parallel to the equator?
8. A. What is a great circle?
   B. What is the shortest distance between two points on the Earth?
9. A. What is the circumference of a circle?
   B. How many degrees does it have?
10. A. Into what units may degrees be divided?
    B. What are the corresponding distances as measured along great circles on the Earth's surface?
11. A. Where is the reference place for the prime meridian?
    B. What is the meridian exactly opposite the prime meridian on the other side of the globe called?
    C. What two hemispheres does this great circle line create?
12. How are parallels of latitude numbered?
13. Using an atlas or other reference book, locate the following places in terms of their latitude and longitude in degrees and minutes:
    A. Washington, D.C.
    B. Chicago, Illinois
    C. San Diego, California
    D. Honolulu, Hawaii
    E. Colón, Panama
    F. Gibraltar
    G. Baghdad, Iraq
    H. Tokyo, Japan
    I. Sydney, Australia
14. A. How are distances measured at sea?
    B. Compare a land or statute mile with a nautical mile.
15. A. How are distances measured on a nautical chart?
    B. What tool is used to measure distance on a chart?
16. A. What is the unit of speed in the marine environment?
    B. How are speeds determined on a vessel?
17. What are the true directions of the four cardinal points of the compass?
18. What are the instruments by which direction can be reckoned on a vessel?
19. Compare and contrast a true bearing, a magnetic bearing, and a relative bearing.
20. If a ship is on course 050° T, and a lookout sights an object on the starboard beam at 090° R, what is the true bearing of the object?
21. If a lookout sights a merchant ship at 285° R, forward of the port beam, and his or her own ship's course is 135° T, what is the true bearing of the contact?
22. A. What is a nautical chart?
    B. How does it differ from a map?
23. What does the hydrographic information on a chart consist of?
24. A. What is the best-known and most widely used map and nautical chart projection?
    B. Where is the greatest distortion on this kind of projection? Why?
25. A. What is a gnomonic projection?
    B. How is this type of chart used by a navigator during voyage planning?

26. What is meant by the scale of a chart?
27. A. What are soundings?
    B. How are they shown on a nautical chart?
28. A. What is a compass rose?
    B. What does it facilitate?

New Vocabulary

navigation
meridians
parallels
great circle
prime meridian
nautical mile
dividers
speed log
cardinal points
magnetic compass
variation angle
course, course line
nautical chart
NOAA
Mercator projection
gnomonic projection
scale (chart)
sounding (depth)
terrestrial sphere
longitude
latitude
circumference
International Date Line
statute (land) mile
knot (nautical speed unit)
true direction
gyrocompass
magnetic north pole
heading
bearing
electronic navigational chart (ENC)
hydrographic information
rhumb line
Lambert conformal conic projection
legend (chart)
depth contour

7

Marine Navigation

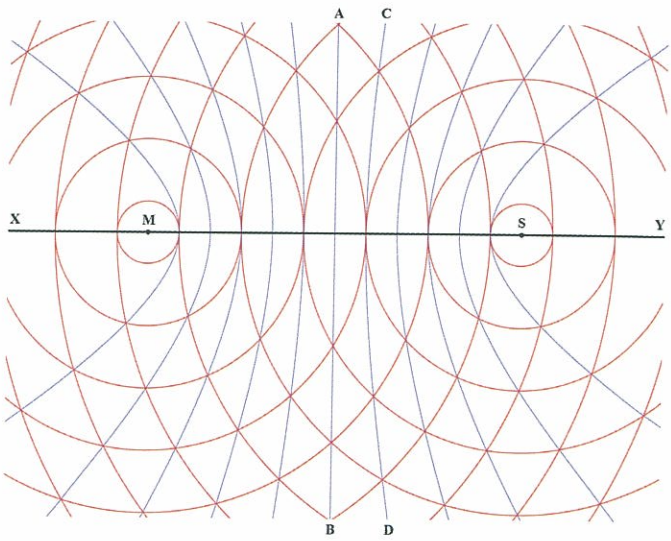
Now that you are familiar with the terrestrial coordinate system and nautical charts from the preceding chapter we are ready to discuss how these come into play when navigating a vessel at sea, called **marine navigation**. Although the subject matter in the following sections focuses on the navigation of surface craft in the marine environment, the principles are also applicable to subsurface navigation of submarines, and by extension to land and air navigation as well.

The Evolution of Marine Navigation

For most of the early history of seafaring over the last two thousand years or so, marine navigation was a rather arcane (mystical) art and science performed mainly by a select few mariners skilled in its practice. Major advances in marine navigation occurred with the development of cartography and the marine magnetic compass in the 1400s that made possible the Age of Discovery over the next three centuries. The invention of accurate timepieces in the 1700s enabled longitude and thence position at sea to be determined from celestial observations.

When radio technology became available early in the twentieth century, it was gradually adapted for marine navigation as well. The use of radio waves made it possible for the first time in history to determine a vessel's position when well offshore at sea in any weather condition, independent of any need for visual observations of celestial bodies or landmarks. A navigator could get radio bearings, and later other kinds of positioning information, to and from stations or points far beyond what people could see from on board ship. Position finding in mid-ocean regions, however, still required the use of traditional celestial navigation techniques.

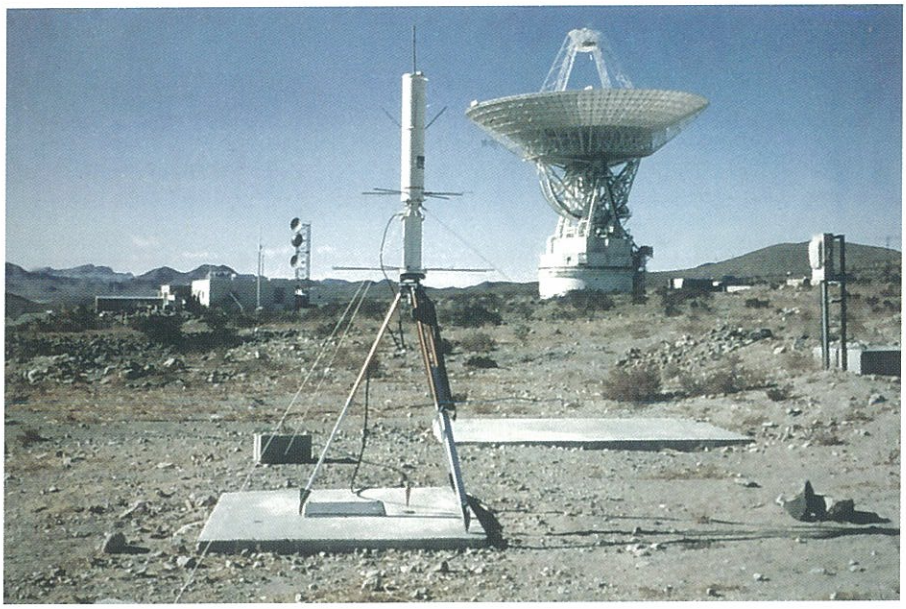
In the 1950s several different kinds of **hyperbolic radionavigation systems** were introduced. With names such as Decca, Loran, and Omega, these consisted of networks of ground station radio transmitters that established hyperbolic grids of lines of position formed by their long-range radio signals. At first these networks were mainly regional in nature, but eventually in the case of Omega and to a lesser extent loran,



Hyperbolic lines of position, shown here in blue, were established from the interaction of radio signals (shown in red) transmitted by a pair of master and slave stations in the hyperbolic navigation systems of the second half of the twentieth century. The intersection of lines of position formed by at least two such pairs determined a fix.

the coverage became worldwide. With the proper receivers and charts overprinted with their grid lines, navigators for the first time could obtain lines of position and determine and plot fixes whenever and wherever they wanted in all types of weather throughout the entire world. These systems remained in use until the last of them was decommissioned in 2010.

In the 1960s space technology was added, enabling positioning information to be obtained from radio signals transmitted by satellites in orbit around the Earth. The Navy established the first complete system of this kind in 1964. It was called the **Navy Satellite System** (NAVSAT for short), or Transit in the civilian community, after the names given the satellites. It ultimately consisted of eight transmitting satellites in six-hundred-mile-high orbits. They provided intermittent two-dimensional position-fixing capability about every thirty to ninety



A Navy NAVSAT ground station at Goldstone Lake, California, circa 1980. *NASA*

Museum model of an early NAVSAT satellite. *National Electronic Museum, Daderot*

minutes at mid-latitudes worldwide, with longer intervals in lower latitudes near the equator. Initially intended as a navigation aid primarily for Polaris ballistic missile submarines, the NAVSAT system's use soon spread to other military and civil navigation applications of all kinds in both the United States and abroad. For the next thirty years until it was phased out in 1996, NAVSAT proved to be one of the most cost-effective government-sponsored programs in U.S. history, providing highly reliable positioning information to all manner of users worldwide.

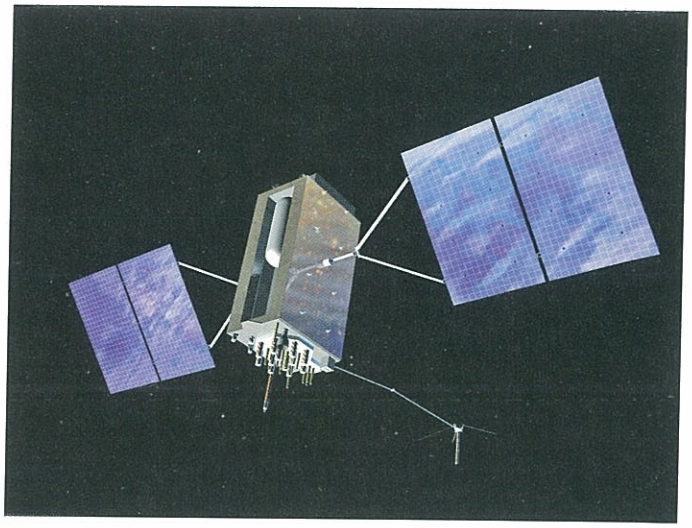
The Global Positioning System

In 1973 the U.S. Department of Defense initiated the development program for what would become the **Navstar Global Positioning System**, now familiar to everyone simply by its acronym, GPS. It is operated and maintained by the U.S. Air Force to meet national defense, homeland security, and civil, commercial, and scientific needs. It became fully operational in 1995 with the orbiting of twenty-four operational satellites. The first receivers were large, bulky sets costing some $10,000 each, but continuing advances in solid state electronics technology sparked largely by the computer and space industries brought rapid and dramatic reductions in both their size and price, eventually resulting in all the ways in which we currently use this system.

As of January 2017 the GPS system consists of a constellation of thirty-one operational satellites plus some older decommissioned ones that could be reactivated in case of need, and their supporting ground stations. The satellites circle the Earth in six 10,900-mile-high circular orbits. First-generation Block I GPS satellites broadcast signals on two frequencies, one for general civil use and the other for military use, but the Block II satellites now in orbit broadcast signals on two additional frequencies for civil use and two others exclusively for military use. Next-generation Block III satellites now in production for

A Delta II rocket blasts off with a GPS satellite on board. *USAF*

Artist's rendition of a GPS Navstar Block II satellite. *USAF*



Artist's rendition of a GPS Block III satellite. *USAF*

launch over the next several years will broadcast even more signals, including a fourth civil signal designed to facilitate interoperability between GPS and other international global satellite navigation systems (described below).

The basic GPS civil signal broadcast by all satellites, designated the L1 signal, is specified by the U.S. government to be capable of providing continuous three-dimensional positioning information on land, sea, and in the air accurate to within 7.8 meters (25 feet) of true position everywhere on the Earth, 95 percent of the time. Actual system performance exceeds this specification, with the average error in recent years being less than 1 meter (about 3.3 feet) most of the time. The accuracy actually experienced by civil GPS devices, however, varies depending on satellite geometry, signal blockage, atmospheric conditions, and the quality of the receiver. The average GPS-enabled smartphones that use this L1 signal, for example, are typically accurate to within about 5 meters (roughly 16 feet) under open sky, and are slightly less accurate within buildings, on bridges, under trees, in vehicles, and the like.

An Air Force satellite systems technician checks a bank of monitors at the Air Force GPS operations center at Schriever Air Force Base in Colorado. It maintains and monitors all the satellites in the GPS system. *USAF, Mike Meares*

Most other GPS-enabled devices commercially available to the general public use only the basic standard GPS L1 civil signal as well. The other two Block II and III satellite signals that civil users can access for such needs as surveying and aircraft navigation and air traffic control require much more expensive specialized receivers. U.S. military GPS receivers and guidance systems use the two additional military signals transmitted by the newer GPS satellites to eliminate signal distortion error caused by the Earth's atmosphere. This provides increased accuracy for applications such as precision weaponry.

The GPS system can yield even better accuracy when corrections to its positioning information are determined by stationary land-based reference receivers and transmitted to suitably equipped GPS receivers in the surrounding area. This enhancement is called **differential GPS** (DGPS), and with it specialized high-end receivers are capable of producing positions accurate to within a few centimeters. DGPS signals are broadcast throughout the United States and U.S. coastal waters by land-based transmitters operated by the Federal Highway Administration and by transmitters on buoys operated by the Coast Guard. Many foreign governments worldwide also sponsor DGPS broadcasts. A similar system that transmits ground-based corrections to orbiting geostationary communications satellites, and thence to users over wider areas on or near the

A remote GPS reference station used in making differential GPS corrections for the area in which it is located. *Tony Atkin*

surface, is called *wide-area differential GPS* (*WADGPS*), or alternatively, the *wide area augmentation system* (*WAAS*). The Federal Aviation Administration operates it mainly for use by aircraft during precision approaches to airports. It is currently anticipated that all ground-based DGPS transmitters will be turned off once the satellite-based WAAS and third-generation Block III GPS signals become widely available over the next several years.

Ordnancemen load 500-pound bombs onto a Marine F/A-18 hornet. The bombs are fitted with a GPS-enabled Joint Direct Attack Munition (JDAM) guidance kit that converts standard unguided bombs into precision-guided "smart" weapons. There is an inertial navigational system and a GPS receiver in the tail section.

Applications of GPS

GPS has revolutionized the practice of navigation on land, sea, and air, and even in near-Earth space. It has an amazing variety of civil and commercial applications, including navigation and tracking systems for ships, boats, cars, and trucks; aircraft navigation and landing systems; surveying; and much more. GPS-based navigation systems are now standard equipment on most cars and trucks. Semiautonomous passenger cars partially guided by GPS are now becoming available, with fully autonomous cars and trucks planned to follow within a few years. Most cell phones now come equipped with GPS-based navigation applications for personal use, and these applications can be easily obtained for use on laptop computers and a wide variety of other devices.

GPS has become an indispensable military asset as well. It is the core navigation system used by all U.S. military services and the Coast Guard for their aircraft, vessels, vehicles, and troops on the ground. It is a basic component of guidance systems for autonomous aircraft, waterborne, and ground vehicles; and for precision weapons, ICBMs, and cruise missiles. Block II GPS satellites carry optical, X-ray, and electromagnetic pulse sensors that can detect nuclear detonations, a major component of the U.S. Nuclear Detonation Detection System.

In near-Earth space (altitudes out to the geosynchronous orbital altitude of about 24,000 miles), GPS is used by the International Space Station (ISS) for precision timekeeping, orbital altitude adjustments, rendezvous and docking operations, and support of Earth science observations; and by other orbiting space missions for orbital injection, measuring and maintaining their orbits, and conducting science observations.

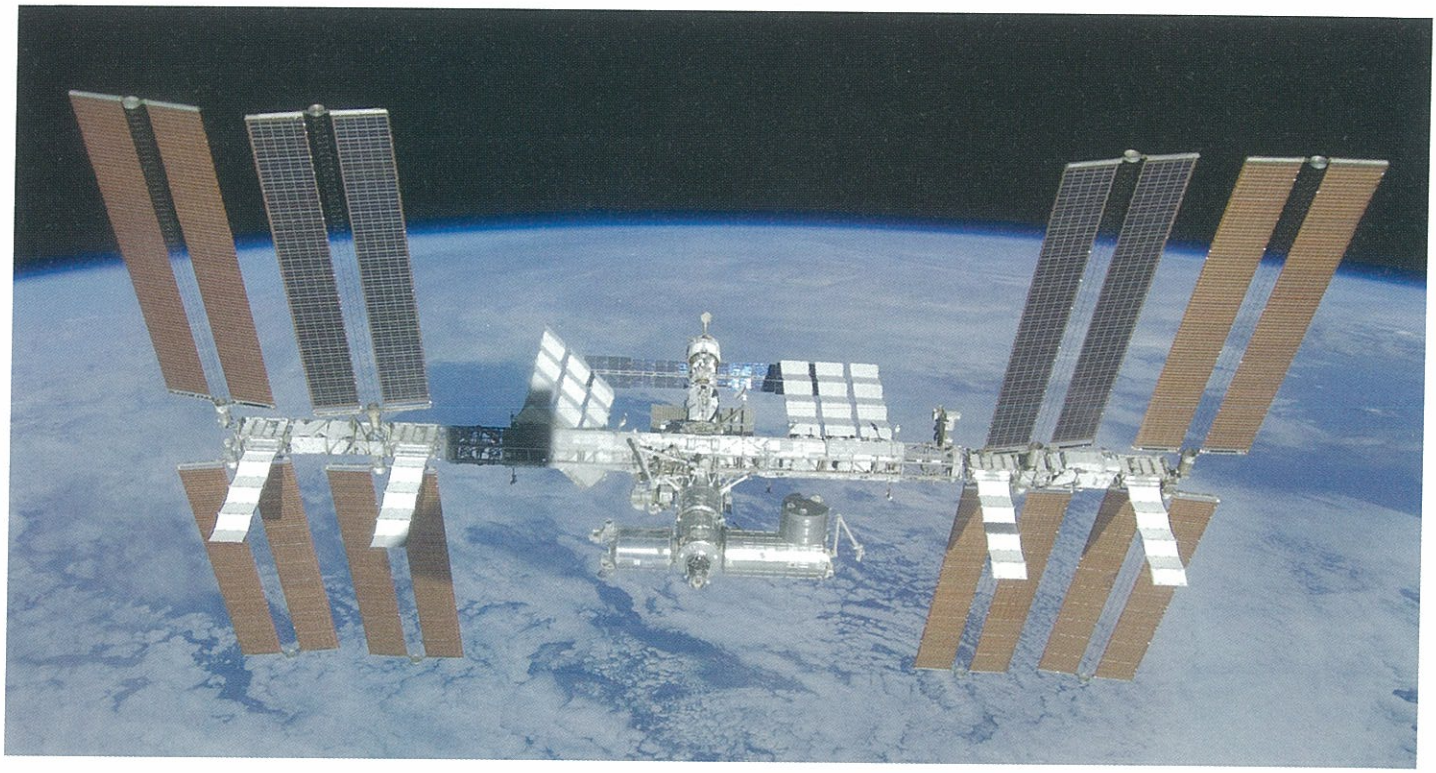
Even more innovative uses of its capabilities are sure to be developed during the coming years.

Other Satellite Navigation Systems

In addition to the United States, several other nations and the European Union have also implemented or are in the process of developing their own versions of GPS. After more than thirty years of effort, a comparable Russian system called GLONASS finally became fully operational with global coverage in late 2015. A Chinese system called BeiDou became operational with coverage of the Chinese mainland in 2011 and is scheduled to be extended to global coverage by 2020. The European Union with some assistance from Russia is currently implementing a system called Galileo, also scheduled to become fully operational with global coverage by 2020.

Many GPS receivers and plotters are currently available that enable use of either GPS or GLONASS signals, with devices that will work with Galileo planned for the near future.

Receivers and other devices designed to use the BeiDou system are becoming widely available throughout most of



The International Space Station uses GPS for a number of applications including altitude adjustments and rendezvous and docking with resupply spacecraft.

A typical ECS (electronic chart system) marine navigational plotter. (Garmin) Plotters like this one are widely used and can receive either GPS or Russian GLONASS signals. Unlike the ECDIS chartplotters discussed later in this chapter, however, ECS plotters do not always display their plots on regulation electronic navigational charts, and so are not legally certified to be used in lieu of plots maintained on regulation ECNs or paper nautical charts.

Asia. As mentioned above, next-generation U.S. Block III GPS satellites now in production will broadcast a new civil signal intended to facilitate interoperability with these other systems.

Japan and India operate more localized satellite-based navigation systems that cover their land and surrounding regional sea areas. The Japanese system is necessary to provide coverage in deep canyons in the mountainous terrain characterizing much of the home islands where GPS signals cannot always be received. India felt the need for such a system to provide coverage over its territory in the event of future hostilities that might preclude its use of the worldwide systems operated by the United States and Russia, and possibly also those of China and the European Union when they come online in the 2020s.

Ship's Inertial Navigation System

Another important electronic navigation system in modern marine navigation is the **ship's inertial navigation system** (SINS). In essence, SINS uses a system of highly precise gyroscopes along with computers to track the motion of a vessel equipped with it with great accuracy during times when there is no access to GPS or other external position-fixing systems. Although most SINS systems are continuously updated using external systems such as GPS under normal operating conditions, they can maintain accurate positioning information without such updates for seven to ten days or more. This makes them ideal for use by submerged submarines or AUVs when GPS signals cannot be received for extended periods, or by aircraft carriers that must supply precise prelaunch positioning information to their aircrafts' avionics systems regardless of GPS availability. SINS is a completely self-contained system, so it would be an especially valuable wartime navigation aid. SINS requires minimal outside information, cannot be jammed, is not affected by adverse weather, does not radiate energy, and is not detectable by enemy sensors.

In addition to submarines and aircraft carriers, SINS systems are also carried by most of the newer Navy cruisers and destroyers, as well as aviation-capable amphibious ships and some merchant ships.

Plotting

Although most Navy surface ships now rely on GPS and SINS for routine navigation at sea, it is still a Navy requirement that manual methods of plotting and navigation be used in addition to GPS and/or SINS whenever entering port or otherwise operating in restricted waters. As marvelous as modern electronic navigation equipment is, it can still malfunction, and power supplies may fail at critical times. GPS is also subject to hacking, jamming, or destruction, especially in wartime. Navigators must, therefore, still know how to make celestial observations at sea and visual observations when closer to shore, and must be capable of using these to maintain a plot of the ship's position on a traditional paper nautical chart by the manual methods described in this section whenever necessary. A manual position plot is of course also a necessity at all times for vessels not equipped with GPS technology or without the power-generating capability to sustain it. This includes many sailboats and other small watercraft.

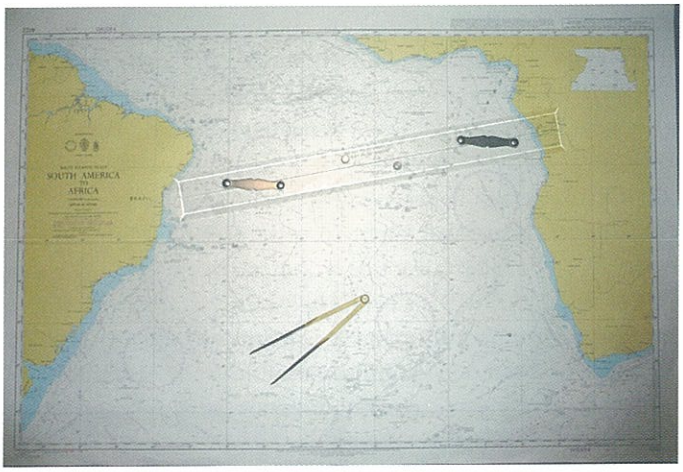
For manual plotting purposes the navigator usually uses the largest-scale Mercator nautical chart available that depicts the area in which he or she is operating because it shows the greatest detail of water depths and navigation aids. The appropriate chart is taped to a chart table on the bridge for use by the navigator and quartermasters, with perhaps a duplicate of the same or a smaller-scale chart in the chart house to be used as a backup.

The basic instruments used in plotting are *parallel rulers* and *dividers*. Some form of *protractor* may also be used in lieu of the chart's compass rose. The simplest type of parallel ruler consists of two straightedges connected by pivoted metal straps near each end. The connecting straps allow the two straightedges to be opened and closed while always remaining parallel to each other. The true or magnetic direction of any course or bearing line drawn on the chart is determined by placing the side of one straightedge alongside it and then "walking" the ruler carefully across the chart to the nearest compass rose. Using the reverse procedure, desired true or magnetic course lines or bearings may be plotted on the chart by walking the parallel ruler from the compass rose back to the place on the chart where the line is to be drawn. Another type of parallel ruler consists of a single straightedge incorporating a roller that allows it to be rolled rather than walked to or from the nearest compass rose.

A protractor does just about the same thing as parallel rulers but more easily. A simple protractor such as the one you probably use in school consists of a graduated arc, usually 180°, on a piece of clear plastic. It can be used in conjunction with a straightedge to draw or determine the direction of any line on the chart.

Another widely used type of simple plotter incorporates both a protractor with a grid that can be aligned with any handy parallel or latitude line for measuring direction and a straightedge pivoted on the center of the protractor for plotting courses or lines of bearing.

The *parallel motion protractor* (*PMP*) used on board Navy ships is a more complicated but sturdier and easy to use plotter. Sometimes called a drafting machine, this plotter consists of two movable arms connected together; one arm is anchored with a swivel to one edge of the chart table, and the other has a circular protractor and ruler on the free end (see the illustration). The protractor and ruler can be moved to any area on the chart and aligned with true or magnetic north using a



A Mercator chart with a parallel ruler and a set of dividers resting on it. *BoH*

A quartermaster uses a parallel motion protractor to maintain a position plot on a nautical chart on the bridge of the aircraft carrier USS *Abraham Lincoln* (CVN 72). The screen of a GPS plotter is on the upper left. *Jerine Lee*

convenient meridian, parallel of latitude, or compass rose, and then be locked into position with a lock switch so that the protractor does not rotate as it is moved further around the chart. The ruler is pivoted on the center of the protractor and can be moved around to any desired bearing, then locked in place if desired by another lock switch. It can quickly be positioned to determine the bearing of any line plotted on the chart or to draw any desired line of bearing or course line on it.

Fixes and Lines of Position

In plotting a ship's location on a chart, a fix is an accurate position determined without reference to any previous position, using electronic methods or visual or celestial observations. A fix position is the intersection of two or more **lines of position** (LOPs—lines along which a vessel must be located) obtained at the same time by some or all of these means.

In clear-weather navigation near land, visual LOPs are obtained by taking visual gyrocompass or magnetic compass bearings to objects or landmarks whose position is known and printed on a chart of the area. Lines corresponding to the bearings are plotted on the chart, extending to the chart symbols representing the objects or landmarks used. Such lines are called *bearing LOPs*. They are labeled with the four-digit time of observation above the line.

A special kind of bearing LOP is the *visual range*. A ship is said to be on a visual range when two landmarks or specially designed range markers are observed in line one behind the other. Such an LOP is considered one of the most accurate obtainable. Visual ranges are extensively used when navigating in extended narrow waters such as the Panama Canal.

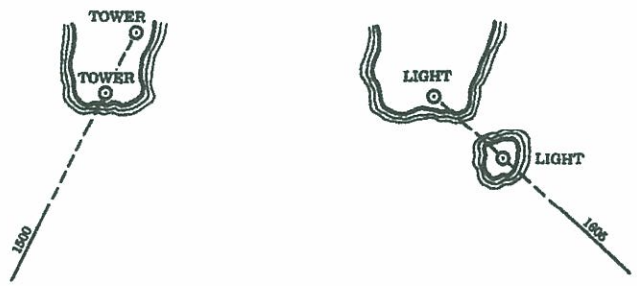
LOPs for fixes can also be obtained by electronic means such as radar, or by observation of celestial bodies. Each of these is discussed in more detail below.

When the distance from an observer to an object can be determined, a circular line of position can be drawn with the object as the center and the radius equal to the distance. The entire circle need not be drawn, because the navigator normally knows the ship's position well enough that drawing an arc of the circle is sufficient. Such an LOP is called a *distance arc*.

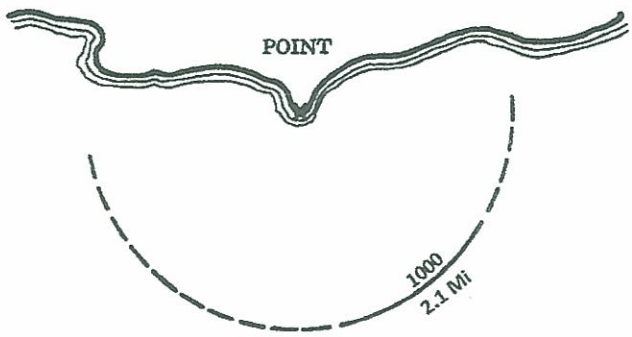
The arc is labeled with the time above expressed in four digits, and the distance below in nautical miles (and tenths). The distance to a landmark may be determined by using radar, a stadimeter (an optical instrument that indicates the distance to an object of known height, such as a lighthouse or ship masthead), or a sextant (an optical instrument normally used to

Two examples of visual bearing LOPs.

An OOD on the guided-missile destroyer USS *McCampbell* (DDG 85) observes a visual bearing with a bearing circle on a bridge gyrocompass repeater. *Declan Barnes*



Two examples of visual range LOPs.



An example of a distance arc LOP.

A quartermaster uses a stadimeter to obtain a range to a ship whose masthead height is known. To use a stadimeter, the observed object's height in feet is set onto the scale at the bottom of the instrument, then the range dial beneath is rotated until the top of the object is brought into coincidence with its bottom in the sights. The range in yards can then be read off the dial. *Nardelito Gervacio*

make celestial observations in celestial navigation) in combination with a height versus distance table.

In selecting objects from which to determine lines of position for fixes, the navigator must consider the number to be used and the angle of intersection of their lines of position. The closer LOPs come to crossing at right angles, the less error there generally will be. Also, for fixes it is best to have at least three LOPs, since each acts as a check on the other two. If all LOPs cross in a pinpoint or form a very small triangle or other geometric shape, the fix may be considered reliable. If a larger triangle or other geometric shape is formed, the fix position is generally assumed to be in the center of it and is considered less reliable.

In summary, fixes for manual plotting may be obtained by means of the following combinations of lines of position (the first three are much more commonly used than the latter three):

- two or more lines of bearing
- a distance arc and a line of bearing
- two or more distance arcs
- a visual range and a distance arc
- a visual range and a line of bearing
- two simultaneous visual ranges

The symbol for a fix is a small circle or triangle around the point of intersection. For identification, it is labeled horizontally with the time in four digits. Other navigation plotting symbols and their meanings are shown in the graphic above.

SYMBOL	DESCRIPTIVE LABEL	MEANING
	FIX	AN ACCURATE POSITION DETERMINED WITHOUT REFERENCE TO ANY PREVIOUS POSITION. ESTABLISHED BY ELECTRONIC, VISUAL, OR CELESTIAL OBSERVATIONS.
	DR	DEAD RECKONING POSITION. ADVANCED FROM A PREVIOUS KNOWN POSITION OR FIX. COURSE AND SPEED ARE RECKONED WITHOUT ALLOWANCE FOR WIND OR CURRENT.
	EP	ESTIMATED POSITION. IS THE MOST PROBABLE POSITION OF A VESSEL, DETERMINED FROM DATA OF QUESTIONABLE ACCURACY, SUCH AS APPLYING ESTIMATED CURRENT AND WIND CORRECTIONS TO A DR POSITION.

Standard plotting symbols used by navigators, quartermasters, and operations center personnel to mark a ship's position on a navigation plot.

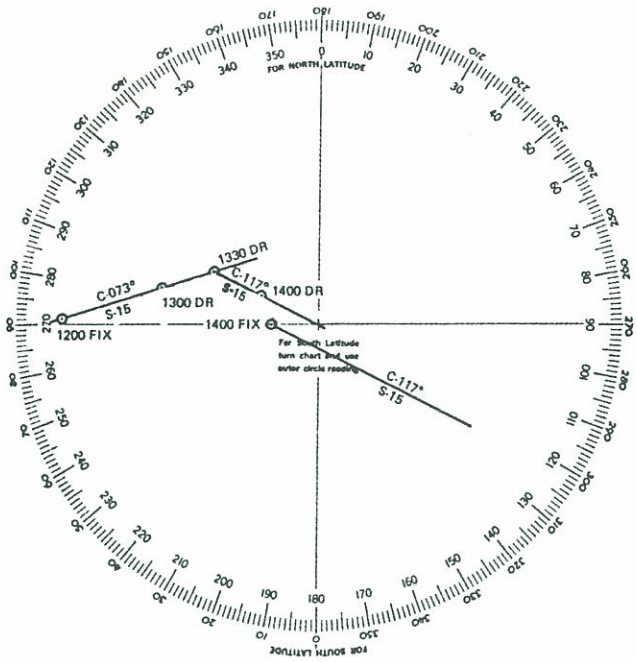
When the symbols depicted are used, it is not necessary to label the position (except for time), because the symbol indicates what type of position it is.

The frequency of plotting manual fixes varies according to the circumstances in which the navigator is operating. In mid-ocean the navigator may only be able to plot a fix once every several hours or more, depending on the availability of information from which to plot them. When approaching land or if the ship is operating in more confined waters, the frequency increases to once every fifteen minutes, or every six, or ultimately every three minutes in restricted piloting waters as described below. In the interim between fixes the navigator keeps track of the vessel's position using *dead reckoning.*

Dead Reckoning

During intervals between fixes, or whenever periodic fixes are unavailable for extended periods for any reason, a vessel must be navigated by **dead reckoning**. This refers to the practice of determining a vessel's position from the direction and distance theoretically traveled from a known starting point, normally the last good fix. The term is derived from the phrase *deduced reckoning* used in days of old, when "deduced" was often abbreviated "de'd" and spoken as "dead."

In dead reckoning, a line called a *course line* is plotted on a nautical chart from every new fix in the direction in which the vessel is proceeding. The direction, or course, is labeled above the line, and the speed in knots below the line. Then, future positions, called DR (dead reckoning) positions, are computed, plotted, and labeled with semicircles and times along this line as required for safe navigation. Each time the vessel changes course or speed, a new DR position is computed and plotted, and a new course line is extended from it. This is known as the **dead reckoning plot** for the ship, and the completed plot is called the **DR track**. But a ship underway is moving through



A sample DR plot on a compass rose showing a fix at 1200, and DR positions at 1300, 1330, and 1400. A course change was made at 1330. At 1400 a new fix was obtained, and the vessel's position was updated on the plot accordingly.

A typical ECDIS plotter. Sometimes called *chartplotters*, they project their displays onto regulation electronic navigational charts certified by the IMO, and so are a legal alternative to manual position plots on paper charts on naval vessels and merchant ships. *Martek Marine*

a very unstable element. Wind and current may cause the ship to drift from the presumed course, or its speed to vary from what is set, even though the helmsman has very carefully tried to steer the exact course. For this reason, DR positions are only approximate, and their accuracy decreases over time.

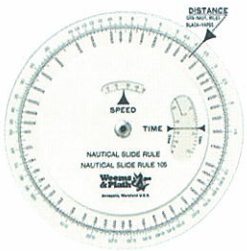
High-end electronic plotters called *ECDIS* (electronic chart display and information systems) such as the one shown above right, like the ECS (electronic chart system) plotter shown earlier, incorporate continuous fix updates from GPS or GLONASS and project the ship's current position and the DR track onto an electronic chart projection on a large screen.

ECDIS plotters, sometimes called *chartplotters*, use standardized electronic navigational charts (ENCs) that meet technical requirements of the International Maritime Organization (IMO) and so are legally accepted as alternatives to manual position plots on paper charts. ECDIS plotters eliminate the need to maintain a manual dead reckoning plot during normal operations. Many can also display information from a vessel's depth finder (sonar) and radar if so equipped. They have become standard equipment on most Navy and many merchant marine ships. The know-how to do a manual DR plot is still a necessary skill for every marine navigator, however, in the event of a power loss, equipment failure, or damage that renders the electronic plotter unusable. Even when electronic plotters are in use, therefore, many navigators, especially those on Navy ships, keep a manual DR plot on a paper chart as a backup and for practice. Such manual plots are required on all Navy vessels as a backup when in restricted waters, and as a primary method if ECDIS plotters are not available.

Piloting

Piloting is determining the position and directing the movements of a vessel operating in restricted (relatively shallow) waters near land by using radar, landmarks, constructed navigational aids, and water depth readings made by a *depth finder* (described below). It is primarily used when entering or leaving port and in coastal navigation. The navigator usually plots and labels an *intended track* prior to entering piloting waters showing the intended courses and turning points in any narrow channels, and shading to indicate dangerous waters nearby. In piloting, the navigator maintains the DR plot and keeps the bridge control team informed about any nearby danger (rocks, shoal water, wrecks, etc.) and the ship's position relative to the intended track. He or she fixes the ship's position frequently and accurately (normally at least every three minutes) both by the use of GPS and by manual position plots based on radar ranges and sightings taken of navigation aids and land features. The navigator recommends all courses to take and turns to be made to the commanding officer and conning officer.

Navigational equipment used in piloting includes the GPS plotter, if available; gyrocompass repeaters or a magnetic compass to determine the ship's heading and bearings to navigational aids and landmarks; a speed log, either mechanical or electronic, to indicate ship's speed; a bearing circle or telescopic alidade with which to make bearing observations; radar, on



A nautical slide rule. This simple form of analog computer greatly facilitates time-distance-speed calculations during piloting and when working with the maneuvering boards described in unit 4 of this text. By rotating the top disk and the distance disk under it over the square base, and setting any two of the three quantities beneath the appropriate markers, it will indicate the remaining quantity under the third marker. *Weems and Plath*

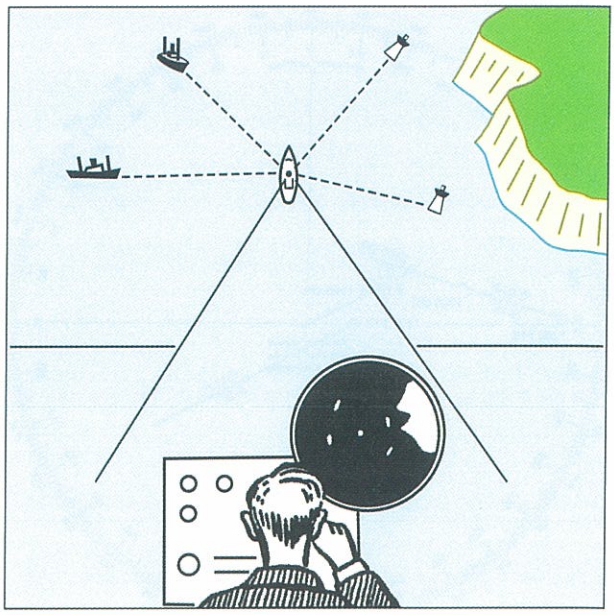
vessels so equipped, to determine the ranges and bearings to land features and navigation aids; a fathometer or echo sounder to determine water depth; paper and electronic charts that show the outlines of the shore and the positions of land and seamarks, aids to navigation, and the depths of water; various plotting instruments such as parallel rulers and dividers or a PMP, to maintain the DR plot; and a circular *nautical slide rule*, an inexpensive type of simple analog computer that facilitates quick solutions for speed, time, and distance.

Depth Finder (Echo Sounder)

A **depth finder**, also called an *echo sounder* or sometimes a *fathometer*, determines the depth of water under a vessel by measuring the time it takes a sound signal to reach the bottom and return. These operate on the basis of the fact that sound travels through water at about 4,800 feet per second. (This speed varies with temperature, salinity, and depth but is a good average figure.) The devices send out a sound signal that bounces off the ocean floor and returns to the echo sounder's transducer much like an echo. Half the time in seconds required for the sound to make the round trip multiplied by 4,800 is the distance in feet to the bottom. The depth can usually be displayed both digitally and graphically.

Radar

Radar, an acronym derived from the phrase *radio detection and ranging*, was developed originally as a means of detecting and tracking surface ships and aircraft. Later improvements and refinements led to its becoming a valuable electronic navigational device. Its operation is based on the fact that, like sound waves, radio waves are reflected from solid objects. Radar's great advantage over other means of electronic navigation is that it does not require external transmitting stations. Its chief disadvantage, however, is that the maximum range of most navigational radars is currently limited to slightly more than line-of-sight. Extensive research has been underway for years to extend this range to distances over the horizon, and some breakthroughs have been made.



Representation of a radar PPI presentation oriented to true north.

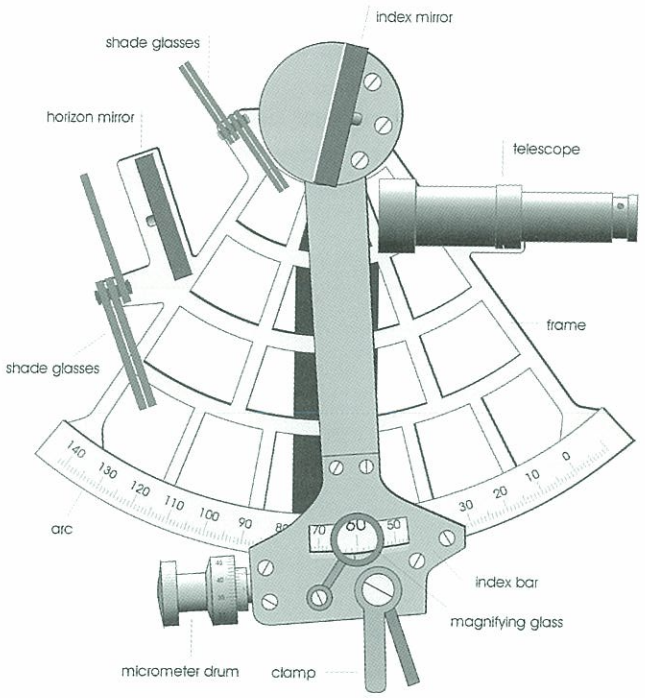
Radar involves sending out a narrow beam of very high frequency (VHF) radio wave pulses. Upon striking any object in their path, they are reflected and return to the transmitter as "echoes," in much the same way as a sound signal transmitted by a fathometer or sonar reflects from a submerged object. Exact measurement of the time of return of each pulse yields the distance, or range, to the object. The bearing can be determined by the position of the antenna when the reflected pulse is received, which is indicated with a bright line called a *sweep* on a radarscope. Targets appear as bright spots of light called *pips*. The form of scope most often used for navigation on naval vessels is the *plan position indicator* (*PPI*), which gives a bird's-eye view of the area covered by the radar, with the transmitting vessel in the center.

Radar has a number of important advantages as a navigational device. It can be used at night and during periods of low visibility. Because it simultaneously yields both the distance and bearing to a target, a fix can be obtained from a single object, although the preferred method is to obtain and use radar ranges from two or more objects because the bearing information, particularly from land features, can sometimes be inaccurate. It can also be used to locate and track other vessels and storms, and thus is important for ship safety.

Celestial Navigation

Electronic navigation systems and piloting techniques all determine position by reference to features on the Earth using gyroscopes or satellites in near-Earth space. The remaining

An operations specialist marks a contact on a radar screen on the bridge of an LSD. *Michael Russell*



A sextant schematic. Light rays from the body observed reflect off the index mirror to the horizon mirror and thence through the telescope to the eye of the observer. The index bar is moved with the clamps until the body is brought down to the horizon, then the micrometer drum is rotated until the body appears to rest exactly on the horizon. The whole degree of the altitude angle is read from the scale on the frame in the window of the index bar, and the exact minutes and tenths are read from the scales on the micrometer drum. *Joaquim Alves Gaspar*

branch of navigation, which determines position by observations of heavenly bodies such as the Sun, Moon, and selected stars and planets, is called **celestial navigation**. It is the only method of navigation at sea that is totally independent of the need for any onboard or external electronic systems. A precise *altitude observation* of the angle that any of the aforementioned celestial bodies makes with the horizon, along with the precise time of observation, yields (after processing) an accurate line of position. Two or more such LOPs can then be combined to yield a celestial fix.

Up until the last fifty years or so, navigation by celestial observations when at sea and out of sight of land was the main method of navigating on the oceans. The advent of long-range radionavigation systems, however, followed by the widespread availability of GPS in our era, made celestial navigation a vanishing art. Celestial navigation remains a mandated and valuable skill for all Navy navigators to have, however, especially given the increasing level of concern about the vulnerability of GPS satellites and those of other satellite-based navigation systems to hacking, spoofing, or destruction by hackers, terrorists, or rogue states in peacetime or potential enemy states in wartime.

The optical instrument used in celestial navigation to measure the angle (altitude) between a heavenly body and the visible horizon is the **sextant**. Celestial observations of the stars, planets, and possibly the Moon are made during either morning or evening twilight, and the Sun during daylight, as these are the times when the horizon is visible enough for altitude observations relative to it. After obtaining a precise altitude and time of observation for each body observed, the navigator can then work out the LOPs resulting from each sighting either manually by methods called *sight reduction* using various almanacs, tables, and sight reduction forms, or electronically by use of computer navigation applications programs.

After obtaining the celestial LOPs, the navigator plots them on a nautical chart of suitable scale to form a *celestial fix*, in the same manner as terrestrial LOPs are plotted to form a

terrestrial fix during piloting. Once a celestial fix is plotted, a DR plot is laid out from it in the normal manner until the next fix is obtained.

Many of the aforementioned electronic navigation applications programs available today will automatically compute the fix position for the navigator directly from celestial observations, making it unnecessary to manually compute and plot the LOPs to obtain the fix. Associated plotters will then extend the DR plot from the fix until the next round of celestial observations is made, just as they do for fixes obtained from GPS or one of the other satellite navigation systems now available.

Critical Thinking

1. Describe the steps that a sailor of a small boat might go through in preparing to navigate the boat on an extended ocean voyage. Include the navigation equipment that might be brought along on such a voyage.
2. Use the Internet to research the navigation applications programs available from the Naval Observatory and private companies, and determine whether or not they would be applicable for use on board Navy and commercial ships as well as by private individuals operating pleasure craft.

Study Guide Questions

1. A. What advances occurred in the art and science of marine navigation in the 1400s?
   B. What era did they make possible?
2. What did the invention of accurate timepieces in the 1700s make it possible to do at sea?
3. What was the basic principle of the hyperbolic radionavigation systems introduced in the latter half of the twentieth century?
4. What was the first worldwide satellite navigation system established by the Navy in 1964?
5. What satellite-based navigational system that became operational in 1995 has revolutionized the practice of terrestrial and near-Earth space navigation?
6. What navigation system do Navy ships now rely upon for most routine navigation at sea?
7. Who operates and maintains the GPS system?
8. A. What is the specified accuracy of the L1 GPS signal that most civil devices use?
   B. What is the actual system performance?
9. What ground-based enhancements are used to increase the accuracy of the GPS system?
10. What are some of the civil and commercial applications of GPS?
11. What are some of the military uses of GPS?
12. What other satellite-based global positioning systems are now being developed and deployed by other countries besides the United States?
13. What is the SINS system used for in the Navy?
14. When must navigators of Navy ships use traditional manual methods to maintain their ships' navigational plots?
15. What is a navigational fix?
16. What are lines of position?
17. A. What is dead reckoning?
    B. When is it used?
18. A. What is piloting?
    B. When is it used?
19. What kind of shipboard device is used to determine depth of water?
20. A. What are some of the advantages of radar?
    B. What is radar's chief disadvantage?
21. A. What is celestial navigation?
    B. What instrument is used to make celestial navigation sights?

New Vocabulary

hyperbola
NAVSAT
differential GPS
WAAS
BeiDou (nav system)
SINS
protractor
fix (position)
visual range (bearing)
sextant
DR position
ECDIS
ENC
piloting (navigation)
intended track
echo sounder
sweep (radar)
celestial navigation
sight reduction
celestial fix
hyperbolic navigation system
GPS
WADGPS
GLONASS
Galileo (nav system)
parallel ruler
parallel motion protractor (PMP)
line of position (LOP)
stadimeter
dead reckoning
DR plot
ECS
chartplotters
depth finder
nautical slide rule
fathometer
plan position indicator (PPI)
altitude observation (celestial body)

8

Aids to Navigation

Piloting is one branch of marine navigation. As we learned in the last chapter, in traditional piloting, a ship's position is mostly determined by bearings taken on visible objects whose locations are shown on a nautical chart. Some of these objects may be natural landmarks such as hills, rocks, islands, or cliffs. Others may be large buildings, smokestacks, television towers, church steeples, and so on, that are located close to shore where they can be easily spotted by navigators.

Most **aids to navigation**, though, are devices specially constructed to assist navigators in the safe navigation of their vessels or to warn them of dangers or obstructions to navigation. These include lighthouses, navigation lights, buoys, and beacons. Most navigable international waterways, well-traveled coastal areas, and inland waters of the world's littoral nations are well marked with these navigation aids. Elsewhere, however, these kinds of aids may or may not be present to assist the navigator. When specially constructed aids are not available, or when they become inoperative or out of position, then natural landmarks must be used.

This chapter discusses the major types of constructed navigational aids found in international and U.S. coastal and inland waters. All persons who operate vessels at sea and in navigable inland waters must know about these navigation aids, just as one who drives a car or truck on the highways of the United States or foreign countries must be able to interpret the road signs on and alongside them.

Detailed descriptions of all the navigational aids discussed in this chapter are presented in *Nautical Chart Symbols, Abbreviations, and Terms, Chart No. 1*, available at most marine supply stores and on the NOAA website (**www.nauticalcharts.noaa.gov/mcd/chartno1.htm**). Cadets going through the material in this chapter will find it helpful to have sections P and Q of *Chart No. 1* available either in paper form or in electronic form.

Navigation Lights

Since vessels can be underway at night as well as by day, structural **navigation lights** are important aids to night navigation. These lights are placed at positions where they will best serve to assist in visual position finding at night and in conditions of poor visibility. They are identified by their distinctive colors, patterns of flashes, and timing intervals (periods). Of these, the *timing interval* or *period*—the time it takes to complete each cycle of flashes of a light—is considered the most definitive for identification purposes, because that is the least likely thing to be confused if several navigational lights are present in a given area. These identifying attributes, together with height and nominal visibility, are usually printed in abbreviated form near magenta (purple) light ray symbols on nautical charts covering the area in which a vessel is operating. To avoid confusion with lighted buoys, the abbreviated data for navigation lights on structures is printed near their symbols using vertical (Roman) letters and numbers, and the data for lights on buoys is printed in *italics*. Details on navigation lights and lighted and unlighted buoys are also set forth in publications called *Light Lists* that are available for purchase in most nautical supply stores and for free online from the NOAA website (**www.noaa.gov**). There is a separate volume for each region of the United States. Similar publications called *Lists of Lights* contain similar information for navigation aids in foreign waters.

Light Phase Characteristics

There are three principal general patterns of flashes, called **phase characteristics**, of navigational lights: fixed, flashing, and occulting. *Fixed* lights burn steadily. *Flashing* lights show single flashes of light at regular intervals—never more than thirty flashes per minute—with the duration of light less than the duration of darkness. There are variations of these called *fixed and flashing*, with the fixed light intensifying at intervals with two or more bright flashes; and *group flashing*, in which two or more groups of flashes are shown at regular intervals. *Occulting* lights are totally off at regular intervals, the duration of light always being greater than the duration of darkness. *Group occulting* lights have two or more off periods at regular intervals.

Variations of these principal light characteristics include *equal interval*, in which the duration of light equals that of

darkness, and *Morse code*, in which the light flashes represent a Morse code character (usually the letter A).

Section P of *Chart No. 1* shows the various light phase characteristics that may be shown by lighted aids to navigation in U.S. waters, along with their abbreviations used on nautical charts. *Light List* publications also contain this information.

Visibility of a Navigation Light

The *visibility* of a navigation light is the distance in nautical miles that a mariner can see the light at night. The distance at which a given navigation light may be seen depends on its intensity and height above sea level, the height of the observer's eye, and the existing *meteorological visibility conditions* (weather). Information about the intensity and height of navigation lights can be found in *Light Lists*. A navigator will usually know his or her eye height at different positions on the vessel from which he or she normally makes observations and can estimate the meteorological visibility conditions in any of several ways. With this information the navigator can compute the exact visibility of a light using various tables. A good approximation of the distance at which a light may be seen is printed on nautical charts beside the light symbol. This *charted range* is the distance a light will shine in clear weather and is about the distance a mariner in a small boat can usually expect to see the light.

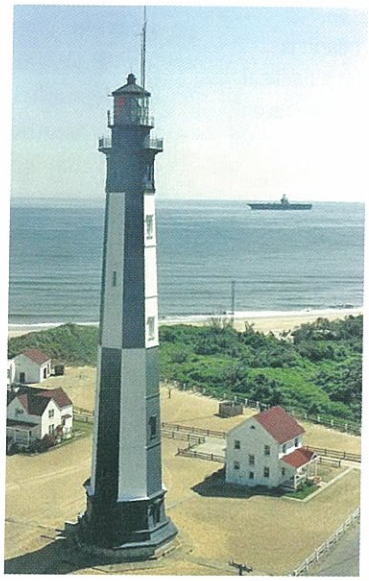
Lighthouses

There are many **lighthouses** along the coasts of the United States and the Great Lakes, along many interior U.S. waterways, and at other similar locations throughout the world. They were placed wherever a powerful light, called a *primary light*, could be of assistance to navigators or where very dangerous water required a warning beacon of long-range visibility. Since the range of visibility of a light increases with its height, the main purpose of a lighthouse was to elevate its light high above sea level to maximize the distance over which it could be seen. Some were also equipped with audible fog signals that sounded in periods of low visibility in addition to their lights.

At one time, most U.S. lighthouses and their lights were operated and maintained by keepers who lived at the lighthouses, under the auspices (control) of the federal and state governments. Now, however, most of the lights and fog signals have been shut down, and others still in operation are automatic, with no keepers required. Many lighthouses have been taken over by nautical historical societies. Even if their lights are now inoperative, however, their towers are still useful as land-based navigation aids from which to obtain visual bearing lines of position during piloting. The towers are usually painted in distinctive colors and patterns (bands, stripes, diamonds, etc.) to make them easier to identify in the daytime.

Light Towers, LNBs, and Minor Lights

At some locations primary navigation lights are placed atop large structures of girders or concrete, called **light towers**, painted similarly to lighthouses. Some powerful offshore primary lights marking harbor entrances and the like are mounted in **large navigational buoys** (LNBs) moored offshore. Less powerful *minor* or *secondary lights* are located on smaller structures in coastal and inland waters. All of these lights are automated and require only occasional routine maintenance.



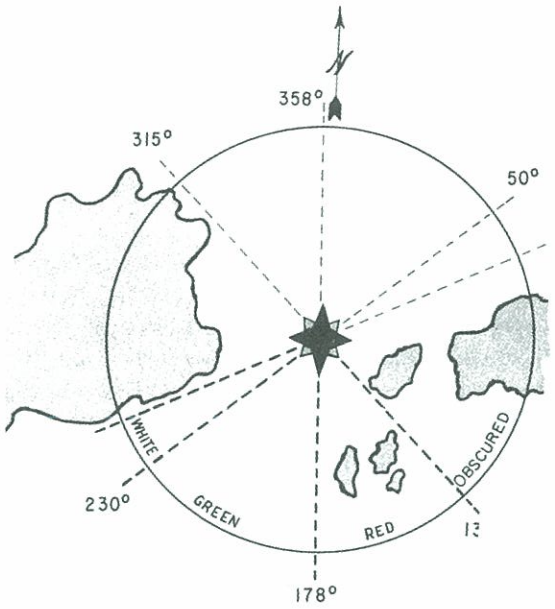
The Fort Story lighthouse, Virginia Beach, Virginia. *Eric Clement*

A coastal primary light atop a concrete light tower. *Tony Kinghorn*

Alternating and Sector Lights

If a navigation light is made to change color in a regular pattern, either by alternately energizing different-colored lights or by passing colored filters around a single white light, the light is termed an **alternating light**, abbreviated "Alt." on a chart and in *Light Lists*. If combined with unusual phase characteristics, alternating lights present a very distinctive appearance that cannot be easily mistaken. They are used for special applications requiring the exercise of great caution, such as entrances to harbors and rivers. Aero beacons at airports near coasts that can be used for marine navigation if they are visible from seaward are usually alternating lights as well.

Some land-based navigation lights have **sectors** (arcs of a circle) of fixed red glass filters placed in their lanterns to indicate areas of water too hazardous for safe navigation. Arcs over which the red light shows are the dangerous sectors. Corresponding danger bearings on a nautical chart of the area indicate the red sector where a vessel could run aground on rocks, shoals, or some other hazard. Some such lights also have a green sector that indicates a turning point or the best path across a shoal. The remaining sectors of these lights are white. All sector bearings shown on charts or stated in *Light Lists* are true bearings *to* the light, and the same phase characteristics are shown in all sectors.



A navigation light with red, green, and white sectors. The bearings shown at the bottom of the arcs are those from the light. On a nautical chart and in a light list, the bearings given would be the reciprocals on the corresponding top arcs, as would be seen from seaward by a vessel transiting clockwise south of the light. The printed description of the light would read "obscured from land to 315°, red thence to 358°, green thence to 050°, white thence to land."

Navigation Marks

Navigation marks are buoys and beacons placed in navigable waterways to assist a vessel's navigation in restricted waters. **Buoys** are moored, floating markers placed to guide ships and boats safely along channels and in and out of ports. A **beacon** may consist of a single wooden or concrete *pile*, or a *dolphin* consisting of several piles, or a metal or concrete tower. They are permanently fixed to the Earth's surface by being imbedded in the bottom in water areas or driven into the ground on land. Beacons in water areas with markers called **daymarks** affixed to them are used in lieu of buoys to serve the same purposes. Such beacons are much less expensive to construct and maintain than buoys, so they are much more extensively used in shallower waters. Both buoys and beacons may be lighted. If unlighted, beacons with only daymarks on them are called **daybeacons**. If lighted with minor or secondary lights, beacons are referred to simply as *lights*.

Daymarks on daybeacons that mark a channel in U.S. waters. Red triangular daymarks with sequential even numbers mark the right side coming from seaward, and green squares with sequential odd numbers mark the left side.

Buoys and beacons for mariners are like street signs for motorists on land. They mark channels and delineate the limits of safe areas of water in which a vessel can operate, and they warn vessels away from hidden dangers and lead them to anchorage areas. They may be of various sizes, and may often be lighted, but it is mainly the shapes and coloring of buoys and the daymarks on beacons that indicate their purpose. Buoy and daymark symbols are printed on all large-scale nautical charts depicting offshore waters, coastal approaches, harbors, bays, and navigable rivers so that the buoys and beacons can help determine position in piloting. Chart buoy symbols are usually diamond shaped, with magenta fill color if the buoys are red, and green fill if they are green. Both symbols have a magenta light ray or circle at their base if they are lighted. Beacon symbols are triangles or squares with the same coloration as buoy symbols. Magenta is used in lieu of red on nautical charts because red will not show up under red lighting at night. See *Chart No. 1*, any *Light List* volume, or any large-scale nautical chart for examples of all of these symbols.

Buoys are valuable aids to navigation, but they must never be depended upon alone. They may drag their moorings in heavy weather or be set adrift if hit by a passing ship. Lights on them may go out, and any whistles, bells, and gongs on them may fail to function.

Buoyage Systems

There are two general kinds of buoyage in use throughout the world: the **lateral system** and the **cardinal system**. The lateral system is used to mark channels and navigational dangers in navigable waters throughout the world, and the cardinal system is used to mark the position of hazards or safe water offshore and in some seaways. Both of these buoyage systems have been standardized worldwide by a regulatory organization called the International Association of Lighthouse Authorities (IALA). Under the IALA regulations, cardinal markers are the same everywhere, but there are two different lateral buoyage systems. **IALA System B** is used in the waters of North and South America, Japan, the Republic of Korea, and the Philippines; and **IALA System A** is used in the rest of the world. In both their lateral systems, the coloring, shape, and lighting of buoys, beacons, and daymarks all delineate channels on the basis of what their location is when *returning from seaward*, sometimes called the direction of buoyage.

In IALA System B, which includes the territorial and inland waters of the United States, all lateral buoys and daymarks marking the right side of channels returning from seaward are colored red and are marked with successive even numbers. Left-hand channel buoys and daymarks are colored green with successive odd numbers. *From seaward* in the U.S. IALA lateral system is considered to be proceeding in a southerly direction along the Atlantic Coast; a northerly and westerly

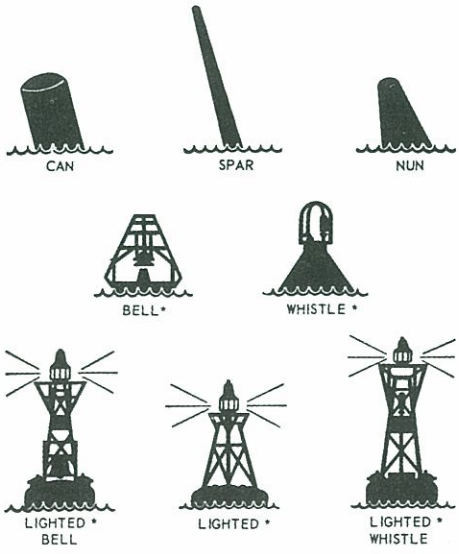
direction along the Gulf Coast; and a northerly direction along the Pacific Coast. The U.S. Intracoastal Waterway on the Atlantic and Gulf coasts is similarly marked, proceeding from New England to the lower coast of Texas. In an inland navigable river, the direction of buoyage is always upriver toward the river's source. IALA System A uses a reverse scheme of colors.

The cardinal system is mostly used to mark offshore waters; it is not much used in U.S. waters. It is so named because its buoys and beacons indicate the *cardinal points* (north, east, south, or west) in which direction the safe water lies. They use conical **top-marks** (triangular shapes), black-and-yellow stripes on the buoys and beacons, and distinctive flashing light characteristics to indicate on which side they should be passed.

Types of Buoys

With the exception of the can and nun buoys described below, a buoy's type has no special navigational significance in the U.S. IALA lateral system, but can help identify it. There are eight main types of buoys used in U.S. waters:

- *Spar buoys* are upright wooden poles or tubes of steel that are often used to mark obstructions.
- A *can buoy* is shaped much like an oil drum. If unlighted, green left-hand channel buoys must be can buoys.
- A *nun buoy* has a conical shape like the habits that nuns in religious orders used to wear; hence the name. If unlighted, red right-hand channel buoys must be nun buoys.
- A *bell buoy* has a framework supporting a bell. Older bell buoys are sounded by the motion of the sea. Newer types are operated automatically by compressed gas or electricity.



Types of buoys used in the inland waters of the United States.

- A *whistle*, or *horn*, buoy is similar to a bell buoy in shape but carries a whistle sounded by the sea's motion or horns that are sounded at regular intervals by mechanical or electrical means.
- A *gong buoy* is also similar to a bell buoy in shape, but it has a series of gongs, each with a different tone, with hammers that are moved by the motion of the sea.
- A *lighted buoy* carries batteries or gas tanks to power the light and has a framework that supports it.
- A *combination buoy* is one in which a light and sound signal are combined, such as a lighted bell, gong, or whistle buoy.

Coloring of Buoys

In U.S. waters, red buoys mark the right side of a channel and green buoys the left side, returning from seaward. They are called **channel buoys**. Of great help in remembering this placement of channel buoys is the jingle "red-right-returning." If unlighted, right-side channel buoys are always red nun buoys. Unlighted left-side channel buoys are always green can buoys.

Green-and-red horizontally banded buoys, called **preferred-channel** or **junction buoys**, mark obstructions or channel junctions. They are of no particular type or shape. They may be passed on either side, but it is wise to give them a wide berth. If the top band on a preferred-channel buoy is red, the best channel is to the left of the buoy, returning from seaward. If the top band is green, the preferred channel is to the right.

In both IALA systems red-and-white vertically striped **safe-water buoys** mark fairways, mid-channels, and offshore approach points. They have no particular shape or type. Some may have a spherical red top-mark.

Black-and-red horizontally banded buoys, usually spar buoys, mark isolated dangers within navigable waters in both systems. They sometimes have top-marks consisting of two vertical black balls. They should be given wide berth in order to avoid the danger they mark.

A coastal combination buoy channel marker. A seal is on board for a rest. Note the light and radio antennae at the top. *RadicalBender*

Some buoys called **special buoys** of no particular shape or type, and usually unlighted, are not meant to be used for navigation. White-painted buoys, for instance, mark anchorage areas. Buoys with black-and-white horizontal stripes are sometimes used to mark fish trap areas. A white buoy with a green top usually designates a dredging area. Yellow buoys sometimes mark pipelines, but can have other informative

functions as well. Cylindrical white buoys with orange markings are informational buoys marking restricted areas, speed limits, and the like.

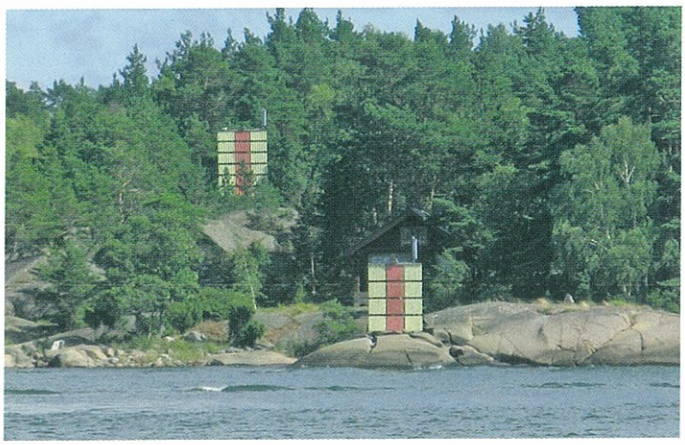
Daybeacons and Ranges

Daybeacons are unlighted structural beacons. *Daymarks* on these beacons marking channels are colored and numbered in sequence with any channel buoys that may be present. Those on the right coming from seaward are red and triangular (like nun buoys), and those on the left are green and square (like can buoys). Daybeacons marking channel junctions carry diamond-shaped daymarks with red triangles or green squares on them, which indicate the preferred channel like junction buoys do. Daybeacons are not normally used to mark fairways. Many daymarks incorporate reflectors that show the same colors as lighted buoys would at night.

Some daybeacons are marked similarly to and used in lieu of various special buoys in shallower water. Most of their markers are white panels with orange borders and black lettering. They are used to give directions and information, and warn of hazards, obstructions, speed limits, and off-limits areas.

Two beacons located some distance apart on a specific true bearing that line up with the center of an approach channel make up a **visual range**. They are usually placed on land and carry large, rectangular daymarkers with vertical stripes in the center. Many are fitted with lights for visibility at night. When a vessel is in a position such that the two daymarkers are exactly in line one over the other by day, or the lights are in line by night, the vessel is said to be "on the range" in the center of a channel. Such ranges are valuable for pilots and conning officers who must guide ships along narrow channels. For example, much steering through the Panama Canal is done on ranges. Similarly, visual ranges are used often on the Columbia River in the Pacific Northwest.

If lighted, such beacons are called *range lights* in the United States, and *leading lights* in other areas of the world. They are used at night in the same manner as daybeacon ranges by day.



A navigational range with beacons supporting range daymarkers for use by day and range lights on top for use at night. When a vessel sees the daymarkers or lights in line when proceeding toward the beacons, the vessel is "on the range" in the middle of the channel.

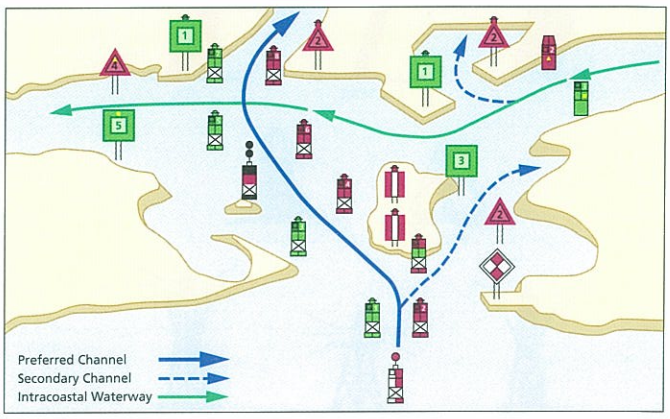
Numbering and Lights on Channel Markers in U.S. Waters

In U.S. waters, as noted above, red buoys and beacon daymarks marking the right side of a channel bear sequential even numbers, starting with the first marker from seaward. Green channel buoys and beacon daymarks marking the left side of the channel coming from seaward have sequential odd numbers. If channel markers are added after the numbering sequence has been established, the extra buoys and beacons are given a letter suffix, as for example, buoy number 1 followed by extra buoy 1A across from daybeacon number 2 on the other side. Banded or striped buoys are not numbered, but some have identification letters on them, such as Governors Island West End Shoal Bell Buoy (GI) and East Rockaway Inlet Bell Buoy (ER).

Red lights are used only on red channel buoys and beacons having red daymarks. Green lights are used only on green channel buoys and beacons having green daymarks. White lights are the only lights used on preferred-channel (junction) or safe-water buoys.

Many of the phase characteristics of lights on lighted buoys and beacons in U.S. waters are the same as those of structural navigation lights described earlier, but some are unique to buoys. The principal characteristics are as follows:

- Some type of *flashing*, *occulting*, or *isophase* (equal durations of light and darkness) light may be on channel buoys or beacons marking the sides of a channel.
- A *quick-flashing* light, as least sixty flashes per minute, may be on channel buoys or beacons marking channels at turning points requiring special caution.



The color scheme of buoys and beacons and their lights and day shapes in U.S. waters and the Intracoastal Waterway, coming from seaward.
U.S. Coast Guard

- A *composite group flashing* light, flashing a series of two plus one short flashes, may be on a preferred-channel buoy or beacon marking a junction or turning point.
- A *Morse A* flashing light (a series of short and long flashes, recurring at a rate of about eight per minute) may be on a safe-water buoy marking a fairway, mid-channel, or offshore approach point.
- A *group flashing* light with a recurring series of two flashes may be on an isolated danger buoy marking a danger in or near navigable waterways.

These and other less frequently seen buoy and beacon light phase characteristics are illustrated in *Chart No. 1* and in *Light Lists*.

Intracoastal Waterway

The U.S. **Intracoastal Waterway** is an extended inland channel in which a light-draft vessel can navigate along almost the entire U.S. East and Gulf Coasts from Boston, Massachusetts, almost to the Mexican border to Brownsville, Texas, without going into the ocean. The waterway consists of a combination of natural inlets, rivers, bays, and sounds, and some manmade canals. The channel is dredged wherever and whenever necessary to maintain a minimum depth of at least seven feet, with at least twelve feet being the norm for most of its length. By using the Intracoastal Waterway a vessel can remain inside natural or artificial breakwaters for almost the entire three-thousand-mile length of the waterway.

Standard colors, shapes, and lights are used for all navigation marks along the Intracoastal Waterway, and each has part of its surface painted yellow. All buoys have a yellow band at the top. Triangular red channel beacon daymarks have a small yellow triangle at the top, and square green channel beacon daymarks have a small yellow square. All the marks are numbered consecutively on each side, even numbers to the right, and odd numbers to the left, proceeding from seaward. Because the numbers would become excessively large in such a long line of marks, they are numbered in groups of about two hundred, starting again at 1 at natural dividing points.

Critical Thinking

1. List the attributes of an ideal night navigation aid.
2. What are the similarities between land navigation aids such as signs alongside a highway and navigation aids along a channel through water?

Study Guide Questions

1. A. What are aids to navigation?
   B. What do they include?
2. What are light lists?
3. What are the three principal phase characteristics of navigational lights? Briefly describe each.
4. A. What is meant by the visibility of a navigation light?
   B. Upon what factors does it depend?
5. What was the traditional purpose of a lighthouse?
6. A. What are navigation marks?
   B. What do they consist of?
7. What is the purpose of buoys and beacons?
8. Why must buoys alone not be depended upon for piloting?
9. What are the two main systems of buoyage in use worldwide?
10. A. What areas of the world are covered by the IALA System B?
    B. What areas are covered by IALA System A?
    C. What differentiates the two?
11. What are the eight main types of buoys in U.S. waters?
12. A. How are channel buoys and daymarks colored in U.S. waters?
    B. What is the jingle used as a reminder for which side of a channel red buoys and daymarks are on?
13. A. How do preferred-channel buoys indicate the preferred channel?
    B. What do safe-water buoys mark?
14. A. What is a daybeacon?
    B. What marker does it display?
15. A. What is a navigational range?
    B. Where are such ranges used a great deal for piloting?
16. How are channel buoys and daybeacons in U.S. waters numbered?
17. How are channel buoys and beacons lighted in U.S. waters?
18. A. What is the name of the inland channel in which light-draft vessels can navigate from the Chesapeake Bay almost to the Mexican border without going into the ocean?
    B. What is the significant color identifying all buoys, daybeacons, or light structures along this channel?

New Vocabulary

navigation lights
light lists
fixed light
charted range (of a light)
sectors
buoy
daymark
lateral system (of buoyage)
top-marks
can buoy
bell buoy
combination buoy
preferred-channel buoy
special buoy
quick-flashing light
period (of a navigation light)
light phase characteristics
occulting light
primary light
navigation marks
beacons
daybeacon
cardinal system (of buoyage)
spar buoy
nun buoy
gong buoy
channel buoy
safe-water buoy
range (leading lights)
Intracoastal Waterway

9

Time

You probably have not given much thought to the study of time. In the Navy, time and timekeeping are of great importance, both because the routine of shipboard life is regulated by the clock, and because time is essential in the navigation and operation of a naval vessel. Navigators need to know the exact time in order to do celestial navigation.

If you have ever taken a long plane trip across the country, or to Hawaii or Europe, you have felt the effects of rapid time-zone changes. It often takes a day or two to get your body adjusted to the new time schedule—when to get up, when to eat, when to go to bed. This condition is called *jet lag*. It occurs because your body is used to reckoning time based on the relationship of the Earth and the Sun. As we will see below, this means that your day becomes considerably longer if you are traveling in a westerly direction, and shorter if you are traveling easterly.

This chapter discusses how time is kept in the Navy and the other military services, how it is reckoned, and how to deal with time-zone changes around the world.

Military Timekeeping

We are all familiar with how to tell time by watches and clocks. We know that the new day begins a fraction of one second after midnight and concludes twenty-four hours later at midnight. The time between midnight and noon is labeled "a.m."; these letters mean *ante meridiem*, the abbreviation for "before the middle of the day" (noon). The time between noon and midnight is labeled "p.m.," the abbreviation for *post meridiem*, or "after the middle of the day." We are comfortable with this system of timekeeping in civilian life because we can simply look out the window, so to speak, to see if it is morning or afternoon. We do not confuse 5:00 in the evening with 5:00 in the

The twenty-four-hour clock (military time) helps to avoid confusion in military operations, like the mission of these special forces SEAL team members embarked in a speeding inflatable boat off the coast of East Africa. *Alexandra Minor*

morning, to say nothing of 1:00 in the morning and 1:00 in the afternoon.

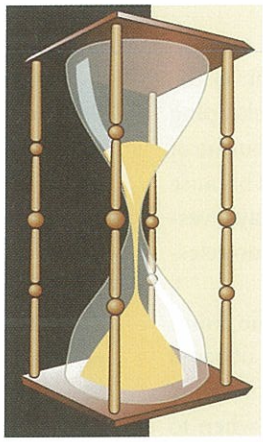
The United States, however, is among only a handful of nations (Canada, India, and Australia are others) that still use the twelve-hour a.m. and p.m. system of timekeeping. Most other nations in the world tell time by the twenty-four-hour clock, as does our Navy and the other U.S. armed services. Because of the rarity of its general use among civilians in North America, in our country this kind of timekeeping is often referred to as "military time." The twenty-four-hour clock greatly facilitates international communication and coordination among far-flung forces around the globe by basing all times on Coordinated Universal Time (see below), thus rendering time conversions unnecessary, especially between different standard time zones. It avoids the confusion that would happen if the a.m. or p.m. were accidentally left out of directions or orders. Worldwide computer-based communication on the Internet and via satellites is also greatly facilitated by the use of the twenty-four-hour clock.

In this way of keeping time the day begins a fraction of a second after midnight, 0000 (zero hour), and continues past 0100 (1:00 a.m.) and 0200 (2:00 a.m.) toward noon, 1200. The time after noon continues with 1300 (1:00 p.m.), 1400 (2:00 p.m.), and so forth until 2400, midnight. The terms *o'clock*, *a.m.*, and *p.m.* are not used; nor is a colon used to separate hours from minutes. Rather, we speak in terms of "hundred." For example, 0100 is spoken "zero one hundred," 1000 is "ten hundred," 1800 is "eighteen hundred," and 2130 is "twenty-one thirty." Traditionally, the U.S. Army and Air Force include the spoken word "hours" when officially citing a military time (e.g., "twenty-one thirty hours" for 9:30 p.m.), but this practice is not followed in the Navy.

All NJROTC cadets should learn to use the twenty-four-hour clock. Mathematically, it is very easy to figure out; simply add all p.m. time numbers to 1200 (noon). For example, 2:25 p.m. becomes 1425, and 10:30 p.m. is 2230. You should memorize the twenty-four-hour clock so it becomes second nature when telling time:

Morning (a.m.)		Afternoon (p.m.)	
0100	1 a.m.	1300	1 p.m.
0200	2 a.m.	1400	2 p.m.
0300	3 a.m.	1500	3 p.m.
0400	4 a.m.	1600	4 p.m.
0500	5 a.m.	1700	5 p.m.
0600	6 a.m.	1800	6 p.m.
0700	7 a.m.	1900	7 p.m.
0800	8 a.m.	2000	8 p.m.
0900	9 a.m.	2100	9 p.m.
1000	10 a.m.	2200	10 p.m.
1100	11 a.m.	2300	11 p.m.
1200	12 p.m./noon	2400/0000	12 a.m./midnight

While 0000 and 2400 are exactly the same time, it is common practice to start each day at 0001 and end it at 2400.



Rendition of a typical hourglass used to reckon the passage of time before clocks and watches were common.

Ship's Bell Time

Before timepieces such as clocks and watches were common, the passage of time on board ship was reckoned by the use of an **hourglass** and announced by bells. The hourglass consisted of two sealed vertical glass chambers joined in the middle by a narrow opening through which fine sand ran from one end to the other, usually every thirty minutes. The hourglass would then be turned over to start measuring another thirty minutes, and a bell would be struck so all hands would know a half hour had passed. It was struck once at the end of the first half-hour of each four-hour watch, twice at the end of the second, and so on, until eight bells were struck at the end of the fourth hour. After eight bells were struck, the sequence started over again.

The tradition still continues on board some Navy ships, in spite of the use of clocks and watches. The bells are rung in pairs; that is, if there are two or more bells to be rung, they are rung closer together than the odd bell. For example, five bells would sound like "ding-ding, ding-ding, ding." An odd number of bells marks half past the hour, and an even number marks an hour. When used, bells are rung only from reveille to taps, but not during divine services or when fog requires that the bell be used as a fog signal.

Old-fashioned "ship's clocks" with chimes that go through the bell sequence described above are available commercially.

Time and Arc

People have reckoned time according to the travel of the Sun once around the Earth each day since ancient times. Of course, since the time of the medieval astronomer Copernicus in the sixteenth century we have known that it is really the Earth's rotation that makes the Sun seem to move. But for navigation, and to make it easier for us to understand how time works, it is often helpful to use the ancient concept of the Earth as standing still at the center of the universe, with the Sun and all the other celestial bodies moving around it.

The Sun thus appears to make one complete 360° revolution around the Earth during each twenty-four-hour day. Actually, as we will see below, on any specific day during the year it will usually take a few minutes more or less than twenty-four hours for the Sun to complete its journey. But on the average over a year, we can say that it takes exactly twenty-four hours.

Because the Sun goes 360° around the Earth in twenty-four hours on the average, we can say that there is a definite relationship between arc as measured in an east-west direction on the surface of the Earth (which we saw in the first chapter in this unit is longitude) and time. If we divide 360° of arc around the Earth, or longitude, by 24 hours, we see that it takes the Sun 1 hour to go 15° of arc, or longitude. And since it travels 15° in 1 hour, the Sun must go 1° (60 minutes of arc) in 4 minutes (1/15 × 60 minutes = 4 minutes). Thus, one degree of longitude can be thought of as being equivalent to four minutes of time. This relationship is of basic importance both in navigation and in traditional methods of keeping time, as we will see.

Kinds of Time

There are two kinds of time in general use in the world today. One, called **solar time**, is reckoned or derived from the daily travel of the Sun around the Earth each day, as described above. The other, called **atomic time**, is reckoned according to the unchanging rate of vibration of certain radioactive elements, most usually cesium, and is therefore independent of any celestial phenomenon. Both of these are described in the following sections.

Apparent Time

Throughout most of human history the Sun has been the most convenient reference for reckoning time. Solar time based on the apparent position of the Sun from an observer's position is called **apparent time**. If the Sun is directly over the meridian we are on, we say that it is noon local apparent time (called *local apparent noon* in navigation, or LAN). When it is directly over the meridian 180° away from ours, it is midnight local apparent time. All other intermediate local apparent times would also be reckoned according to the travel of the Sun relative to our meridian.

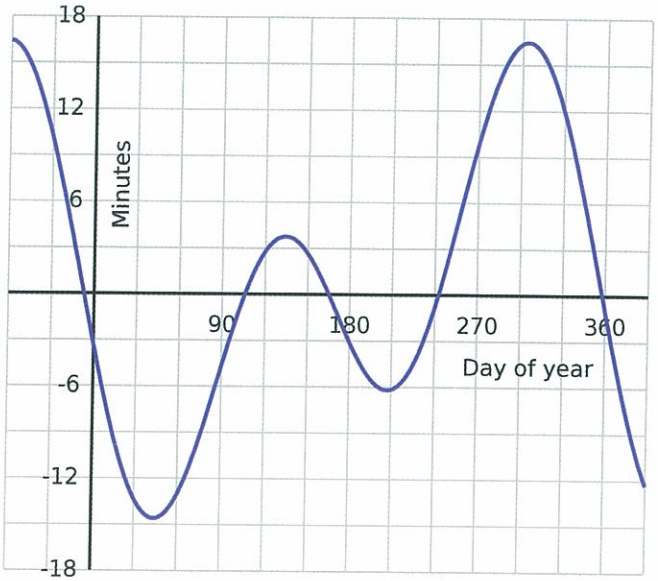
If the Earth stood still in space and the Sun orbited in a perfect circle around it above the equator, all the days reckoned by apparent time would be exactly the same length everywhere on Earth. But as we learned in *Naval Science 2*, the Earth revolves around the Sun in an elliptical orbit (like a race track); the Earth's axis is inclined with respect to the plane of its orbit around the Sun; and the Earth's speed along its orbit varies. Therefore, the time required for a complete rotation of the Earth on its axis relative to the Sun—in other words, the length of a solar day— varies continually according to the position of the Earth in its orbit and the location of the observer on its surface.

Mean Time

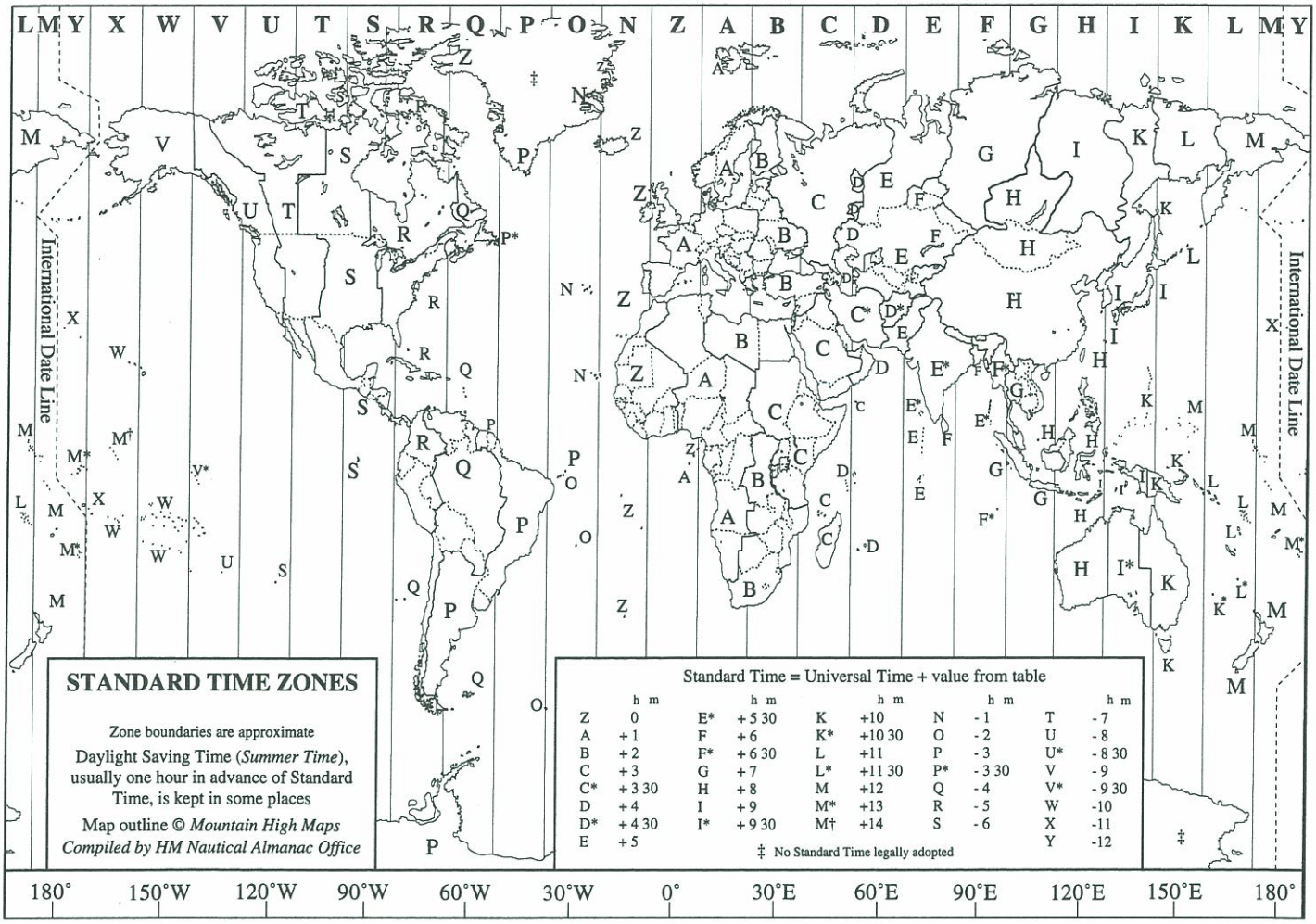
It would be very confusing if some days and hours had more and some had fewer minutes and seconds because of the Earth's motion around the Sun. To eliminate this confusion, an *average* solar time is used; this is called *mean solar time*, or more often just **mean time**. It is based on the motion around the Earth of an imaginary *mean Sun*, which always makes the 360° circuit around the Earth above the equator in exactly twenty-four hours. Time reckoned according to the travel of the mean Sun relative to an observer's meridian is termed **local mean time (LMT)**. So if your watch says it is 1200 LMT, the *mean* Sun is over your meridian, not the *actual* Sun.

In November of each year the actual Sun is about sixteen and a half minutes ahead of the mean Sun, and by February it has fallen behind by some fourteen minutes. The difference between apparent time and mean solar time at any moment is called the **equation of time**. It is tabulated in navigational publications called *almanacs* that tabulate times for all manner of celestial phenomena, and it must be taken into account for certain tasks involving observations of the Sun in celestial navigation at sea.

As a point of interest, if a navigator knows the equation of time at his or her location and records the exact time of LAN with an accurate timepiece, the navigator's longitude can be



Graph showing how the value of the equation of time—the difference between apparent time and mean solar time—varies as the year progresses from day 1 to day 365. When the value is positive, the actual Sun is ahead of the mean Sun, and when negative, it is behind. *Drini*



Standard time zone chart of the world. The prime meridian (0°) is the central meridian for the Zulu (Z) time zone. Successive time zones lie every 15° to the east and west. Each time zone has a letter designator as indicated on the chart. The numbers in the inset table must be added to Universal (Zulu) time to find standard (zone) time. Their inverse values are the zone descriptions of the various time zones. *By permission HM Nautical Almanac Office*

accurately determined by multiplying the average travel rate of the mean Sun, 15° per hour, by the difference in time between the Greenwich meridian (called Zulu or Universal Coordinated Time, as will be explained below) and the observed time of LAN, as corrected by the equation of time. It is this fact that basically made possible the determination of longitude at sea by means of celestial observations once accurate clocks were invented in the 1700s, as noted in chapter 7 of this unit.

Zone Time

Since local mean time is based on the relationship between one's own meridian and the mean Sun, a slight difference in longitude between two places would result in a slight difference in time kept. Though not very significant in days of old, this difference would be very impractical in our modern world. For example, if we set our watches to LMT, we would have to reset them every few blocks along an east-west street. In New York City, for instance, a difference of about nine seconds LMT occurs between one end of 42nd Street and the other end.

To eliminate this problem, in the early part of the last century **standard time zones** were established around the world. All clocks and watches within a standard time zone are set to the same time, and there is a difference of one hour between one time zone and the next. It takes the mean Sun exactly one hour, or sixty minutes, to traverse, or *transit*, each time zone. Because there are twenty-four hours in a complete day, and 360° of longitude around the Earth, each standard time zone is 15° of longitude wide (360/24 = 15).

The standard time zones begin at the Greenwich meridian (0°). Every meridian east and west of Greenwich that is a multiple of 15° (15°, 30°, 45°, 60°, and so on) is a standard time meridian. Each standard time meridian is at the center of its

time zone, and the zone extends 7.5° degrees (half of 15°) on either side of the meridian. Since the Earth rotates toward the east, time zones to the west of Greenwich are earlier; to the east, the zones are later.

The standard time zone system is fixed by international agreement and by law in each country. Certain time zones have some irregular boundaries, however, to allow all inhabitants of various island groups and geographic regions within countries to keep the same time to make life easier for the people living there.

Local mean time along each standard time meridian is **zone time (ZT)**, or **standard time** for that entire time zone. Each time zone is identified by an alphabetical letter and by a negative or positive number from 1 to 12, east or west of the prime meridian. The number is called the *zone description* (*ZD*) of the zone, and the letter is called the *suffix*. Time zones to the east of Greenwich have negative zone descriptions, and time zones to the west have positive ones.

To separate one day from the next, the 180th meridian in the mid–Pacific Ocean has been designated the *International Date Line*. The time of day is the same on both sides of the line, but west of the line it is one day later than it is to the east.

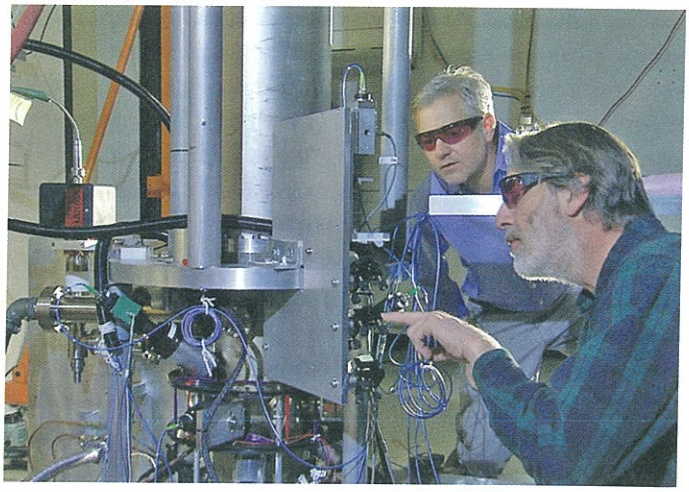
The continental United States has four standard time zones. The East Coast keeps +5 Romeo (R) time, called Eastern Standard Time (EST). Central Standard Time is +6 Sierra (S), Mountain Standard Time is +7 Tango (T), and Pacific Standard Time is +8 Uniform (U). All of Alaska keeps +9 Victor (V), and Hawaii keeps +10 Whiskey (W).

Daylight saving time (DST) is simply zone time set ahead one hour to extend the time of daylight in the evening; it is usually implemented in summer except for certain countries in Europe where it may be adopted in wintertime. This is done strictly for convenience ashore in many localities in the United States and several other countries in North America, Europe, and the Middle East. Daylight saving time is not used in navigation.

Zone Time and GMT

Greenwich Mean Time (GMT) is the ZT at the Greenwich meridian. The Greenwich meridian is the standard time meridian for the time zone numbered 0. It has the zone description suffix letter Zulu (Z), which is now also used to designate the modern worldwide atomic time standard, **Coordinated Universal Time** (UTC—see below). Most naval communications use Zulu time as their time standard, so you must know how to convert the local time in any zone to Zulu (UTC/GMT), and vice versa.

Remember that the solar day has twenty-four hours, and each time zone represents one hour. Beginning with the 0 zone (Greenwich), time zones run east and west from zone 1 to zone 12, with zones east of Greenwich being minus, and those west of Greenwich being plus. (Note that the +12 and –12 zones each extend over only 7.5° of longitude.) The zone description (ZD) tells you the difference in hours between your zone time and UTC/GMT. To convert the time in any time zone to Zulu time, you must *add* the zone description number algebraically to the zone time. To convert from Zulu to zone time, you must *subtract* the zone description. This procedure can be represented by the following simple algebraic formulas:



Two physicists work with a cesium atomic clock at a facility of the U.S. National Institute of Standards and Technology (NIST).

$$\text{Zulu time} = \text{ZT} + \text{ZD} \text{ and } \text{ZT} = \text{Zulu time} - \text{ZD}$$

When using the formulas you must be careful to remember to use the rule of algebra that two minuses together make a plus. For example, if we were at a position in a time zone east of Greenwich where the zone description was –5 and we wanted to convert a Zulu time of 0600 to our standard zone time, we would set up the formula like this:

$$\text{ZT} = \text{Zulu} - \text{ZD}$$
$$\text{ZT} = 0600 - (-5) = 1100$$

Standard time zones are also described by letter suffixes, as noted earlier. In writing military time, it is generally required that a local time zone's suffix letter be placed after the numbers, or the letter Z if it is a Zulu time. Thus, in the example above, we would add the letter E to our result, for 1100E, since that is the time zone having the zone description of –5. As other examples, 11:00 in the morning in Norfolk, Virginia, zone time would be written 1100R; 3:30 p.m. in San Diego would be written 1530U. This avoids confusion for the person reading that time.

Coordinated Universal Time

As mentioned above, the modern basis for timekeeping that has come into ever wider use in our era because of its extreme

accuracy is *atomic time*, better known as Coordinated Universal Time, or sometimes Universal Coordinated Time, abbreviated by international accord as UTC. This time is based on the frequency of vibrations of the radioactive cesium atom. Because cesium is a fairly common element, it is readily available to be used in *atomic clocks* as a time standard everywhere on Earth. UTC rather than GMT became the official standard for world time on 1 January 1972.

Since GMT is based on the changing relative motion of the Earth and the Sun, and UTC is based on the unchanging cesium frequency, GMT and UTC can differ, with the amount of the difference gradually tending to increase over time because the Earth's rotation rate is very gradually slowing. Hence, a correction called a *leap second* is added at the middle or end of some years as required to keep UTC in sync with GMT. This has occurred every nineteen months on average since UTC was adopted as the worldwide standard in 1972. Even with this correction, the two time standards can differ at certain times by as much as nine-tenths of a second. But the difference is usually smaller and can be disregarded for most navigational purposes.

In addition to being the national timekeeping standard for most nations, UTC is used as the time standard for the Internet and the World Wide Web, as well as by all computer servers, online services, and other entities that rely on having a universally accepted time. For several years it has been the time standard by which all celestial phenomena and positions of bodies have been tabulated in the *Nautical* and *Air Almanacs* for use in celestial navigation, and it is the time standard used in aviation for flight plans and air traffic control. National Weather Service weather forecasts and maps all use UTC to avoid confusion about time zones and daylight saving time. The GPS system plus all other forms of space-based technology and the International Space Station also use UTC as a time standard. For most practical purposes in the U.S. military, Zulu (time zone Z) time is now used to designate UTC, including in the date/time groups of messages, even though it was originally used to indicate GMT. The traditional time zone descriptions and suffix letters are still used to designate time in local time zones throughout the world.

In the United States, National Institute of Standards and Technology (NIST) radio stations in Colorado and Hawaii broadcast UTC time signals every minute, twenty-four hours per day, and these may be accessed either by radio or by phone. UTC time signals are also incorporated into GPS signals, and the UTC times are indicated on many GPS-based navigation sets and plotters.

Date/Time Group

Another aspect of time in the Navy involves the time and the day, month, and year used for military communications. Messages and other data keep coming twenty-four hours a day, every day of the month, and every month of the year. Therefore, there must be some way to identify exactly when a communication was originated or received, both for reference and for filing requirements. To do so, the Navy and other services and government agencies use the date/time group.

Let us assume that a message originated at 1635Z on 15 April 2020. This would be placed in the message heading as 151635Z APR 20. The first six numbers and letter Z show the date, the time, and the ZD suffix (normally Z for UTC) at which the message was sent and received. For further clarification, the month and year are also added. All messages sent by U.S. military services and all other U.S. government agencies, as well as those of our allies, are subsequently referenced and filed by their originator and the date/time group.

Critical Thinking

1. Why is an accurate timepiece of great importance in celestial navigation as sea?
2. What are the advantages of keeping zone time as opposed to a single standardized time throughout the world? Would you prefer to keep time according to your local zone time or keep a standard time such as Coordinated Universal Time? Justify your answer.
3. Look up the telephone number of the NIST radio station WWV in Colorado on the Internet and use it to check the accuracy of your watch or other timepiece (caution: long distance telephone rates may apply if you use landlines!).

Study Guide Questions

1. Why do you suffer jet lag if you take a long east-west plane flight?
2. What do a.m. and p.m. mean?
3. Why do the U.S. Navy and other armed services use the twenty-four-hour clock?
4. What would the following times be on the twenty-four-hour clock?
   A. 8:30 a.m.
   B. 5:45 p.m.
   C. 11:15 p.m.
   D. Midnight
5. A. How did telling time by ship's bell originate?
   B. What is the maximum number of bells struck?
6. What is the basic relationship between longitude (arc) and time?
7. Why does the length of each solar day vary slightly?
8. What is mean solar time?
9. A. How many degrees of longitude are in each standard time zone?
   B. How long does it take the mean Sun to transit each standard time zone?
10. How is each time zone identified?
11. How do the dates on each side of the International Date Line differ?
12. What are the four standard time zones in the continental United States? Identify each with its alphabetical suffix and numerical ZD.
13. What is daylight saving time?
14. Convert the following zone times to Zulu (GMT/UTC) times:
    A. 1200 at San Diego (ZD = +8U)
    B. 1700 at Norfolk (ZD = +5R)
    C. 0600 at Rome, Italy (ZD = –1A)
15. Convert the following GMT/UTC times to zone times at the locations in the previous question:
    A. 0800 Zulu
    B. 1600 Zulu
16. What is Coordinated Universal Time (UTC), and how is it reckoned?
17. What are the local date/time groups for the following:
    A. 0835 local time at Norfolk, Virginia, on 23 March 2020
    B. 7:30 p.m. local time at San Diego, California, on 17 May 2020 (DST in effect)
    C. 2230 local time at Rome, Italy, on 9 July 2020 (DST not in effect)
18. Convert the local date/time groups in question 17 to Zulu date/time groups.

New Vocabulary

jet lag
post meridiem (p.m.)
solar time
apparent time
mean time
local mean time
time zones
zone description (ZD)
daylight saving time
Zulu time
leap second
date/time group
ante meridiem (a.m.)
hourglass
atomic time
local apparent noon (LAN)
mean Sun
equation of time
zone (standard) time
time zone suffix letter
Greenwich Mean Time (GMT)
Coordinated Universal Time (UTC)
time signals
NIST

Unit 4

Rules of the Road and Maneuvering Board

Just as there are rules for drivers of vehicles on land, so there are rules for those who handle ships and boats on the water. The automobile and truck driver must know traffic signals and signs, highway markings, and the rules of the road for motor vehicles. The ship and boat "driver" must know the buoyage systems, lights and signals, and nautical rules of the road governing traffic afloat on the waters of the world. Chapter 10 of this unit will introduce you to the basic nautical rules of the road that must be followed by all those operating a vessel on the inland waters of the United States and on the world's oceans.

When maneuvering a ship or boat either to comply with the rules of the road or for other purposes, there are two primary safety rules: (1) do not hit anything (e.g., another vessel or other object), and (2) do not run aground (i.e., hit bottom or shore). In pursuit of compliance with the second caveat, in the Navy all those involved in directing the movements of vessels study the subject of marine navigation as summarized in the previous unit of this text. A valuable aid in complying with the first caveat in addition to a thorough knowledge of the nautical rules of the road, is a good understanding of relative motion. To help develop this understanding a very useful tool is the ability to construct relative motion plots on a printed sheet called a *manuevering board*. Chapter 11 in this unit will introduce the fundamentals of this skill.

10

Nautical Rules of the Road

The nautical traffic laws are contained in several sets of rules commonly known as the *nautical rules of the road* or the *navigation rules*. There are two main sets of these rules by which Navy ships operating in international and U.S. waters must abide: the *International Regulations for Prevention of Collisions at Sea, 1972*, referred to as the **COLREGS**, or simply the **international rules**; and the *U.S. Inland Navigation Rules*, nowadays referred to simply as the **U.S. inland rules**. Both sets of rules mandate the navigation lights vessels must show at night or in poor visibility and the markers called day shapes that they must hoist by day, as well as the rules for maneuvering when two vessels are approaching each other and some danger of collision exists. The COLREGS govern vessels underway on the high seas in international waters and internal waters of many foreign countries, and the U.S. inland rules, vessels underway in the internal (i.e., inland) waters of the United States.

The 1972 COLREGS were developed as an international convention (type of treaty) by the International Maritime Organization and became effective worldwide in 1977 after ratification by most of the maritime nations of the world, including the United States. The COLREGS formalized and consolidated into international law many formerly nonstandardized rules and traditional practices that had been followed by vessels at sea for many years preceding. The United States followed suit with a corresponding set of U.S. inland rules established by Congress under the *Inland Navigational Rules Act of 1980*, which became effective in 1981. For a while they were sometimes called the *unified rules* because they combined three sets of rules formerly in effect in the internal rivers and other waters of the United States. For the most part the international rules and U.S. inland rules, as they will henceforth be referred to in this chapter, are closely aligned in content and format, but there are some significant differences in a few of the rules that will be pointed out later in this chapter.

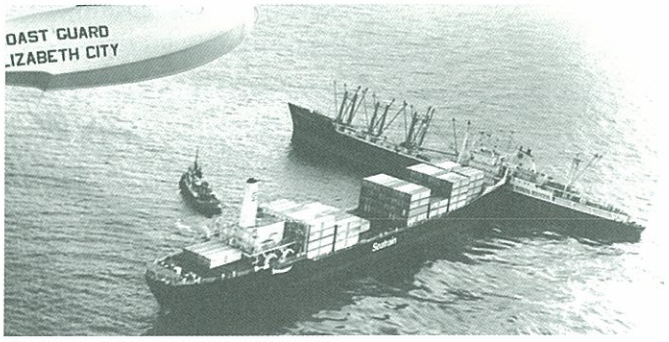
Where Rules Apply

The international rules must be obeyed by all vessels that travel on the high seas and in the territorial waters of all nations. Most nations also use the international rules to govern how vessels must operate in their internal waters, with the notable exception of the United States and the littoral nations of continental Europe. They have their own set of navigation rules with which vessels operating in their internal waters must comply. A few others, like Canada, have adopted the international rules to govern navigation on most of their internal waters, with only minor modifications to serve particular needs within some of them.

The U.S. inland rules must be obeyed by all vessels that navigate within the lines of demarcation of the internal waters of the United States (described in chapter 14 of the Naval Knowledge section of this textbook). These include all inland bays, harbors, rivers, and lakes, including the Great Lakes, but do not include U.S. territorial waters beyond the demarcation lines (generally the shorelines along the seacoasts).

Purpose and Scope of the Rules

The rules of the road govern all waterborne traffic underway on the water. Their purpose is to prevent ship collisions, which can result in the loss of lives as well as millions of dollars through damage or sinking.



The nautical rules of the road have one purpose—to prevent ship collisions. A Coast Guard plane flies over the results of a collision of a containership and a passenger-cargo ship east of Cape Hatteras, North Carolina, that resulted in loss of life and the release into the sea of some 24,000 gallons of fuel oil.

Under the rules a vessel is considered *underway* when not at anchor, or made fast to the shore, or aground; so a ship stopped dead in the water can still be underway. In such a situation the vessel is said to be "underway but with no way on." There are two broad classes of vessels to which the rules apply: power-driven vessels and sailing vessels. As defined in the rules, a *power-driven vessel* is any vessel propelled by machinery, even if it may also have sails up. Any vessel under sail alone is considered a *sailing vessel* whether propulsion machinery is on board or not. Because they are more easily maneuvered, power-driven vessels must usually give way to sailing vessels. On the other hand, in harbors and narrow channels, small craft and sailboats must avoid collisions by standing clear, because larger vessels do not have as much freedom of movement.

In the event of a collision on water, the applicable international and inland rules are used by the admiralty law courts of the nations involved to decide who will pay for the damages. Unless the vessels are equally at fault or there was nothing more that either one could have done to prevent the collision, by international agreement the courts must split the damages according to *degree of fault* (e.g., one vessel 30 percent at fault, the other 70 percent at fault, etc.).

In addition to rules for maneuvering, called **steering and sailing** rules, both international rules and inland rules cover vessel lights and day shapes, sound signals, and distress signals.

Rules for Lights and Shapes

Under both international rules of the road and the inland rules of the United States and other countries, a number of different standardized navigation lights must be shown by surface vessels of all types and sizes when underway from sunset to sunrise, and during times of reduced meteorological visibility due to fog, smoke, heavy rain, snow, or other causes. Lights that could be mistaken for required lights must not be shown.

The most basic of these navigation lights are called **running lights** and consist of distinctive white, red, and green lights that must be shown by all vessels when underway at night or by day in reduced visibility conditions. There are also a number of additional special lights that must be shown by vessels engaged in certain activities that restrict their ability to maneuver, or to indicate other states of reduced maneuverability. By day, there are various corresponding geometric markers called **day shapes** that these vessels must hoist to indicate the same types of information.

Running Lights

All surface vessels underway at night and in poor visibility conditions during daylight must show distinctive white, red, and green *running lights*. Although the exact requirements differ somewhat depending on the size and kind of vessel, all boats, ships, surfaced submarines, and other surface craft underway in both international and inland waters must display them.

The basic requirements for running lights are the same in both sets of rules. All power-driven vessels longer than 12 meters (39 feet) must display a white light high in the fore part of the vessel, usually but not necessarily on a mast, called the *masthead light*; red and green *sidelights* mounted on the sides, with the port sidelight red and the starboard sidelight green; and a white *stern light*. Vessels longer than 50 meters (164 feet) are also required to display an additional white light on an aftermast called the *range light*, positioned higher than and well aft of the masthead light. It is optional on all smaller vessels. Small powered craft less than 12 meters in length may display a single all-round white light (a light visible 360° around) in lieu of masthead and stern lights, but they must also display sidelights. Power boats less than 7 meters (23 feet) long may show only a single all-round light.

Sailboats underway are not required to display masthead lights, but they must display sidelights and a stern light if longer than 20 meters (65 feet). These lights may be combined as a single lantern near the top of the mast on boats less than 20 meters long. Sailboats under 7 meters in length may either display the foregoing lights or a single all-round white light. All sailboats underway except those displaying a lantern may also display in addition to their running lights, near the top of the mast, two vertical all-round lights, with the upper light red and the lower one green.

In addition to normal running lights, an air-cushion (hovercraft) vessel when underway with its hull above water must also show an all-round flashing yellow light.

On vessels 50 meters or more long, the masthead and range lights must be visible from a distance of at least six miles, with

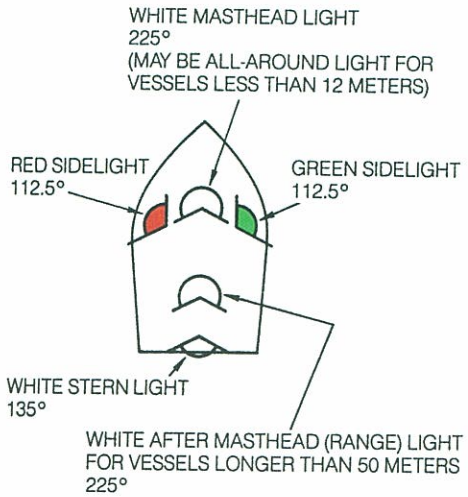


Diagram of the mandated arcs of visibility for masthead, sidelights, and stern lights, for both international and inland rules.

Photo taken at dusk showing the masthead, range, and sidelights of the guided-missile destroyer USS *Ross* (DDG 71) while transiting the Mediterranean Sea. *Robert Price*

an arc of visibility extending 112.5° to either side of the bow (225° total). The sidelights must each have an arc of visibility of 112.5° from the bow to abaft the beam, and the stern light 67.5° to either side of the stern (135° total; see the diagram). The sidelights and stern light must all be visible at least three miles away. Running lights on smaller vessels have somewhat lower range requirements, depending on their size. All-round lights where specified must be visible for 360° around the horizon. The word *visible* when applied to lights means visible on a dark night with a clear atmosphere.

Running lights must be turned on by day any time the range of meteorological visibility is reduced to less than the range of a vessel's required sidelights.

The purpose of running lights is to warn vessels of the presence or approach of other vessels, and to show in which direction they are going. On a dark night at sea, it is nearly impossible to see anything of a ship or boat except the running lights. The sidelights are arranged so that when you see both the red and green sidelights, and the masthead and range lights are in line, you are looking at the bow and the vessel is heading directly toward you. When you see only the green sidelight along with the masthead and range lights, you are looking at the starboard side, somewhere from the bow to slightly abaft the starboard beam. When you see only the red sidelight along with the masthead and range lights, you are looking at the port side, somewhere from the bow to abaft the port beam. If viewed from astern, only the white stern light is visible, warning overtaking vessels that another vessel is ahead. If a vessel is observed at any forward aspect, the pattern of the white masthead and range lights together with the sidelights indicate its heading.

Other Lights and Day Shapes

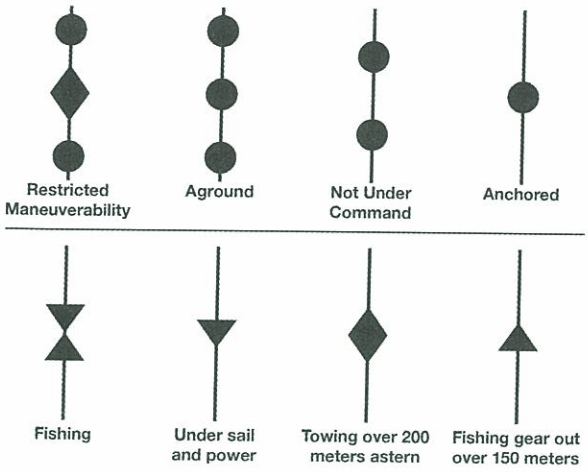
In addition to the normal underway running lights described above, there are several other special combinations of lights and *day shapes* (geometric shapes such as balls, cones, and diamonds, usually colored black and made from canvas stretched over a metal framework, or sometimes in the Navy, wire mesh), displayed by vessels engaged in certain activities or in a special status.

Most harbors require large ships to take on board a pilot who is thoroughly familiar with the harbor, berthing arrangements, and handling of local tugboats to take the ship into port. When entering port at night, the captain and OOD or other conning officer of a ship will want to know the instant the pilot boat is sighted in order to signal it alongside. "White over red, pilot ahead" is a little memory aid to use when looking for the special all-round identifying lights displayed on the mast of a power-driven pilot boat at night. By day, pilot boats may usually be identified by the word *PILOT* displayed on the sides.

Vessels towing with a length of tow less than 200 meters (656 feet) display two all-round white lights in a vertical line in lieu of the masthead light. If the tow extends beyond two hundred meters astern of the towing vessel, a third all-round white light must be displayed below the second light. Vessels or barges under tow must display sidelights and a stern light. By day, if the length of the tow exceeds two hundred meters, a black diamond day shape is hoisted on both the towing vessel and the tow where it is best visible. Regardless of the length of the tow, if the towing results in a vessel being restricted in its ability to maneuver, at night it displays three vertical all-round lights, with the highest and lowest being red and the middle one white; and by day, three day shapes in a vertical line, with the highest and lowest being balls, and the middle one a diamond.

In both sets of rules the term *not under command* refers to ships and craft that are disabled and cannot maneuver in accordance with the rules to keep out of the way of another vessel. A vessel longer than 12 meters not under command under any circumstances at night or in poor visibility conditions must show two vertical all-round red lights where best seen in lieu of any white masthead lights. If underway with way on, such vessels must also show sidelights and a stern light, and if anchored or aground, anchor lights as described below. During daylight, a private vessel longer than 12 meters not under command and either underway or at anchor hoists two black balls in a vertical line, or if aground, three balls in a vertical line. A naval vessel hoists the "5" signal flag, and will also hoist the two or three black ball day shapes as a warning to any other nonmilitary vessels if in international waters.

If at anchor or moored to a buoy, all vessels longer than 7 meters must show anchor lights at night and a black ball day shape by day. Vessels less than 50 meters long show a single all-round white light forward. If longer than 50 meters, a similar



Some of the more common day shapes that vessels in various circumstances of reduced maneuverability are required to hoist. *BoatSafe.com*

light aft must be shown also. The forward light should be higher than the one aft, usually on the top of the jackstaff at the bow of a ship. Powerboats and sailboats typically display their anchor light from their mast top. The black ball day shape is displayed in the forward part of the vessel, usually from a crosstree of the mast where it is clearly visible from all directions.

All vessels aground show the two all-round red lights of vessels not under command, plus the appropriate anchor lights at night and three black ball day shapes in a vertical line by day.

Vessels restricted in their ability to maneuver, like an aircraft carrier or other vessels engaged in flight operations, show vertical day shapes by day consisting of a black ball on top, a black diamond in the middle, and another black ball on the bottom. By night such ships show three vertical all-round lights consisting of a red light at the top and bottom and a white light in the middle, in addition to their customary running lights.

Like running lights when underway, all these special lights are also required to be turned on by day whenever the visibility conditions decrease to less than the range of the vessel's sidelights.

Other unique lights and day shapes are prescribed for vessels engaged in various specialized activities such as fishing, trawling, cable laying, underwater operations, and dredging, or that are constrained by their draft in international waters. The provisions governing these may be found in books covering the complete navigation rules for both international and U.S. inland waters published by the Coast Guard and private publishers and available at most nautical supply stores and large libraries and bookstores. There are also many Internet websites that contain detailed information on the navigation rules, including the U.S. Coast Guard Navigation Center website (www.navcen.uscg.gov).

A quartermaster hoists day shapes indicating a restriction of her ship's ability to maneuver during flight operations. Note their construction, consisting of fabric stretched over collapsible metal frames. Sometimes shapes made of wire mesh are also used in the Navy. *Michael Liebernecht*

Special Rules for Naval Vessels

Many naval vessels, because of their special construction, cannot comply exactly with the rules for navigation lights and day shapes. In such cases the vessels must meet the requirements of the rules as nearly as possible. Any departures from the rules of the road for naval vessels are provided for by U.S. law. Some examples of these variations are the following:

- The horizontal separation of the white lights on destroyers and smaller ships is often less than that required by the rules.
- The white lights on aircraft carriers are usually on the superstructure and off the centerline.
- Special lights such as speed lights, carrier landing lights, and colored recognition lights may be shown on naval vessels during certain specialized operations.
- During certain exercises, naval vessels may show no lights at all. In peacetime, however, the officer in tactical command will usually order navigation lights turned on if a merchant ship approaches the formation. Departure from the rules of the road for exercises is not a good idea if it could result in a collision with a merchantman.

- Special lights and day shapes are required for minesweepers when they are engaged in sweeping operations.
- U.S. submarines are specially authorized to display an amber-colored intermittent flashing beacon—three seconds on, three seconds off—when running surfaced, in addition to other required lights.
- As previously mentioned, air-cushion hovercraft vessels such as landing craft when underway with their hulls above water must also display an all-round flashing yellow light.

Steering Signals

Whistle signals called *steering signals* are required by both international rules and U.S. inland rules for vessels approaching and maneuvering within sight of one another whenever any possible danger of collision exists. Under inland rules, except for backing, whistle signals are signals of *intent* sounded before any maneuvers are made. The vessel that sounds a signal in inland waters does not execute a maneuver until the other vessel makes the same signal in reply, meaning that it understands and agrees. If the other vessel does not understand the signal or considers the proposed maneuver dangerous, it replies with the danger signal consisting of not less than five short, rapid blasts.

Whistle signals in international waters, however, with the exception of an overtaking situation described below, are signals of *action* or *execution* sounded when a vessel is starting a maneuver. No replies are necessary except in the overtaking situation. Since international waters are not as crowded as inland waters, international rules for whistle signals are not as demanding as inland rules. Whistle signals are absolutely essential to safe navigation, however. The international whistle signals are the following:

- One short blast: I am altering my course to starboard.
- Two short blasts: I am altering my course to port.
- Three short blasts: My engines are going astern.
- Five or more short blasts: Danger signal.

Under inland rules, the one-short-blast signal is a signal of intent on the part of the originating vessel to leave the other to its port side, and agreement on the part of the other. The two-short-blast signal is a signal of intent and agreement to leave the other vessel to starboard. The three-short-blast signal for backing and the danger signal have the same meanings under both sets of rules.

Under both sets of rules, any time a vessel does not understand the actions or whistle signals of another approaching vessel, disagrees with a proposed action, or wants to warn of impending danger, it sounds the danger signal. Once the danger signal has been sounded in any approach situation, it is accepted practice for both vessels to slow down or stop until agreement can be reached on how to proceed, either through radio communications or by instituting another round of whistle signals.

Confusion over whistle signals is probably responsible for more collisions at sea than any other part of the rules of the road. Though all the rules are important, the steering and sailing rules are the ones most essential to avoiding collision. The rules are designed to keep vessels clear of one another.

Steering and Sailing Rules

Both international and inland rules govern situations in which two vessels are approaching each other with the risk of collision. There are three such basic approach situations under the steering and sailing rules: meeting, overtaking, and crossing. The situation depends upon the relative position of the two vessels when they first sight each other. Vessels do not need to maneuver if they will pass clear by simply maintaining their courses and speeds. But when two ships or boats approach each other and there is a risk of collision, at least one must keep out of the way of the other. This may be done by altering course or by slowing, stopping, or backing engines. The vessel that must keep out of the way of the other is called the *give-way* vessel. The other ship is required to maintain course and speed and is called the *stand-on* vessel.

The rules say that *risk of collision* between two vessels can be determined by carefully watching the compass bearing of an approaching vessel. If the bearing remains constant and does not appreciably change as the range decreases, such risk should be considered to exist. Such conditions are called constant bearing, decreasing range situations in the Navy, abbreviated by the acronym **CBDR**. When in such a CBDR situation, the vessels are said to be on a "collision course." There is a sarcastic saying among mariners: "A collision at sea can ruin your whole day." There is no mariner who does not take the possibility of collision very seriously.

The following sections explain the procedures to be followed by power-driven vessels under both sets of rules for each of the three basic approach situations. The rules for sailing vessels in these situations are much different. They are dependent for the most part on which vessel has the wind on the port side (i.e., is on a port tack) and which has the wind on the starboard side (i.e., is on a starboard tack) in each situation. They will be given following the discussion as it relates to power-driven vessels.

Meeting Situation

In a meeting situation, both vessels are give-way vessels. In all waters, power vessels meeting head-to-head or nearly so are required to pass port to port. If any maneuvering is necessary,

both vessels must alter course to starboard so as to pass port to port. International rules authorize only a port-to-port passing and are silent on a starboard-to-starboard passing. Therefore, it is implied that a starboard-to-starboard passing is proper under international rules only when there is no risk of collision and no maneuvering is needed to effect the passage. In U.S. inland waters, starboard-to-starboard passing is authorized only if the vessels are not meeting directly head-to-head and safe passage is assured without any maneuvering. In other words, under either set of rules, if in a meeting situation and any maneuvering must be done to ensure safe passage, then the passage should always be made port to port.

In a meeting situation in international waters in which the vessels are not head-on, where no maneuvering is necessary for safe passage, no whistle signals are sounded. Both ships maintain course and speed and pass clear. If maneuvering is required in order to pass port to port, each ship sounds one short blast as it is executing the right turn. The vessels may choose to sound the appropriate action signals when maneuvering back onto their original courses, but these signals are commonly omitted because the danger of collision has passed.

In a meeting situation in inland waters, regardless of whether or not any maneuvering is required, whistle signals of intent and agreement must be exchanged. As in international waters, if any maneuvering is required to effect a safe passage, the passage must normally be made port to port. In so doing, one vessel gives one short whistle blast telling the other vessel that it intends to either stay on course to the right or come right to make the passage. After the other vessel has answered with a single short blast, indicating understanding and agreement, both vessels maneuver as necessary to make the port-to-port passage. Any turns should be large enough to clearly show the action to the oncoming vessel (normally 5–10° in a channel, and about 15° degrees in open waters). Under inland rules, after agreement has been reached and the turns have been executed, no further sound signals are required during maneuvering to make a safe passage or to return to the original courses.

Even when two vessels are going to pass starboard to starboard with no maneuvering required, a two-short-blast signal of intent and agreement must still be exchanged under inland rules.

Under both sets of rules, starboard-to-starboard passages are discouraged because misunderstandings can easily lead to a collision. There is another old nautical saying that warns: "Two short blasts are the first two notes of the collision waltz."

Crossing Situation

A crossing situation on the water is analogous to a four-way-stop situation on land. In both sets of rules, the power-driven vessel having the other to starboard somewhere within the arc of its sidelight is the give-way vessel. The vessel to starboard is the stand-on vessel and must maintain course and speed. The give-way vessel is required to maneuver if necessary to avoid crossing ahead of the stand-on vessel and pass astern of it. This may mean reducing speed, stopping, altering course to starboard, or backing down. Give-way vessels are prohibited from turning to port in order to try to cross ahead of the stand-on vessel.

In international rules, the give-way vessel must sound one short blast if it makes a turn to starboard, or three short blasts if it backs down. If it does neither, no signals are sounded. In inland waters, the give-way vessel must sound a short blast to indicate its intent to leave the stand-on vessel to port. The signal is answered with a short blast by the stand-on vessel to indicate agreement. The give-way vessel then maneuvers if necessary to pass astern of the stand-on vessel.

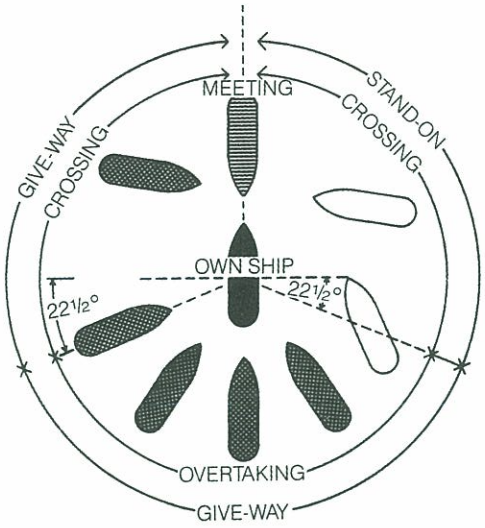
Overtaking Situation

In an overtaking situation, one vessel is overtaking another somewhere within the arc of the lead ship's stern light. In both sets of rules the overtaking vessel is the give-way vessel, and the overtaken vessel is the stand-on vessel. The overtaking vessel must keep clear of the overtaken vessel. In international waters, a vessel that desires to overtake another in a narrow channel or fairway sounds two *prolonged blasts* (blasts of four to six seconds' duration) followed by one short blast to signal that it intends to overtake on the starboard side, or two prolonged blasts followed by two short blasts if it intends to overtake to port. If in agreement, the vessel about to be overtaken sounds the international Morse code signal for "C" (i.e., concur): one prolonged blast, one short, one prolonged, and one short. If in disagreement, the vessel to be overtaken sounds the danger signal, warning that the action is too dangerous and may involve risk of collision or hitting some obstruction. Throughout the maneuvering to pass, the overtaking vessel sounds the appropriate turning action signals.

In inland waters, regardless of circumstances, the rules for overtaking are similar, except that the preliminary two-prolonged-blast signal is not sounded. The overtaking vessel sounds only one short blast if proposing to pass the other vessel on its starboard side, and two if proposing to pass on its port side. If in agreement, the vessel being overtaken sounds a similar signal. If the vessel being overtaken considers the proposed maneuver too risky for any reason, it sounds the danger signal of five or more short blasts. Once agreement has been reached, no further sound signals are required to carry out the passing maneuver.

Approach Situation Rules for Sailing Vessels

The rules that apply to the three basic approach situations for sailing vessels are much simpler and much more condensed

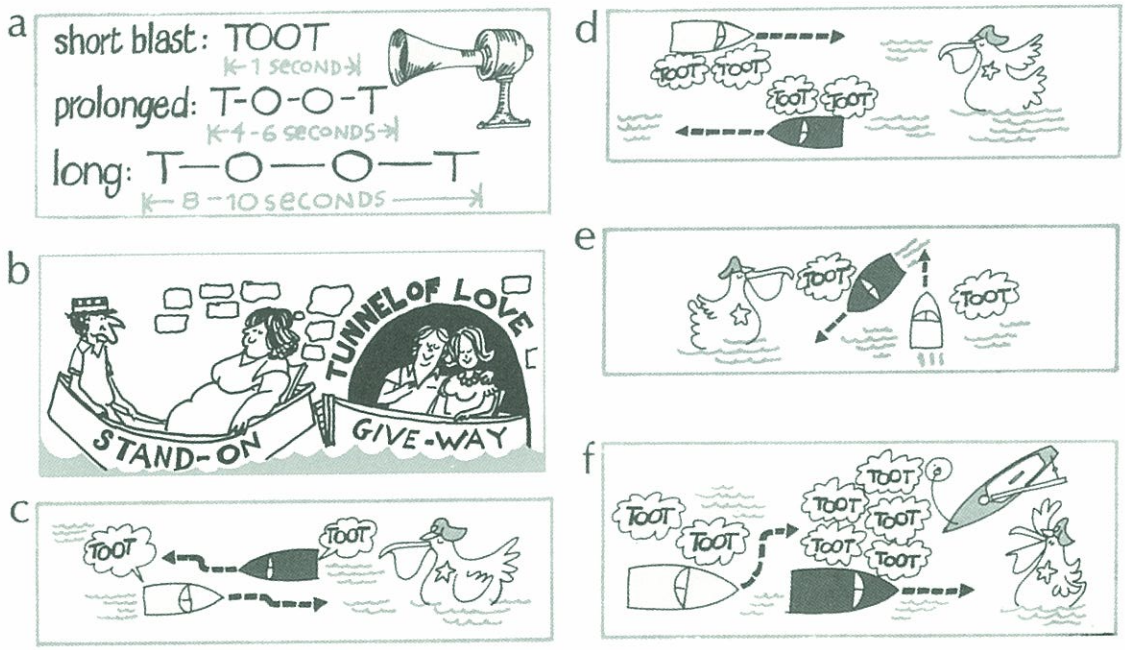


Typical meeting, crossing, and overtaking situations as viewed by own ship.

than those for power-driven vessels. They are as follows under both sets of rules:

- When each vessel has the wind on a different side, the vessel that has the wind on the port side shall keep out of the way of other.
- When both vessels have the wind on the same side, the vessel that is to windward (i.e., upwind) shall keep out of the way of the vessel that is to leeward (i.e., downwind).
- If a vessel with the wind on the port side sees a vessel to windward and cannot determine with certainty the side of the other vessel the wind is on, the former vessel shall keep out of the way of the latter.

Sailboats are not obliged to sound any audible steering signals under either set of rules. Many, however, carry portable air horns that may be sounded in emergency situations in which they believe the give-way sailboat is not taking appropriate action to avoid a collision.



Summary of inland rules whistle signals.
a—Length/duration of whistle signals.
b—Crossing situation. Stand-on vessel is on starboard hand (to the right) of give-way vessel. Stand-on vessel must maintain course and speed; give-way vessel must maneuver, slow, or stop to allow stand-on vessel to pass ahead.
c—Meeting head-on. Both vessels must give way. Vessels exchange single short blasts and maneuver to pass port to port.
d—Meeting situation, but clearly safely separated, allowing for starboard-to-starboard passage with no maneuvering. Vessels exchange two short blasts.
e—Crossing situation, no maneuvering required. Stand-on vessel passes ahead after exchange of one short blast.
f—Overtaking situation, danger to port. Overtaking vessel proposes overtaking to port with two short blasts, stand-on vessel replies with danger signal (five or more short blasts), indicating to give-way vessel that it may not pass to port because of danger on that side. Inland rules also specify that if agreement in any of these approach situations is reached by means of a radiotelephone, the sound signals are optional.

Channels, Bends, and Leaving a Berth

Both inland and international rules say that powered vessels must keep to the starboard side of a narrow channel. Both sets of rules provide that a powered vessel approaching a bend in a channel, if unable to see for at least half a mile ahead (defined as a *blind bend*), must sound a prolonged blast at that time. This must be answered with a prolonged blast from any approaching vessel on the other side of the bend that hears it. If no answer is received, the first vessel may consider the channel ahead clear and may proceed with customary caution. If another vessel is approaching, after the vessels are in sight of each other, the usual signals for meeting and passing should be given, depending on the rules governing the waters they are in.

Under inland rules, a power-driven vessel leaving its dock or berth sounds a prolonged blast to indicate its change of status. This is sounded whether or not vision is obscured beyond the slip or berth. If the vessel is backing from its berth, the prolonged blast is followed by the three-short-blast backing signal, indicating that the vessel is backing.

Avoiding Collisions

In all approach situations in both international and inland rules, the stand-on vessel normally has the right-of-way; that is, the legal responsibility to maintain course and speed in crossing and overtaking situations. In unusual instances, however, this might not be the thing to do if a collision is to be avoided. For example, in a driving situation on land, the driver of an approaching car may fail to stop at a stop sign or red light, either by mistake or perhaps because the brakes failed. Under such circumstances it would not show good judgment for another driver to keep on going and plow into the car simply because the law gave him or her the "right-of-way." In fact, the court would be apt to judge such a driver guilty of negligent driving.

Similarly, both inland and international rules of the road require a vessel's captain to take timely action to avoid collision, even if this might necessitate departing from the rules. Rule 8 under both sets of rules specifies that "any action taken to avoid collision shall . . . if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship." Such an imminent danger of collision is called "in extremis," and rule 8 as it applies to these situations is referred to by admiralty courts as the "rule of good seamanship." Under more routine conditions not involving an imminent collision, a departure from the rules of the road is permissible only when an immediate danger or special circumstance exists, or when the ordinary practice of seamen dictates a departure from the rules—for example, when more than two vessels are approaching one another. Under these conditions, rule 8 is referred to as the "rule of special circumstances." Otherwise, the rules must be strictly followed.

Fog Signals

Under both sets of rules, audible fog signals must be sounded by all vessels by day or at night in any condition that reduces meteorological visibility to less than the range of a sidelight in any direction around a vessel underway, at anchor, moored to a buoy, or aground, similar to the requirement to display running or anchor or warning lights under the same conditions.

A power-driven vessel sounds a prolonged blast of from four to six seconds' duration on the whistle at least every two minutes when it has way on in a fog or other reduced visibility conditions. If stopped but underway (not anchored, moored, or aground), it sounds two prolonged blasts, two seconds apart, at least once every two minutes. If anchored, a bell is rung for about five seconds at intervals of not more than one minute. If a vessel is longer than 100 meters, the bell is sounded in the forward part of the ship, followed by the sounding of a five-second gong in the after part of the ship. If an anchored vessel believes there is a possibility of collision with an oncoming vessel, it may sound three blasts (one short, one prolonged, and one short) to warn the approaching vessel of its position.

If at any time a vessel hears a fog signal forward of its beam and cannot tell from where the signal is coming, the vessel must reduce speed to bare steerageway (the minimum speed at which the rudder is effective). If necessary, it must take all its way off.

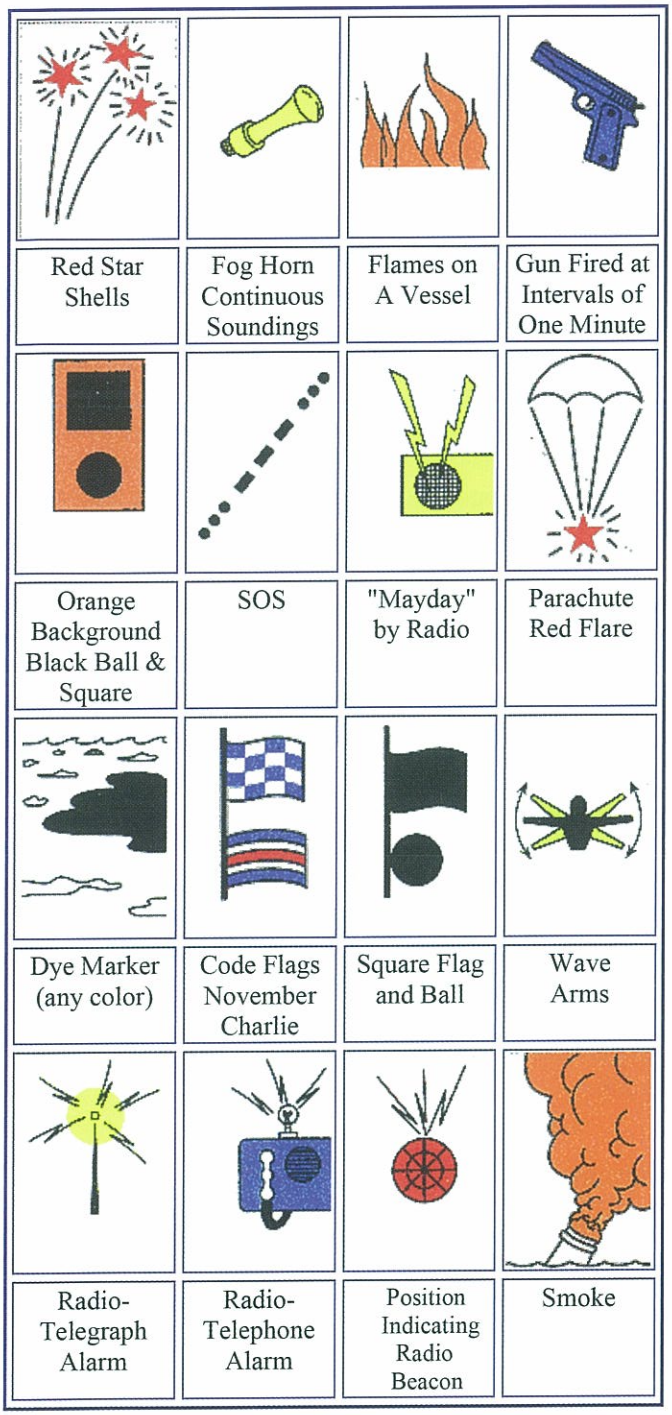
A whole list of special fog signals exist for sailing vessels, vessels aground or towing, fishing, and certain other situations. These are not covered in this text but may be found in the rules if needed.

Distress Signals

International and U.S. inland rules provide a common list of acceptable common distress signals that may be used to call attention to a vessel in need of assistance. Vessels in distress may use one or more of these signals whenever necessary.

There exists a common misunderstanding that the national ensign hoisted upside down is a signal of distress. A man-of-war would not subject the national colors to this indignity, but the belief is widespread among private recreational craft owners. Therefore, if a craft is seen stopped with its ensign hoisted upside down, it probably is in distress. Distress signals specified under international and inland rules are as follows:

- Red star shells
- A continuous sounding with any fog signal apparatus
- Flames from a burning tar or oil barrel



Distress signals authorized under international and U.S. inland rules.
U.S. Coast Guard

- A gun or other explosive signal fired at intervals of about one minute
- An orange flag with a black square and black ball beneath it
- The signal group (SOS) in Morse code
- Radiotelephone (voice) signal "Mayday"
- Red parachute flare
- Dye marker of any color
- A flaghoist flying the flags November Charlie (NC)
- A flaghoist flying a square flag with a ball or anything resembling a ball below it
- Slowly and repeatedly raising and lowering arms outstretched to each side
- Radiotelegraph alarm
- Radiotelephone alarm
- Position-indicating emergency radio beacon
- A smoke signal giving off orange-colored smoke

Critical Thinking

1. Compare and contrast the nautical rules of the road for the crossing, meeting, and overtaking situations with similar situations when driving on land.
2. List the fundamental differences in maneuvering situations between the international and inland rules of the road.

Study Guide Questions

1. A. What are the two sets of rules governing the nautical rules of the road?
   B. Where is each in effect?
2. What is the purpose of the rules of the road?
3. What designation is given to any vessel propelled by machinery?
4. A. When is a vessel "underway"?
   B. If a vessel is stopped in the water but not anchored, moored, or aground, what is its status?
5. A. What running lights must a vessel show at night and in poor visibility conditions by day?
   B. What is the purpose of these lights?
6. What light combination indicates a power-driven boat with a harbor pilot on board?
7. A. What light combination indicates a vessel towing with a length of tow less than two hundred meters?
   B. Towing with a length of tow exceeding two hundred meters?
   C. What lights does the vessel or barge being towed display?
   D. What are the corresponding day shapes?
8. A. What is meant by the term *not under command*?
   B. What are the lights and day shapes that indicate this condition?
9. A. What anchor lights must be shown by a vessel at anchor or moored to a buoy?
   B. What day shape is used to show that a vessel over 7 meters long is at anchor?
10. Why are some U.S. naval vessels not able to comply exactly with the rules for navigation lights and day shapes? Give some examples.
11. What is the basic difference between most steering whistle signals in U.S. inland rules and international rules?
12. If a ship does not understand a whistle signal or considers a proposed maneuver in an approach situation dangerous, what signal must that ship sound?
13. What are the three basic possible situations when there may be risk of collision when two vessels are approaching in sight of each other?
14. How can a risk of collision between two vessels be determined?
15. Under the nautical rules of the road, what are two vessels in an approach situation with a risk of collision called, depending on their responsibilities?
16. A. In a meeting situation, what is the responsibility of both vessels?
   B. What is the preferred type of passage if any maneuvering is required?
17. What is the rule in a crossing situation?
18. What is the rule in an overtaking situation?
19. A. What is the whistle signal under both international and U.S. inland rules for approaching a blind bend in a channel?
   B. What is the inland rules whistle signal for leaving a berth (or changing status)?
20. What term defines a situation in which collision is imminent?
21. Under what conditions must fog signals be sounded?
22. What kinds of signals may be sounded or shown to call attention to a vessel in need of assistance?

New Vocabulary

rules of the road
COLREGS
power-driven vessel
running lights
sidelight
arc of visibility
pilot (ship)
towing lights
steering signals (whistle)
stand-on vessel
leeward
prolonged blast (whistle)
fog signals (sound)
anchor light
distress signals
international rules (maneuvering)
inland rules
underway
range light (ship)
stern light
day shape
anchor lights
"not under command"
give-way vessel
windward
blind bend
in extremis
bare steerageway

11

The Maneuvering Board

During your years as an NJROTC cadet you will have occasion to be involved with boats and ships. On training cruises or visits to naval bases you may find yourself on board a boat or a ship engaging in some type of maneuvers for training purposes. It is to be hoped that you will have a chance to participate in such maneuvers, either as an observer or possibly as a junior watchstander.

This chapter introduces you to the basic concepts of a plotting sheet known as a **maneuvering board**, used in the Navy to solve problems involving relative motion of ships and boats. Although called a "board," it is actually a paper sheet overprinted with a set of concentric rings and scales. The maneuvering board is a tool designed for graphic solutions to relative motion diagrams. Those who have taken second- or third-year high school math courses or physics may recognize the relative motion diagrams drawn on the maneuvering board as *vector diagrams*.

While the maneuvering board can be used to solve a variety of problems, we will concentrate here on some of the types of approach situations discussed in chapter 10 of this unit on the nautical rules of the road. Specifically, we will be concerned with finding the courses and speeds of other vessels we may encounter, and their closest points of approach (CPAs) to a hypothetical vessel we are on. Such information is essential to our ability to predict their future positions and to decide upon any maneuvers we may need to make to avoid collisions. Although modern communications technology can sometimes be used to simply ask the other vessels what their intentions are, in the end we must depend upon our own verifiable data and maneuvering board solutions to ensure our vessel's safety.

An operations specialist plots on a maneuvering board using a parallel plotter on the bridge of a Navy destroyer while visitors from the Republic of Singapore Navy look on. Note the nautical slide rule handy nearby for speed-time-distance computations. *Eric Cutright*

Other types of problems that are routinely solved using the maneuvering board include courses and speeds our ship should take to go to assigned stations in a formation, or to avoid other ships, or to get the proper relative wind for conducting flight operations with aircraft. As part of their formal training, enlisted operations specialists and line officers who stand deck watches spend many hours learning to solve all kinds of maneuvering problems with the maneuvering board.

On board Navy ships much of what used to be done using maneuvering boards is now done by computer. Nevertheless, learning how to do the manual computations on the maneuvering board is a great way to become familiar with relative motion, which is a key component of almost any situation involving two or more moving objects. Such situations can include learning to drive a car on busy streets or highways, maneuvering boats or Navy ships on the seas, and flying the most sophisticated jet aircraft.

Relative Motion

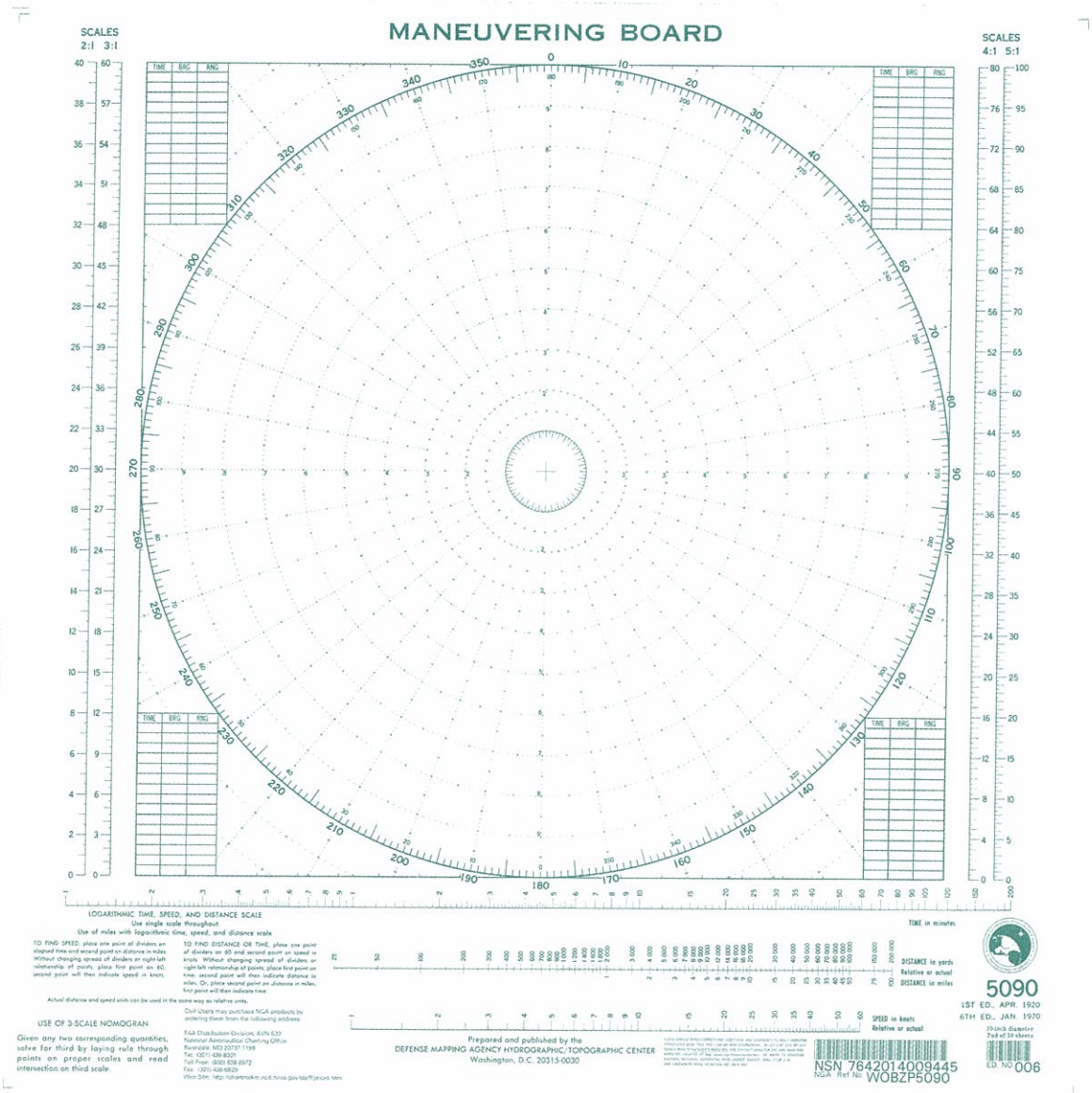
You know both from observations of the world around you and from math and physics courses you may have taken that there is no such thing as absolute rest or absolute motion. Rather, all states of rest or motion are said to be relative to some reference point in space or location on the Earth. In driving a car, for example, the reference for how fast you are going is the road on the Earth's surface (or sometimes the police officer's radar or laser gun). In a passing situation, you in your car are the

reference for how fast another car passing you is going. And the reference for parallel parking is the car in front and the car behind the empty space you want.

At sea, the reference for what other vessels are doing relative to your vessel is your boat or ship. To determine these things, we construct a relative motion plot on the maneuvering board composed of *vectors*. A vector is a plotted line used to represent any quantity that has both magnitude (size) and direction. The head of the line is labeled with an arrowhead; its length represents the size of the quantity being represented, and its direction represents the direction of the quantity. Since vessels have courses (direction) and speeds (magnitude) of travel, vessel courses and speeds can be conveniently represented by vectors drawn on the maneuvering board.

The Maneuvering Board Plot

The plot on a maneuvering board is a type of plot called in mathematics a **polar plot**, wherein all quantities are plotted using their magnitudes and directions, as opposed to their x- and y-coordinates as would be the case on a standard x-y rectangular-type plot. The maneuvering board features a reference position in the center called the *pole*, a series of concentric circles drawn around the pole at uniform intervals, and a 360°



The U.S. Navy maneuvering board.

"bearing circle" printed around the perimeter, with the opposite or *reciprocal* bearings printed in smaller type beneath. On the left and right margins are scales that can be used to represent lengths of vectors or distances between the concentric circles, and on the bottom is a logarithmic speed-time-distance device (a kind of analog computer) called a **nomogram**. Like a nautical slide rule or calculator, it can be used for any problem dealing with time, speed, and distance. Knowing any two of these quantities will allow you to determine the third.

The polar plot on the maneuvering board can be used to plot both *vectors*, representing vessel courses and speeds, and *points*, representing locations of your own and other vessels. For other vessels, these points can then be connected to show their *tracks*, another form of vector.

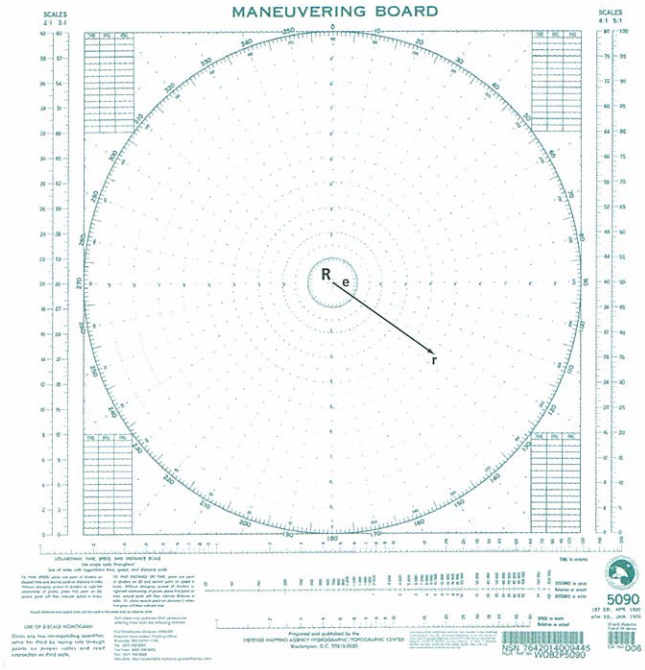
To use the maneuvering board you will need the following plotting instruments: a pencil to draw vectors and plot points, a parallel ruler and a triangle to assist in drawing vectors and to pick off directions, and navigator's dividers or a compass to pick off distances between two points.

Before we discuss how to solve problems on a maneuvering board, you must first understand that we are about to draw, or "plot," two different motion diagrams on the same sheet. The first of these is the *relative motion line* (RML) or plot. It consists of connected points representing the locations of another vessel relative to your own vessel at various times, plus the future track of that vessel based upon projecting this line. The second is the *speed triangle*. It consists of three sides made up of vectors representing your own vessel's actual course and speed, the other vessel's relative course and speed, and its actual course and speed. Keeping these two plots separate and distinct in your mind will help alleviate the natural confusion that learning this new skill often brings.

In order to construct a maneuvering board plot, it is first necessary to decide the frame of reference for the plot you are going to construct. For most purposes, this will normally be your own vessel. So the first step is to plot a point on the pole to represent your boat or ship. For clarity, especially when learning the maneuvering board, it is usually labeled with a capital R, for *reference vessel*.

Next, you represent your own vessel's course and speed with a vector plotted on the maneuvering board. To do this, first choose a suitable scale to represent the magnitude of the speed from among those in the left and right margins; either the 3:1 or the 4:1 scale is usually a good choice because this will produce a nice-sized vector to work with on the plot. Now, using a straightedge or the parallel ruler, lay off a line for the vector, using the pole as the origin, toward the appropriate bearing on the perimeter corresponding to your vessel's heading. Finally, using the dividers, lay off the scaled length of the vector representing your vessel's speed from the pole and place an arrowhead on the end of the line. Customarily, the base or tail of the vector at the pole is labeled with a lowercase *e*, and the head defined by the arrowhead is labeled with a lowercase *r*, so that the vector *er* represents the reference ship's course and speed.

As an example, suppose your vessel is on course 125° at a speed of 15 knots. If the 3:1 scale is selected to represent the magnitude of the speed, the dividers are set for this value by placing one end at 0 at the bottom of the 3:1 scale and opening them until the other end is over the mark representing 15 on the scale. The spread of the dividers now represents a speed of 15 knots. Now, using a straightedge or parallel ruler, draw a line from the pole toward the 125° mark on the perimeter of the outer circle. One point of the divider is placed at the pole, and the other pricks a small point on the line in order to lay off the scaled 15-knot distance. To complete the plot, an arrowhead is drawn at the head of the vector and labeled with a lowercase *r*. The foot, or tail, of the vector at the pole is labeled with a lowercase *e* (see the illustration).



Reference vessel's course and speed vector plotted on a maneuvering board for a course of 125° T and a speed of 15 knots.

Once the vector representing your own vessel's course and speed has been plotted, you are ready to solve any of the basic kinds of maneuvering board problems.

The CPA Problem

A major concern of those in charge of a vessel is to avoid hitting other vessels or objects in the water. To assist in this endeavor, it is very helpful to be able to determine the projected bearing, distance, and time of the *closest point of approach* (CPA) and

the true courses and speeds, if any, of these vessels or objects by use of the maneuvering board. Once this information has been determined, further action can be taken if required to prevent a hazardous situation from developing or to comply with the rules of the road.

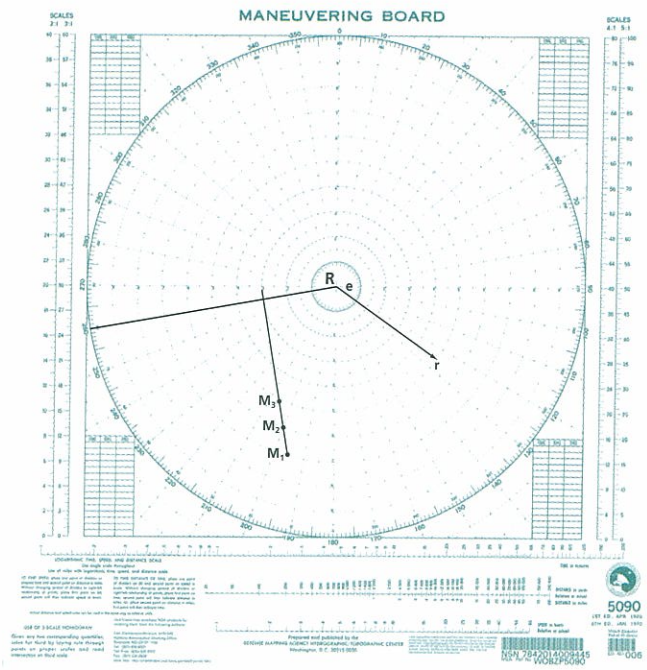
To find the bearing and distance of the CPA of a vessel approaching yours, it is necessary to construct its relative track on the maneuvering board. This is the relative motion line, or RML, referred to above. To do this, several ranges and bearings to it are taken, usually three minutes apart over a period of several minutes. The resulting points are plotted on the maneuvering board and labeled M_1, M_2, and so on (for maneuvering vessel). These points, when connected with an extended line, define the RML of the approaching vessel relative to your own. Note that this will also require you to select a scale for distance just as you did for speed. Usually cadets just learning will have a tendency to use the same choice for both speed and distance to avoid confusion. But it is not necessary for both of them to be the same, as long as you consistently use the same scale for each throughout the problem. Likewise, since we are dealing with relative motion, problems can be solved using either miles or yards as the unit of measurement; just make sure to always use the same units throughout the problem.

The CPA will be the smallest distance from the pole, where your own vessel is, to the extended RML line. Since by geometry we know that the smallest distance between a point and a line is the perpendicular distance between them, it is only necessary to pick off the perpendicular distance on the plot between the pole and the extended RML with the triangle and the dividers, and then move the dividers to the distance scale in use to determine the distance of CPA. In the example shown, the 2:1 scale was used for distance, so the CPA distance is about six thousand yards. To determine the bearing at CPA, just extend the perpendicular distance line to the outer bearing circle. Here, the bearing of the maneuvering vessel at CPA will be 259°. By convention, CPAs are always specified in terms of bearing and distance from one's own vessel to the other vessel.

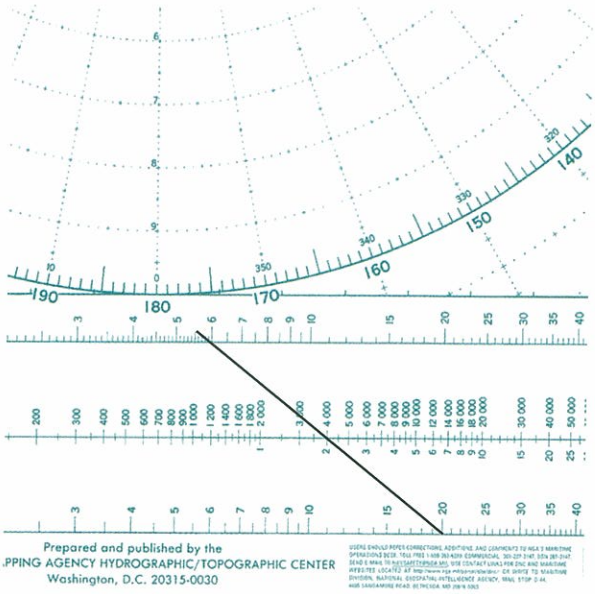
Now, to determine the other maneuvering vessel's true course and speed, we need to complete the construction of a vector diagram (the speed triangle) that will allow us to solve for the other vessel's true course and speed, given our own vessel's true course and speed vector (which we have already plotted) and the other vessel's relative course and speed vector.

To determine the other vessel's relative course and speed vector, we make use of the RML we plotted to find the CPA. The relative speed is the rate at which the other vessel is proceeding along its RML; the relative course is the direction of the RML.

To find the relative speed we can use the speed-time-distance nomogram at the bottom of the maneuvering board. To use the nomogram place a mark on the central distance scale, corresponding with the distance traveled along the RML between any two points, say, M_1 and M_3. Note this scale is graduated in either yards along the top or corresponding nautical miles along the bottom. In our example, the other vessel traveled four thousand yards between M_1 and M_3, so we put a mark at 4,000 on the distance scale. Next, put a mark over the elapsed



Relative motion line (RML) for a maneuvering ship, with the CPA line plotted.



A maneuvering board nomogram set up to find the relative speed given a distance traveled along the RML of four thousand yards in a time of six minutes.

time between M_1 and M_3 on the upper *time* scale of the nomogram, which is graduated in minutes. Here, since six minutes elapsed between the range and bearings obtained for points M_1 and M_3, we put a mark at 6 on the time scale. Finally, draw a straight line through the two marks using a straightedge and extend it down onto the lower *speed* scale. The point on the speed scale thus defined is the relative speed—twenty knots in this case (see the illustration).

Alternatively, if you have a *nautical slide rule* (see the illustration on pages 358 and 388) or an electronic calculator, you could find the relative speed by solving the formula speed equals distance divided by time, making sure you use distances in miles and time in fractions of an hour on the calculator. Or you could use either the **three-** or **six-minute rules**:

> *Three-minute rule:* distance traveled in yards in three minutes divided by one hundred equals speed in knots.
>
> *Six-minute rule:* distance traveled in miles in six minutes times ten equals speed in knots.

In practice, bearings and distances to maneuvering ships used to plot points M_1, M_2, M_3, and so on are generally taken three or six minutes apart, so the two rules above can be quickly applied to find the relative speeds between M_1 and M_2 or M_2 and M_3, and so on.

Having determined the magnitude of the relative speed, we can now plot the relative course and speed vector from the head of our own vessel's true course and speed vector, and then determine the resultant other vessel's true course and speed vector. To do this, place one side of the parallel ruler along the RML and position the other side at the tip *r* of our own vessel's vector.

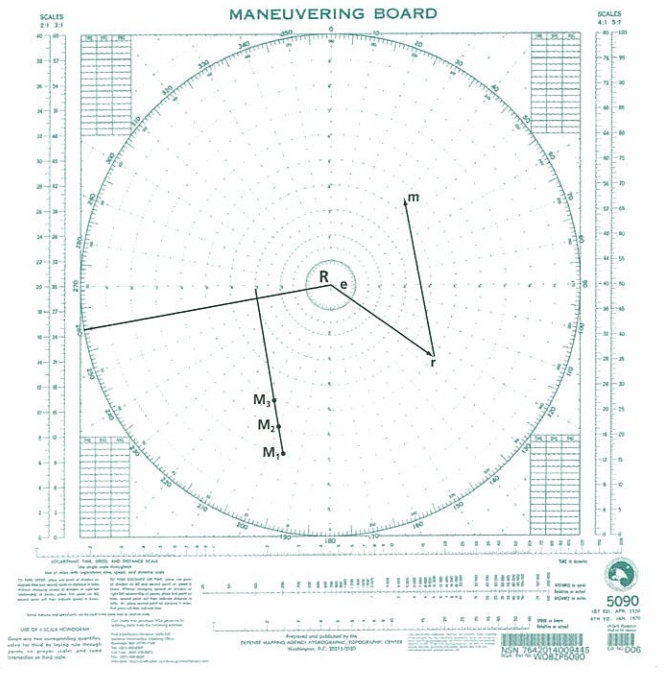
Now draw a line from *r* in the same direction as the RML. Lay off the relative speed along this line with the dividers, being sure to use the same speed scale we used earlier to plot our own vessel's vector, the 3:1 scale in this case (if different scales were used, the resulting vector diagram would not be usable). Place an arrowhead at the end of the relative speed vector and label it with a lowercase *m*. Vector *rm* now represents the relative movement speed vector (see the illustration below left).

To complete this part of the problem, the *em* vector representing the maneuvering (other) vessel's true course and speed is formed by drawing a line from the pole *e* to the end of the relative speed vector (see the illustration below right).

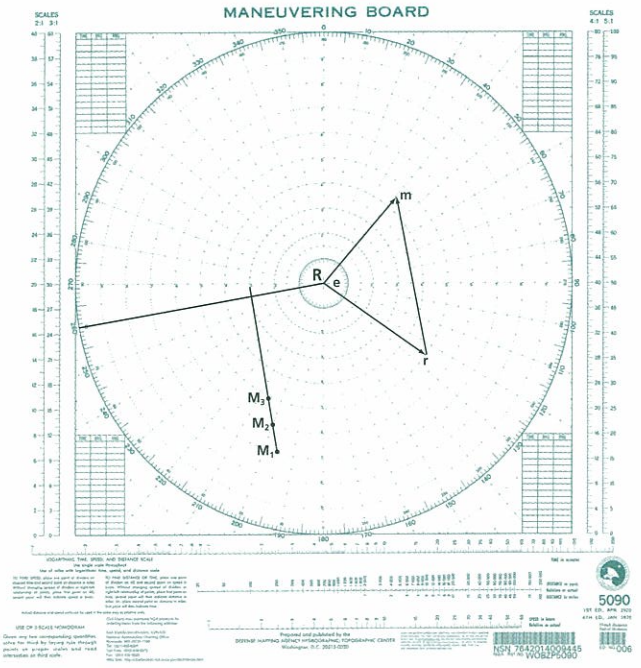
The bearing of the vector *em* is the true course—40° in this case—and its length, measured by the dividers along the 3:1 scale, is the speed—14.5 knots.

Time of CPA

In addition to the bearing and range of the CPA, the captain of a Navy ship will usually also want to know the time when the CPA will occur. Since we have now projected the target vessel's RML and determined its relative speed along that track, it is a simple matter to determine when that vessel will reach the CPA. We need only to measure the distance from the last



The RML track and two sides of the speed triangle, the *er* and *rm* vectors, plotted to find the maneuvering vessel's course and speed (the *em* side of the speed triangle).



Completed maneuvering board plot to find the CPA, time of CPA, and maneuvering vessel's course and speed (the *em* vector).

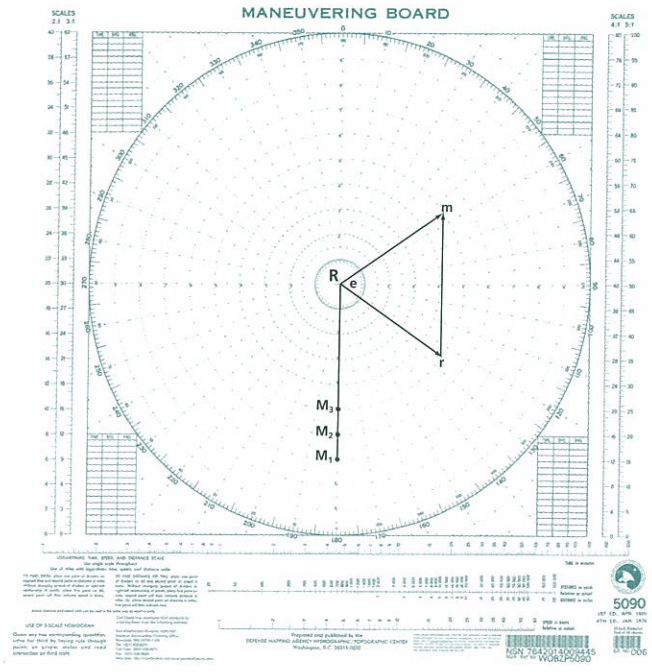
bearing and range taken to the other vessel (M_3) to the point of CPA, and then use either the speed-time-distance formula or the nomogram at the bottom of the maneuvering board to solve for the time.

Here we will again use the nomogram. The relative speed we have already calculated is 20 knots, and the measured distance is about 8,250 yards. Using the 20-knot mark we made previously on the speed scale, and placing a mark at 8,250 yards on the distance scale, drawing a line between the two and projecting it to cross the time scale yields about 12 minutes to CPA. If M_3 was observed at time 1420, then the time of CPA would be at 1432 (1420 + 12 = 1432).

Once the CPA and the other vessel's course and speed have been determined, if the situation requires, the maneuvering board can also be used to solve for a course and speed that our own ship could take to open the CPA to a safe distance. However, this is a more advanced type of problem that is for now beyond the scope of this introduction to the use of the maneuvering board.

Constant Bearing, Decreasing Range

In chapter 10 we discussed the dangerous situation of another vessel having a constant bearing and decreasing range (CBDR) with respect to our own ship. Plotting this situation on a maneuvering board can help illustrate the fact that CBDR is an alarming indicator of a potential collision.



Maneuvering board plot of a constant bearing, decreasing range (CBDR) problem.

As an example, let's say that once again our own vessel is on a course of 125° T at a speed of 15 knots. A contact designated *Skunk M* is observed as follows:

Time	*Bearing*	*Range (yards)*
1215	180°	14,000
1218	180°	12,000
1221	180°	10,000

Simply plotting the relative motion line of the contact will tell us that *Skunk M*'s CPA intercepts our vessel at the pole. And further calculations tell us that it will hit us at 1236 unless something changes.

In this situation, since *Skunk M* is approaching us off our starboard bow with a course of about 045° T as determined by plotting the associated speed triangle, our recommended action would be to change course to the right, so as to pass behind *Skunk M* and leave it to our port side, in accordance with the rules of the road.

Seven Maneuvering Board Rules of Thumb

When learning how to solve problems on the maneuvering board, it can help to remember the following rules of thumb so that you keep the two parts of the plot separate and do not confuse the many lines that will end up on the diagram.

1. The speed triangle consists of your own vessel's actual course and speed vector (*er*), the target (maneuvering) vessel's relative course and speed vector (*rm*), and the target vessel's actual course and speed vector (*em*).
2. The RML is *not* a part of the speed triangle. It consists of the maneuvering vessel's locations over time and the projected track line extrapolated from those positions.
3. The maneuvering board nomogram is *only* used for computing distance, time, and speed of travel. If you have any two of these, you can calculate the third.
4. There are five different scales that can be used for plotting distance and speed on a maneuvering board (1:1, 2:1, 3:1, 4:1, 5:1). Once you choose a scale for each of these, its use must be consistent for that quantity throughout each problem.
5. The actual course and speed vector components (*er* and *em*) of the speed triangle *always* originate in the center of the maneuvering board.
6. The relative course and speed vector component of the speed triangle (*rm*) *hardly ever* originates in the center of the maneuvering board. (The only time it does is when your own vessel's speed is zero.)
7. Remember that the time *of* CPA is *not* the same as time *to* the CPA.

Critical Thinking

1. Compare and contrast a maneuvering board solution for the course and speed of a maneuvering vessel with the conventional head-to-tail graphical solution for the sum of two vectors.

Study Guide Questions

1. What is the maneuvering board used for?
2. At sea, what is the reference for what other vessels are doing relative to your vessel?
3. A. What is normally placed at the center of a maneuvering board, and how is it labeled?
   B. What does vector *er* represent on a maneuvering board?
4. What does the relative motion line (RML) in a CPA-type problem indicate?
5. Your own ship is on course 090°, speed 10 knots. You sight a ship *M* on course 270°, speed 15 knots. What are the magnitudes and directions of the following vectors?
   A. The *er* vector
   B. The *em* vector
   C. The *rm* vector
6. Your own ship is on course 025°, speed 12 knots. You sight a ship *M* on course 000°, speed 15 knots. What are the magnitudes and directions of the following vectors?
   A. The *er* vector
   B. The *em* vector
   C. The *rm* vector
7. A target (maneuvering) ship *Skunk M* is tracked on your ship's radar with the following results:

Time	*Bearing*	*Range (yds)*
0908	276°	10,000
0911	269°	8,300
0914	258°	6,800
0917	244°	5,800

   A. What is the target ship's speed of relative movement?
   B. What are the bearing and range of the CPA?
   C. What is the time of the CPA?
8. Your own ship is on course 150°, speed 15 knots. Ship *M* is observed as follows:

Time	*Bearing*	*Range (yds)*
1100	255°	20,000
1106	260°	15,700
1112	270°	11,200

   A. What is the CPA of ship *M*?
   B. What are the course and speed of ship *M*?
   C. What is the time of the CPA?
9. Your own ship is on course 122°, speed 15 knots. At 0400 a target ship, *Skunk M*, bears 144°, 27,000 yards. *Skunk M*'s course is 020°, 30 knots.
   A. What will be the bearing and range of *Skunk M* at CPA?
   B. What will be the time of the CPA?
10. Your own ship is on course 285°, speed 18 knots. At 0800 a target ship *M* bears 310°, 9,000 yards. The ship's course is 215°, speed 15 knots.
   A. What will be the bearing and range of *M* at CPA?
   B. What will be the time of the CPA?
11. Your own ship is on course 090°, speed 15 knots. You observe bearings and ranges to an approaching ship with the following results:

Time	*Bearing*	*Range (yds)*
1200	000°	10,000
1203	000°	9,000
1206	000°	8,000

   A. What type of approach situation is this?
   B. If no action is taken, how soon will this ship be at your location?
   C. What are the approaching ship's course and speed?
   D. What action should you recommend taking to the captain?
12. Your ship is dead in the water. You observe bearings and ranges to an approaching ship with the following results:

Time	*Bearing*	*Range (yds)*
1600	090°	9,000
1603	094°	7,500
1606	100°	6,000

   A. What are the approaching ship's course and speed?
   B. What are the bearing, range, and time of CPA?

New Vocabulary

maneuvering board	vector diagram
CPA	relative motion
vector	polar plot
pole (of plot)	nomogram
relative motion line (RML)	speed triangle
three-minute rule	six-minute rule

Glossary of Naval Skills Terms

aids to navigation—lighthouses, navigation lights, buoys, and beacons especially constructed to assist in the safe navigation of vessels.

almanac (celestial navigation)—a periodic publication of variable astronomical information.

anchorage—an area assigned for vessels to anchor or tie up to a mooring buoy.

armament—weapons of a ship or aircraft.

armor belts—thick steel belts on the sides of olden day capital ships' hulls to give protection against shells and torpedoes.

athwartships—crosswise direction on a vessel.

atomic time—time reckoned by the use of an atomic clock, usually cesium-based. *See also* Coordinated Universal Time.

barge—in the case of boats, any small craft used for transporting officers senior to a ship's captain; in cargo hauling, a long, large craft, usually flat-bottomed, unpowered, and towed by other craft, used for transporting raw materials, freight, or liquids.

battle dressing station—first aid station equipped to handle battle casualties.

beacon—a navigation aid consisting of a tower or pile normally fitted with a daymark (i.e., a daybeacon), and sometimes also with a light, used in lieu of buoys to guide vessels through navigable waterways.

beam—extreme width of a ship or boat.

bearing—direction of an object from an observer, measured clockwise from one of three reference directions: true north, magnetic north, or a vessel's bow.

bend (knot)—a kind of knot used to join two lines together.

berthing compartment—living quarters for the enlisted crew on a Navy ship.

bilges—spaces between the inner and outer bottoms of a ship.

bitts—a type of deck fitting consisting of a pair of vertical stubby heavy metal cylinders used for handling and securing mooring lines.

boat etiquette—the naval customs and traditions pertaining to small boats.

boat officer—embarked junior officer in charge of a small boat under certain circumstances.

bollard—a large, cylindrical wooden or iron fitting on a pier, often toe-shaped, used in securing a ship's mooring lines.

bowsprit—a beam that extends from the bow of a boat that supports a platform called a *pulpit* above it.

breast line—a mooring line that is perpendicular to a pier and a vessel, used to control a vessel's distance from the pier.

bridge—a platform or compartment on the upper superstructure of a ship, submarine, or large boat from which maneuvers are directed when underway.

building dock—a dry dock used for ship construction.

building ways—an open construction area in a shipyard fitted with blocks upon which ships are built.

bulkheads—inner walls of a vessel or naval installation on land.

buoy—a moored floating marker placed to guide vessels safely along navigable waterways.

camel—a long, low, and narrow floating wooden platform sometimes placed between a ship and a pier or between ships when mooring to act as a buffer or to do maintenance.

capstan—a rotating drum of a winch that raises an anchor cable or other heavy weight.

CAPTOR mine—a mine consisting of an encapsulated homing torpedo suspended above the sea bottom, activated by the acoustic or magnetic signature of a passing ship or submarine.

cardinal buoyage system—a standardized international buoyage system used mainly in foreign offshore waters to mark the position of a hazard or direction of safe water.

cardinal compass points—north, south, east, and west.

cartographers—map and chart makers.

catamaran—a twin-hulled vessel.

CBDR—a constant bearing, decreasing range approach situation.

CBR warfare—chemical, biological, or nuclear (radiological) warfare.

CCS—central control station, a main damage control and coordination center within a ship's damage control organization on newer ships.

chain locker—a compartment in which a vessel's anchor chain is stowed.

chain pipe—a heavily constructed pipe through which an anchor chain runs from a vessel's deck down to the chain locker.

chain stopper—a short length of chain fitted with a turnbuckle and pelican hook to clamp and hold an anchor chain in place.

chartplotters—electronic navigational plotters that project a vessel's navigational plot on regulation electronic navigational charts.

chock—a metal fitting on board a ship through which mooring lines are passed.

class (of ships)—a number of ships or submarines built to the same design and bearing the name of the first ship built in it.

cleat—an anvil-shaped deck fitting for securing lines on a boat, ship, or pier.

closest point of approach (CPA)—the distance and bearing from a reference ship to a maneuvering ship at the point where they make the closest approach to each other.

COLREGS—abbreviation for *International Regulations for the Prevention of Collisions at Sea, 1972,* the international rules of the road convention governing how vessels are to be maneuvered in international waters of the high seas.

commissioning—the formal placement of an officer or naval vessel on active government service

compass rose—a graphic on a nautical chart depicting a true bearing circle with a magnetic bearing circle within it, offset by the variation angle at the location depicted, with a caption in the center giving the size of the variation angle and its annual rate of change.

ConRep—connected replenishment of a ship at sea from another ship alongside.

controllable-pitch propeller—a ship propeller capable of varying the pitch of its blades.

Coordinated Universal Time (UTC)—atomic time based on vibrations of the cesium atom designated as the world timekeeping standard on 1 January 1972.

course—the true or magnetic direction that a vessel is steered through the water.

coxswain—a person in charge of a small powerboat or rowing shell.

damage control—measures used to limit damage to a ship from enemy action, fire, flooding, and smoke.

damage control assistant (DCA)—the officer on board a ship charged with running the damage control organization.

date/time group—a standardized format wherein military and other government messages are referenced and filed by the originator and the date and UTC time of origination.

daybeacon—an unlighted structural aid to navigation.

daylight saving time—standard zone time set ahead one hour to extend the time of daylight in the evening, usually in summer months except in certain European countries where it may be adopted in wintertime.

daymark—a triangular or square marker affixed to a beacon to indicate its purpose, and on cardinal buoys, a conical topmark that indicates the direction of danger.

day shapes—geometric shapes such as balls, cones, and diamonds usually made of canvas stretched over metal frameworks displayed by vessels engaged in certain activities or in a special status.

DCC—damage control central, a main damage control and coordination center within the damage control organization on older ships.

DCPO—damage control petty officer; one is normally assigned to each division on Navy ships.

dead reckoning—a method of deducing the position of an air, land, or water craft by using the courses and speeds traveled since the last established position or fix.

depth contours—hydrographic lines on a nautical chart delineating the limits of areas of certain depths and shoal waters.

depth finder—another name for an echo sounder. *See* echo sounder.

designation (ship)—a group of letters and hull numbers that identify a ship.

deviation—deflection angle between magnetic north and the north point of a magnetic compass needle caused by the presence of iron metal.

dividers—instrument for measuring distance on a nautical chart.

dogs (ship)—latches around the perimeter of doors and hatches of a ship that fasten them in place when shut.

draft—depth to which the hull of a vessel sinks beneath the waterline, measured vertically.

dry dock—a shipyard structure able to contain a ship and be drained or raised so as to leave the ship high and dry.

ECDIS—acronym for *electronic chart display and information system,* a type of GPS plotter accepted as a legal alternative to manual position plots on paper charts.

echo sounder—a sonic device used to obtain water depths by measuring the time required for a sound pulse to make a round trip to the sea bottom and back.

ECN—a standardized electronic navigational chart that meets technical requirements of the IMO for use with ECDIS chartplotters.

ECS—electronic chart systems plotter not certified to be used in lieu of a navigational plot maintained on regulation electronic navigational charts or on paper nautical charts.

eductor—a jet-type dewatering pump.

endurance—the maximum time or distance a vessel can cruise at its most economical speed.

equation of time—the difference between apparent time as reckoned by the passage of the actual Sun and mean time reckoned by the mean Sun.

fantail—the after part of the main deck of a vessel.

fathometer—alternative name for a depth finder. *See also* echo sounder.

fender—pneumatic rubber cylinder with line attached placed on the side of a ship or boat to act as a buffer between it and a pier or another vessel.

fid—a pointed, round, tapered wooden tool used for splicing fiber lines.

fix—a position determined by the intersection of two or more simultaneous lines of position.

fog signals—audible signals consisting of whistles or bells required by the nautical rules of the road whenever a vessel is either under way, moored to a buoy, or anchored in reduced visibility conditions.

forecastle—forward part of the main deck of a vessel.

foremast—forward-most mast of a ship having more than one mast.

frame (ship construction)—transverse girders running athwartships from a ship's keel.

freeboard—the distance from the waterline to the main deck of a ship's hull.

galley—the kitchen on a vessel.

gig—a ship's boat designated for use by the commanding officer.

give-way vessel—the vessel obliged under the nautical rules of the road to maneuver to avoid another vessel during an approach situation while under way. *See also* stand-on vessel.

gnomonic projection—a chart projection in which the globe is projected outward onto a plane tangent to the globe in the center of the area depicted. Great circles appear as straight lines on this type of chart.

GPS—the U.S. Global Positioning System that uses a system of thirty-one operational orbiting satellites to provide three-dimensional positioning information everywhere on the Earth accurate to within fifteen meters or less.

graving dock—another name for an excavated dry dock in which vessel maintenance is performed.

great circle—any circle formed by the intersection of a plane passing through the Earth's center with the Earth's surface; represents the shortest distance between two points on the globe.

Greenwich Mean Time (GMT)—time based on the relationship of the mean Sun to the prime meridian passing through Greenwich, England.

ground tackle—any equipment having to do with a ship's anchors, anchor cable, or handling gear.

GTE—gas turbine engine.

gunwale—the intersection of the main deck of a ship with its side plating.

gyrocompass—an electromechanical compass aligned with true north by means of a spinning gyroscope.

gyrocompass repeater—a remote gyroscope readout duplicating a vessel's gyrocompass card.

habitability—the features designed into a vessel to provide comfortable living conditions for the crew.

hatch—a horizontal opening in the deck of a ship or boat.

hawsepipe—the large, heavily constructed pipe in a ship or boat hull through which the anchor cable chain runs on its way from the deck to the water.

hawser—a thick line used for towing or high-line transfer.

head—nautical term for a lavatory on a vessel; a vessel's bow.

heading—the true or magnetic direction in which a vessel is facing at any moment.

helm—the steering gear for a vessel.

hitch (knot)—a kind of knot used to fasten a line to or around an object.

hold (of ships)—a large storage space below deck on a merchant ship.

hourglass—a timepiece consisting of two glass chambers joined by a narrow opening through which fine sand runs from one the top chamber to the bottom one, traditionally every thirty minutes.

hull—the body or shell of a ship or seaplane.

hydrographic information—information on a nautical chart pertaining to water features such as depth, depth contours, bottom composition, and channels.

hyperbolic navigation systems—twentieth-century radio navigation systems that formed a hyperbolic pattern of LOPs within their areas of coverage by means of time differences between signals broadcast from two or more transmitting stations.

IED—improvised explosive device such as a remote-controlled bomb.

IET—in-port emergency team, a first-response in-port damage control team.

IMO—International Maritime Organization; a specialized agency of the United Nations responsible for setting standards for the safety, security, and environmental performance of international shipping.

in extremis—an approach situation under the nautical rules of the road in which there is imminent danger of collision.

inland rules—the set of national rules governing how vessels are to be maneuvered in U.S. inland waters.

in-port emergency team (IET)—a first-response in-port damage control team.

International Date Line—the 180th meridian in the mid-Pacific region along which it is one day later to the west of the line than it is to the east.

Intracoastal Waterway—the extended inland channel of navigable waterways in which a light-draft vessel can navigate along the U.S. East and Gulf Coasts from the Chesapeake Bay almost to the Mexican border without going into the ocean.

jackstaff—a small vertical flagpole at the bow of a Navy ship from which the First Navy Jack is flown when at anchor.

Jacob's ladder—a portable ladder made of rope used to climb up the side of a ship.

keel—the central longitudinal girder of a ship from which the frames and hull plating rise.

knot—a nautical speed unit equivalent to one nautical mile (two thousand yards) per hour; a fastening in a rope or line.

landlubber—a person who knows nothing of the sea.

lateral buoyage system—a standardized system of buoyage used to mark inland waterways.

latitude—the angular distance of a position on the Earth's surface measured from the equator northward or southward through 90°.

leap second—a periodic one-second correction applied to bring UTC and GMT into conformance with each other.

line of position (LOP)—a locus of points along which a position must be located.

list (of ship)—a permanent lean of a ship to port or starboard.

LNB—large navigational buoy.

longitude—the angular distance of a position on the Earth's surface measured from the prime meridian eastward or westward through 180°.

loran—an electronic radio navigation system used extensively in the twentieth century in which the time difference between the reception of pulse signals originated at a master and one or more secondary radio stations was used to form hyperbolic grid lines of position. The intersection of two such lines formed a fix.

magnetic compass—a mechanical compass aligned with the magnetic north pole by means of a magnetized compass needle.

main deck—the top deck of a ship's hull.

mainmast—the second mast of a ship with two or more masts, except when the first is taller.

maneuverability—the way a ship or submarine handles in turns, backing down, stopping, or evading enemy weapons; and for a submarine, diving and surfacing.

maneuvering board—a printed sheet used in solving relative motion problems.

marlinspike—a tapered steel or wooden tool used for separating strands of rope.

marlinspike seamanship—skill with rope, line, and other deck gear.

material readiness conditions—three basic states of watertight integrity set on Navy ships, consisting of conditions X-RAY, YOKE, and ZEBRA.

mean time—time based on the relationship of the mean Sun with the Earth; that is, a make-believe Sun that travels around the Earth at the equator at a constant speed of 15° per hour.

Med moor—a type of mooring common to the Mediterranean Sea region in which a vessel is secured at a right angle to the pier.

mercator projection—the best known and most widely used projection for maps and nautical charts, on which rhumb lines appear as straight lines.

mess deck—dining compartment for the enlisted crew on a Navy ship.

mizzen mast—a third mast aft of the mainmast on a large sailing ship.

motor sailer—a type of boat designed to be propelled by both power and sail at the same time.

nautical mile—a distance of 6,076 feet, about one and one-seventh times a land mile.

navigation—the art and science of directing a vessel or aircraft from one position to another.

navigation markers—buoys and beacons marking a navigable waterway.

NAVSAT—name given to an early satellite-based global positioning system launched and maintained by the U.S. Navy.

not under command—the state of a vessel that is disabled and not able to operate in accordance with the rules of the road.

nuclear reactor—a main component of a nuclear propulsion plant.

occulting navigation light—a flashing navigation light in which the duration of light is greater than the duration of darkness.

officers country—the living quarters of officers on board a Navy ship.

overheads—ceilings of spaces (compartments) on a vessel.

parallel ruler—a hinged two-part pair of straightedges designed to permit transfer of a parallel line from one place to another on a plot.

phase characteristics (of navigation lights)—patterns of flashes of navigation lights.

piloting—navigation near land using landmarks, aids to navigation, and depth soundings.

pitch (motion)—the upward and downward movement of the bow and stern of a vessel or aircraft around its athwartships axis.

port—nautical directional term for left; an observation window on a vessel; a town or city within a harbor or other navigable waterway where vessels are berthed.

prime meridian—the meridian passing through Greenwich, England.

prolonged whistle blast—a whistle blast of four to six seconds' duration by a ship's whistle.

propeller shaft—a shaft extending from the power plant of a vessel to its propellers, which delivers the rotational power to them.

protection—defensive features of a ship that help it survive an enemy attack.

pulpit—a platform enclosed by lifelines that overhangs the bowsprit of a powerboat or sailboat that provides room to handle the anchor and forward sail.

quarterdeck—the entrance/exit station of a ship.

rail (sailboat)—the deck edge of a sailboat.

range (visual)—two landmarks or navigation aids observed in line one behind the other.

rapid response team—an initial response team of designated damage control personnel that proceeds directly to the scene of fire or flooding both in port and under way.

reduction gears—a system of heavy gears in the propulsion system of a ship that acts like an automobile transmission to transition from the high speeds of an engine to lower propeller shaft speeds.

relative wind—the apparent direction and speed at which a wind is blowing relative to a vessel.

repair locker—a locker within each section of a ship containing a wide variety of damage control equipment for use by repair parties assigned to that section.

repair party—a group of specialists organized to control damage and make repairs throughout a ship during battle or shipboard emergency.

RHIB—rigid-hull inflatable boat.

rhumb lines—lines on the Earth's surface that cross all meridians at the same angle, appearing as straight lines on a Mercator map or chart.

rig (sailboat)—the arrangement of masts and sails on a sailboat.

rigging—a term used to describe all wires, ropes, and chains supporting masts, kingposts, or booms and cargo hooks. Standing rigging includes all lines that support masts and kingposts but do not move, and running rigging includes all movable lines that run through blocks.

right-of-way—the legal right and duty of a vessel to maintain course and speed as a stand-on vessel in certain approach situations under the nautical rules of the road.

RML—relative motion line on a maneuvering board plot.

roll (motion)—circular movement from side to side around the longitudinal axis of a vessel or aircraft.

rules of the road—the nautical rules by which ships maneuver to avoid collisions while under way; traffic rules for vehicles on land.

running lights—lights required to be shown by all vessels when they are under way at night or in reduced visibility conditions by day.

running rigging—adjustable rigging for sails, masts, booms, and the like.

scale (of chart)—the ratio between the size of a feature shown on a chart and its actual size.

SCBA—self-contained breathing apparatus.

scope of chain—the length of an anchor chain, usually divided into fifteen-fathom segments called shots.

scuttle—a round access opening in a hatch; to intentionally sink a ship by flooding.

seamanship—skill in handling a boat or ship, or in doing those things related to the job of a seaman.

sea trials—a series of short cruises to check out the operation of a ship or submarine and its equipment following construction or overhaul.

seaworthiness—a ship's ability to operate in all kinds of weather, high winds, and heavy seas.

sextant—optical instrument primarily used to make altitude observations in celestial navigation.

shakedown cruise—a sea trial to verify seaworthiness, speed, endurance, and maneuverability under simulated operational conditions.

short stay—position of an anchor cable straight up and down, or nearly so, with the anchor barely holding the bottom.

shot (anchor chain)—a fifteen-fathom section of anchor chain, joined to the next shot by a detachable link.

SINS—ship's inertial navigation system.

six-minute rule—distance traveled in miles in six minutes multiplied by ten equals speed in knots.

solar time—time based on the relationship of the actual Sun to the Earth.

soundings—water or tankage depth measurements.

spaces (ship)—the compartments of a vessel.

speed log—device for measuring speed in or on water.

sponsor—a person chosen to christen a ship, traditionally female.

spontaneous combustion—ignition of a material caused by natural heat generated by rapid oxidation of its components.

spring lines—mooring lines that run at acute angles between a pier and a vessel, often in pairs, used to control a vessel's fore-and-aft movement alongside the pier.

stability—the manner in which a ship returns to an upright position after a roll.

stadimeter—an optical device used to determine the distance to an object of known height.

standard time—a system of fifteen-degree-wide sectors or zones of the Earth in which the same time is kept by all in each zone. Uses as a basis the relationship of the mean Sun with the central meridian of each zone. *See also* zone time.

standing rigging—heavy metal or wire supports for spars or masts, permanently installed.

stand-on vessel—the vessel obliged under the nautical rules of the road to maintain course and speed during an approach situation with another vessel while under way. *See also* give-way vessel.

starboard—nautical directional term for right.

stateroom—an officer's berthing compartment on board Navy and merchant vessels; a small crew or passenger berthing compartment on a merchant or cruise ship.

steam turbine—a main component of a steam propulsion plant consisting of several alternating rows of fixed and movable blades similar to those of a fan attached to a central rotating shaft.

steering signals—whistle signals required by international and inland rules for vessels maneuvering within sight of one another. Under international rules such signals are signals of action or execution, and under inland rules they are signals of intent.

stuffing tube—a watertight fitting in a bulkhead through which wires or cables are passed.

superstructure—all structures of a ship above the main deck.

three-minute rule—distance traveled in yards in three minutes divided by one hundred equals speed in knots. *See also* six-minute rule.

time signals—terrestrial or satellite-based broadcasts of signals of UTC time standards.

top-marks—conical or spherical daymarks fitted to the top of buoys to indicate their function or direction of safe water.

transom—the extreme back end of the stern of a powerboat.

trimaran—a triple-hulled vessel.

truck (ship)—the top of a mast.

true bearing—a bearing using true north as the reference.

true wind—true direction and speed at which a wind is blowing over the Earth's surface.

underway—the state of a vessel when it is not at anchor, not moored to a dock or buoy, and not aground.

UnRep—underway replenishment of a ship at sea.

variation angle—the angle between true and magnetic north.

vector diagram—a diagram on a maneuvering board consisting of vectors (arrows) to represent courses, relative motion lines, and speeds.

VertRep—vertical replenishment of a ship at sea by the use of helicopters.

visibility (of a navigation light)—the distance in nautical miles that a mariner can see the light.

voids (ship construction)—empty spaces within a vessel, usually near the bottom of the hull.

water-jet propulsion—a form of vessel propulsion utilizing a high-pressure water jet instead of traditional propellers for propulsion through the water.

waterline—the line on a vessel's hull to which it sinks in the water.

watertight integrity—the ability of a compartment on a vessel to withstand flooding.

windlass—a piece of deck machinery used to handle line, cable, or an anchor chain.

yaw—a lateral swinging movement of the bow and stern of a vessel or aircraft around its vertical axis.

zone time—time reckoned according to the relationship of the mean Sun with the central meridian of each fifteen-degree-wide time zone. *See also* standard time.

Bibliography

Naval Knowledge

Books

Brittin, Burdick H., and Liselotte B. Watson. *International Law for Seagoing Officers.* 5th ed. Annapolis: Naval Institute Press, 1986.

Collins, John A. *Grand Strategy: Principles and Practices.* Annapolis: Naval Institute Press, 1973.

Davidson, Michael J. *A Guide to Military Criminal Law.* Annapolis: Naval Institute Press, 1999.

Filbert, Brent G., and Alan G. Kaufman. *Naval Law.* Annapolis: Naval Institute Press, 1997.

Frieden, David, ed. *Principles of Naval Weapons Systems.* Annapolis: Naval Institute Press, 1985.

Grove, Eric. *The Future of Sea Power.* Annapolis: Naval Institute Press, 1990.

Hobbs, Richard R. *Naval Science 1.* 4th ed. Annapolis: Naval Institute Press, 1996.

———. *Naval Science 2.* 4th ed. Annapolis: Naval Institute Press, 1997.

———. *Naval Science 3.* 2nd ed. Annapolis: Naval Institute Press, 1998.

Hughes, Wayne P. Jr. *Fleet Tactics and Coastal Combat.* 2nd ed. Annapolis: Naval Institute Press, 1992.

Knutsen, Dale E. *Strike Warfare in the 21st Century.* Annapolis: Naval Institute Press, 2012.

Manual for Courts-Martial, United States (2012 Edition). Washington, D.C.: Government Printing Office, 2012.

Stewart, Richard W. *The United States Army in Somalia 1992–1994.* Washington, D.C.: U.S. Army Center of Military History, 2003.

Strategic Assessment 1996: Elements of U.S. Power. Washington, D.C.: National Defense University, 1996.

United States Navy Regulations 1990. Washington, D.C.: Government Printing Office, 1990.

Booklets and Pamphlets

Joint Chiefs of Staff. *National Military Strategy of the United States of America 2015.* Washington, D.C.: Joint Chiefs of Staff, 2014.

Military Sealift Command. *2015 in Review.* Washington, D.C.: Department of the Navy, 2015.

Naval Doctrine Command. *Naval Doctrine Publication 1: Naval Warfare.* Washington, D.C.: Department of the Navy, 2010.

———. *Naval Doctrine Publication 2: Naval Intelligence.* Washington, D.C.: Department of the Navy, 1994.

———. *Naval Doctrine Publication 4: Naval Logistics.* Washington, D.C.: Department of the Navy, 2001.

———. *Naval Doctrine Publication 5: Naval Planning.* Washington, D.C.: Department of the Navy, 1996.

———. *Naval Doctrine Publication 6: Naval Command and Control.* Washington, D.C.: Department of the Navy, 1996.

Secretary of the Navy. *A Cooperative Strategy for 21st Century Seapower.* Washington, D.C.: Department of the Navy, March 2015.

U.S. Delegation Report, Resumed Seventh Session of the Third United Nations Conference on Law of the Sea. New York, 21 August–15 September 1978.

The White House. *National Security Strategy.* Washington, D.C.: The White House, February 2015.

Articles

Bartos, Capt. Christopher A., USMC. "Cyber Weapons Are Not Created Equal." U.S. Naval Institute *Proceedings* (June 2016).

Chowdbury, Suban Kumar, and Hel Kafi. "The Heartland Theory of Sir Halford John Mackinder." *Journal of Liberty and International Affairs* 1, no. 2 (2015).

Fisher, Rand H., and Kent B. Pelot. "The Navy Has a Stake in Space." U.S. Naval Institute *Proceedings* (October 2001).

Friedman, Norman. "The Real Purpose of Strategy." U.S. Naval Institute *Proceedings* (December 2007).

Galdorisi, Capt. George, USN (Ret.). "A Potent One-Two Punch." U.S. Naval Institute *Proceedings* (March 2016).

Gelinne, Capt. John, USN (Ret.). "Every Sailor a Cyber Warrior." U.S. Naval Institute *Proceedings* (April 2015).

Johnson, J. Lee. "Looking beyond Iraq: Developing a Future Strategy." U.S. Naval Institute *Proceedings* (May 2008).

Journal on Defense, Intelligence, and Diplomacy. National Youth Leadership Forum, 2001.

Mayo, Dick. "From the Sea . . . to Cyberspace." U.S. Naval Institute *Proceedings* (October 2000).

Studeman, Mike. "7 Myths of Intelligence." U.S. Naval Institute *Proceedings* (February 2009).

Talmadge, Eric. "New US Submarines Trade Nukes for SEALs." Associated Press, 27 February 2008.

Zelibor, Thomas E." FORCEnet Is Navy's Future." *Armed Forces Journal* (December 2003).

Papers

"A Cooperative Strategy for 21st Century Seapower." Navy, Marine Corps, and Coast Guard White Paper, 2007.

"Forward—from the Sea." Navy and Marine Corps White Paper, 1994.

"From the Sea—Preparing the Naval Service for the Twenty-First Century." Navy and Marine Corps White Paper, 1992.

Hooke, R. D. Jr. "The Grand Strategy of the United States." Institute for National Strategic Studies, National Defense University. Washington, D.C.: National Defense University Press, October 2014.

Mullen, Adm. M. G., USN. "CNO Guidance for 2006—Meeting the Challenge of a New Era." 2006.

"Operating Forward . . . from the Sea." Navy and Marine Corps White Paper, 1997.

"Vision . . . Presence . . . Power." 2000 Program Guide to the U.S. Navy.

Instructions

OPNAV INSTRUCTION 3120.32D. *Standard Organization and Regulations of the U.S. Navy.* Chief of Naval Operations, July 2012.

Internet

Bennet, Jay. "The Future of the Navy's Electromagnetic Railgun Could Be a Big Step Backwards." www.popularmechanics.com, 6 June 2016.

"The Common Law and Civil Law Traditions." Robbins Collection, University of California at Berkeley, School of Law. www.law.berkeley.edu/library/robbins/CommonLawCivilLawTradtions.html.

Defense Advanced Research Projects Agency. www.darpa.mil.

Delahunty, Robert J., and John Yoo. "The Bush Doctrine: Can Preventive War Be Justified?" www.scholarship.law.berkeley.edu/facpubs/775.

DISA. "Joint Information Environment (JIE)." www.disa.mil/About/Our-Work/JIE.

Federal Bureau of Investigation. www.fbi.gov.

Ghoshroy, Subrata. "Navy's New Laser Weapon: Hype or Reality?" *Bulletin of the Atomic Scientists* (May 2015). www.thebulletin.org.

Loris, Nicholas, Bryan Riley, and Brian Slattery. "Sink the Jones Act: Restoring America's Competitive Advantage in Maritime-Related Industries." www.heritage.org.

Maritime Administration. www.marad.dot.gov.

———. "National Defense Reserve Fleet Inventory."

———. "Ready Reserve Force."

———. "Voluntary Intermodal Sealift Agreement (VISA)."

Masters, Jonathon. "The North Atlantic Treaty Organization." Council on Foreign Relations. www.cfr.org.

Military Sealift Command. www.msc.navy.mil.

Mizokami, Kyle. "How the Military Will Be Revolutionized by Laser Weaponry." www.popularmechanics.com, March 2016.

North Atlantic Treaty Organization. www.nato.int.

Sempa, Francis P. "Mackinder's World." *American Diplomacy* (February 2000). www.unc.edu/depts/diplomat/AD_Issues/amdipl_14/sempa_mac1.html.

Ship Parade. www.shipparade.com.

Turse, Nick. "US Special Forces Are Operating in More Countries Than You Can Imagine." www.thenation.com, January 2015.

U.S. Army Corps of Engineers. Waterborne Commerce Statistics Center. "Waterborne Commerce of the United States." www.navigationdatacenter.us, 2014.

Leadership

Books

Chalker, Edsel O. *Leadership Education 1, Air Force Junior ROTC Text.* Maxwell Air Force Base, Ala.: Air Training Command/Air University, 1979.

Cutler, Thomas J., ed. *The U.S. Naval Institute on Naval Leadership.* Annapolis: Naval Institute Press, 2015.

Department of Leadership and Law, U.S. Naval Academy. *Fundamentals of Naval Leadership.* Annapolis: Naval Institute Press, 1984.

Hobbs, Richard R. *Naval Science 3.* 2nd ed. Annapolis: Naval Institute Press, 1998.

Johnson, Brad W., and Gregory P. Harper. *Becoming a Leader the Annapolis Way.* New York: McGraw-Hill, 2005.

Montor, Karel, et al. *Naval Leadership: Voices of Experience.* Annapolis: Naval Institute Press, 1998.

Naval Education and Training Support Command, Pensacola. *A Manual for Navy Instructors.* NAVEDTRA 107. San Diego: Naval Instructional Technology Development Center, 1974.

Articles

Farrell, Lt. Matthew, USN. "The Cycle of Leadership." U.S. Naval Institute *Proceedings* (February 2016).

McDermott, Padraic. "Leading Surface Warfare Officers Straight-to-the-Fleet." Naval Institute *Proceedings* (January 2009).

Van Tol, J. M. "Worse Than a Crime—a Mistake." Naval Institute *Proceedings* (May 2008).

Naval Skills

Books

Burgess, Richard R., ed. *The Naval Aviation Guide.* 5th ed. Annapolis: Naval Institute Press, 1996.

Connell, Royal W., Cdr. USN (Ret.) and Vice Adm. William P. Mack, USN (Ret.). *Naval Ceremonies, Customs, and Traditions.* Annapolis: Naval Institute Press, 2004.

Crenshaw, Capt. R. S. Jr., USN (Ret.). *Naval Shiphandling.* Annapolis: Naval Institute Press, 1975.

Cutler, Thomas J. *The Bluejacket's Manual.* 23rd ed. Annapolis: Naval Institute Press, 2000.

———. *Dutton's Nautical Navigation.* 15th ed. Annapolis: Naval Institute Press, 2003.

Day, Cyrus L. *The Art of Knotting and Splicing.* 4th ed. Revised by Ray O. Beard Jr. and M. Lee Hoffman Jr. Annapolis: Naval Institute Press, 1986.

Dodge, David O., and S. E. Kyriss. *Seamanship.* 2nd ed. Annapolis: Naval Institute Press, 1981.

Frieden, David, ed. *Principles of Naval Weapons Systems.* Annapolis: Naval Institute Press, 1985.

Hobbs, Richard R. *Marine Navigation: Piloting and Celestial and Electronic Navigation.* 4th ed. Annapolis: Naval Institute Press, 1998.

———. *Naval Science 1.* 4th ed. Annapolis: Naval Institute Press, 1996.

———. *Naval Science 2.* 4th ed. Annapolis: Naval Institute Press, 1997.

———. *Naval Science 3.* 4th ed. Annapolis: Naval Institute Press, 1998.

Llana, Christopher B., and George P. Wisneskey. *Handbook of the Nautical Rules of the Road.* 2nd ed. Annapolis: Naval Institute Press, 1991.

Martin, Donald, Paul Anderson, and Lucy Bautamiun. *Communication Satellites.* 5th ed. Reston, Va.: American Institute of Aeronautics and Astronautics Inc., 2007.

Naval Ships' Technical Manual. Washington, D.C.: Naval Sea Systems Command, 2008.

Noel, Capt. John V. Jr., USN (Ret.). *Knights Modern Seamanship.* 17th ed. New York: Van Nostrand Reinhold, 1984.

Shufeldt, Capt. H. H., USNR (Ret.), and G. D. Dunlap. *Piloting and Dead Reckoning.* 4th ed. Revised by Bruce Allan Bauer. Annapolis: Naval Institute Press, 1999.

Tate, William H. *A Mariner's Guide to the Rules of the Road.* 2nd ed. Annapolis: Naval Institute Press, 1982.

Winters, David D. *The Boat Officers Handbook.* 2nd ed. Annapolis: Naval Institute Press, 1991.

Booklets and Pamphlets

International Maritime Organization. *International Regulations for Preventing Collisions at Sea (1927).* London: Parliament of the United Kingdom, 1972.

National Imagery and Mapping Agency. *Maneuvering Board Manual.* Pub. 217. Washington, D.C.: Government Printing Office, 1984.

U.S. Coast Guard. *Navigation Rules and Regulations Handbook.* Washington, D.C.: Department of Homeland Security, August 2014.

Articles

Koch, Andrew. "US Navy's DDG-51 Destroyers to Be Modernized." *Jane's Defense Weekly,* 14 July 2004.

Molenda, Patrick A. "Don't Forget Dedicated Mine Countermeasures." U.S. Naval Institute *Proceedings* (October 2001).

Papers

"Agents of Bioterrorism: Biological Toxins." American College of Surgeons, October 2003.

Instructions

Naval Sea Systems Command. *Naval Ships' Technical Manual.* "Chapter 613. Wire and Fiber Rope and Rigging." Washington, D.C., 30 August 1999.

Office of the Chief of Naval Operations. *Underway Replenishment, NWP 4–01.4*

U.S. Naval Academy. Center for Cyber Security Studies. *SY110 Introduction to Cyber Security Technical Foundation.* 2017.

Internet

Department of Homeland Security. U.S. Coast Guard. "Navigation Rules." navcen.uscg.gov.

Directory of U.S. Military Rockets and Missiles. "Raytheon RIM-161 *Standard* SM-3." www.designation-systems.net.

Global Security. "Basic Seamanship." www.globalsecurity.com.

The Molossian Naval Academy. "Basic Seamanship." www.molossia.org.

Raytheon. "Standard Missile—2." www.raytheon.com.

U.S. Coast Guard Office of Boating Safety. "U.S. Aids to Navigation System." www.uscgboating.org.

U.S. Navy. "AGM-65 Maverick Guided Missile." www.navy.mil.

———. "AGM-88 HARM Missile System." www.chinfo.navy.mil.

———. "AGM-154 Joint Standoff Weapon." www.chinfo.navy.mil.

———. "AGM-114B/K/M Hellfire Missile." www.chinfo.navy.mil.

———. "AIM-9 Sidewinder Missile." www.chinfo.navy.mil.

———. "AIM-120 Advanced Medium-Range, Air-to-Air Missile." www.chinfo.navy.mil.

———. "Joint Direct Attack Munition (JDAM)." www.chinfo.navy.mil.

———. "Penguin Anti-Ship Missile." www.chinfo.navy.mil.

———. "RIM-116A Rolling Airframe Missile (RAM)." www.chinfo.navy.mil.

———. "Sea Sparrow Missile (RIM-7)." www.chinfo.navy.mil.

———. "SLAM ER Missile Systems." www.chinfo.navy.mil.

———. "Standard Missile." www.chinfo.navy.mil.

———. "Vertical Launch ASROC (VLA) Missile." www.chinfo.navy.mil.

Wesco Industries Ltd. "Powerstrand Wire Rope." www.wescovan.com.

Index, Naval Knowledge

Page numbers in **bold** text indicate a photo, line art, or map

administrative organization, 204–11, **206**, **207**, **208**
after steering watch, 220, **220**
air officer and department, **207**, **208**, 210, **210**
air warfare (AW), 39, 55–56
aircraft guns, 135, 147, **147**
aircraft weapon control systems (avionics), 140
amphibious warfare, 39, 59–60, **59**, **60**
anchor watch, 221
Antietam (CG 54), **143**, **144**
area defense, 138
Arleigh Burke–class destroyers, **57**, 139, 145, **145**, 154, 158, 164
Army forces: Delta Force, 180–81; Rangers, 180; Special Forces (Green Berets), 180, **180**, **182**
asymmetric warfare, 45–46, 169–70
autonomous underwater vehicles (AUVs), 90, 189–90, **190**
auxiliary vessels, 39–40
Avenger-class mine countermeasures ships, 189, **189**, 190, 191, 192
aviation organization, 53–55, **53**, **54**, **55**

ballistic-missile submarines, 36, 37–38, **38**, 57–58, **57**, **128**, **152**
barracks security watch, 223
Battle Bill (*Battle Organization Manual*), 204, 211, 214
battle organization, 204, 211–12
battle readiness conditions, 204, 211–12, 215, **215**, 216–17, 223
Benavidez (T-AKR 306), 18, **19**
biological warfare, 195–97
blockades, 131
boat officers, 222
boatswain's mate of the watch (BMOW), 218–19, **218**
brow watch, 220–21
Budget Control Act and military defense spending, 32
Bush Doctrine and George W. Bush, 12, 31–32, **32**, 111
Byers, Edward, **182**

captain's mast (nonjudicial punishment), 100–101
Carl Vinson (CVN 70), **155**, **209**
carrier air wings and air group commander (CAG), 54–55, **54**, **207**, 211, **211**
carrier strike forces (CSFs), 52–53
Carter, Walter, **175**
Carter Doctrine and Jimmy Carter, 31
catering department and personnel, 16–17
cavitation, 188
chain of command, 204–11, **206**, **207**, **208**
chemical, biological, and nuclear warfare, 170, 195–201; authorization for and lawful use of, 130–31; biological warfare and agents, 195–97; chemical warfare and agents, 195–96; damage control and decontamination, 199–200, **199**; nuclear warfare and weapons, 137, 195–96, **195**, 197–98, **197**; preemptive attacks against, 32; radiation fallout and exposure, 197, 198, **198**
Clausewitz, Karl von, 25, **25**, 26, 28–29, 37
collateral duty, 205
combat direction center (CDC)/combat information center (CIC), 56, 139, 205, **208**, 212, **212**, 217, 218, **218**, **219**
combat support agencies (CSAs), 52
combat systems officer and department, 137, **207**, **208**, 209
combatant vessels, 39–40
command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR), 38, 61, 76
command and control organization, 50–52, **50**
command duty officer (CDO), 217, 223
command master chief, 206
commanding officer (CO), 204–5, **205**, **206**, **207**, 211–12, 214
commerce: importance of ocean commerce, 9–10; merchant vessels, 9–16, **10**, **12**, **13**, **15**; sea power and ocean commerce, 3, 9–12; shipping and operating costs, 12
communications: concept and definition of, 49, 64; during GQ, 212; pyrotechnics, 69; reliability of, 64; satellite systems, 61, **61**, 65, **65**; sound, 69; telecommunications, 64–66; visual, 66–69, **66**, **67**, **68**, **69**; watchstanding communications, 219, **219**
communications officer and department, 208, **208**
containment strategy, 29–30
conventional warfare, 169
courts-martial, 100–104, **102**
coxswains, 222, **222**
cruisers, 138
cyber security, 172–73
cyber warfare, 170, 171–78; battlefield for, 172; command relationships, 171–72; concept and definition of, 61, 171; cyber attacks, 173–77; defense against, **173**, **175**, 176–77, **176**; examples of successful attacks, 174; fundamentals of, 172; methods of attacks, 174–75; phases of attacks, 173–74

damage control and decontamination, 199–200, **199**
damage control organization, 212
de Seversky, Alexander, 28, **28**
deck department, 16, **208**, 209, **209**
Deck Log, 206, **216**, 219–20, 221
Defense Advanced Research Projects Agency (DARPA), 88–90
dental officer and department, **208**, 210–11, **210**
departments: shipboard organization and department heads, 207–11, **207**, **208**; watch assignments, 214
destroyers, 138
diplomacy, 108–9
diplomatic missions and staff, 112–13, **112**, **113**
diplomatic recognition, 111–12
discipline and punishment, 99–105; apprehension, arrest, restriction, and confinement, 99–100; civil cases, 104; concept and goals of, 99; courts-martial, 100–104, **102**; initiating and preferring charges, 100; nonjudicial punishment, 100–101; preliminary inquiry, 100; separation from the service, 104; Uniform Code of Military Justice, **96**, 97, 100, 103, 104
distress signals, 69
divisions and division officers, 211
dolphins, 190, **191**
duty day, 217
duty master-at-arms (MAA), 221, 223
Dwight D. Eisenhower (CVN 69), **212**, 218

Effective U.S.–controlled (EUSC) ships, 20
electromagnetic pulse (EMP), 197–98, **197**
electronic warfare (EW), 39
Emergency Fleet Corporation (EFC), 10–11
engineering officer and department, 16, **17**, **207**, **208**, 209–10, **209**, **218**
equal opportunity advisor (EOA), 206
espionage, 77
exclusive economic zones (EEZs), 119, 123–24, 125
executive assistants, 206–7, **206**, **207**
executive officer (XO), 205, **206**, **207**, 212
explosive ordnance disposal (EOD) diver, 189, **189**, 190–91

F-35A/F-35B/F-35C Lightning, **55**, 140, **140**, 147, 164
F/A-18 Hornet/Super Hornet, **5**, **53**, 147, **147**, **151**, **157**
fishing industry and economic zones, 119, 123–24
Fleet Cyber Command (FLYCYBERCOM), 172
flexible response strategy, 30
foreign policy, merchant marine role in, 21
foreign-flag ships, 20
Freedom (LCS 1), **145**, **192**

general quarters (GQ), 211–12, 215, **215**
Gerald Ford–class carriers, 163, 164, 166
guns: aircraft guns, 135, 147, **147**; ammunition, 143–45, **143**, **144**; naval guns, 137–38, **137**, 142–47, **142**, **143**, **144**, **145**, **146**; rail guns, 136, 162, 164–66, **164**, **165**, **166**; range of, **4**, 143; terminology, 142–43, **142**

Hague Peace Conventions, 129–30
Hahn, David, **165**
Halsey (DDG 97), **51**, **132**
Harry S. Truman (CVN 75), **211**, 218
Heartland, 26–27, **27**
helmsman, **218**, 219

information warfare (IW), 39, 60–61
intelligence: concept and goals of, 39, 49, 71; counterintelligence and security, 77–78; cycle for, 71–72; espionage, 77; security breaches, 79–80, **79**; security classifications and clearances, 78–79, **78**; threat evaluation through, 43; types of and methods for gathering, 72–73, **73**
intelligence community, 73–76, **74**
intelligence organizations, foreign, 76–77
irregular warfare, 45–46, 169–70
ISIS/IL (DAESH), 28, 32, 34, 45, 46, 182

John C. Stennis (CVN 74), **54**, **82**, **210**
Joint Special Operations Command (JSOC), 180
Jones Act (Merchant Marine Act, 1920), 10–12
Joyner, Sara, **211**
junior officer of the deck (JOOD), 216, 217, **217**, 220–21

laser weapons, 136, 162–64, **162**, **163**
law, international: concept and goals of, 107, 108–9; defense of legal rights, 125; diplomacy and, 108–9; enforcement of laws of war, 132; evolution of law of the sea, 118; general rules of war on land and sea, 129–30; high seas, law of, 123–24; innocent passage, 119, 120–23, **120**, 125; limits of and rights within waters and coastal areas, 119–23, **119**, **121**, **122**; port visits and local laws, 128–29, **128**, **129**; precepts of law of the sea, 118–23; rules of the road, 120, 124–25; sources of, 109–10; sovereign states, 110–12; visit, boarding, and searching ships, 131–32, **132**; war at sea, law of, 127–33
law, military: discipline and punishment, 99–105; law codes, 93, 94–95; Navy regulations, 96–97; Uniform Code of Military Justice, **96**, 97, 100, 103, 104; U.S. Constitution and, 95–96
liberty, 128–29, **129**, 222
Liberty ships, 10, **10**
lifeboat watch, 219
limited war, 25, 37, 44–45
littoral combat ships (LCSs), **87**, 138, 188, 191–92, **192**
logistics: concept and goals of, 38, 39, 49, 82; elements of, 83–84; for modern warfare, 84, **84**; planning and functional areas of, 82–83, **82**, **83**
lookouts, 219

Mackinder, Halford J., 26–27, **27**, 28
Mahan, Alfred Thayer, 5, 26, **26**, 27, 28, 29
Maritime Administration (MARAD), 11, 19, 21

Maritime Security Program (MSP), 19–20
maritime strategy, 5, 26, 32–33, **32**
massive retaliation strategy, 30
McCampbell (DDG 85), **145**
medical officer and department, **207**, **208**, 210–11
merchant marine: crew on merchant marine vessels, 16–18, **16**, **17**; history of, 9–12; legislation and national policy on, 9, 10–12; life on merchant ships, 17–18; national defense role of, 10–11, 18–21, **18**, **19**, **20**; sea power and, 3, 5–6; vessels, 9–16, **10**, **12**, **13**, **15**; wartime operations of, 9, 10, 21
Merchant Marine Act (1936), 9, 10, 11
Merchant Marine Act (Jones Act, 1920), 10–12
messenger, 219
MH-60S Seahawk helicopter, **84**, **157**, 191–92, **192**
Military Sealift Command (MSC), 18–19, **18**, **19**, 21
mine hunting, 189–91, **190**
mine warfare, 170, 184–94; classification and types of mines, 186–88, **186**, **187**, **188**; concept and definition of, 39; countermeasures, 184, 188–92, **189**, **190**; defensive and offensive mining, 184, 185; effectiveness of, 192–93; evolution and history of, 184–86, **184**, **185**, **186**
minesweeping, 189, 191–92, **191**
missiles/guided missiles: air-to-air missiles, 151, 156–57, **156**; air-to-surface missiles, 151, 157–58, **157**; ballistic missiles, 4, 36, 38, **38**, 149, 150–51, 152, **152**, 158–59; concept and components of, 149–50, **149**; cruise missiles, 4, **4**, 136, 150–51, 152–54, **153**, **154**; designation systems for, 151; evolution and history of, 136; guidance systems, 149–50, 158–60; naval power projection with, 135; range of, 136, 137–38, 152; surface-to-air missiles, 151, 154–56, **155**, **156**; surface-to-surface missiles, 150–51, 154; trajectories of, 158–60, **159**, **160**; types and uses of, 149–50, **151**
mutual assured destruction (MAD) doctrine, 30, 162

national defense and security: Budget Control Act and military defense spending, 32; counterintelligence and security, 77–78; grand strategy and, 24, 29–33; merchant marine role in, 10–11, 18–21, **18**, **19**, **20**; Navy role in, 36–40, **36**; sea power and, 3; security breaches, 79–80, **79**; security classifications and clearances, 78–79, **78**; strategic material transport and, 20–21; threat evaluation, 42–43
National Defense Reserve Fleet (NDRF), 10, 11, 19
naval power, 3, 135
Naval Research Laboratory (NRL), 87
Naval Research, Office of (ONR), 86–87
naval warfare, 38–40
navigator, 205–6, **207**
Navy, U.S.: force capabilities, 37–38; mission of, 36; national strategy and security role of, 36–40, **36**; power projection by, 36, 39–40; regulations, 96–97; sea control function of, 36, 39–40; tactical forces, 39–40
Navy SEALs, 39, **40**, **179**, 180–82, **182**
network-centric warfare, 38
New York (LPD 21), **46**
Nimitz (CVN 68), **53**, **55**
Nixon Doctrine and Richard Nixon, 30–31, **31**, 130
nonjudicial punishment (captain's mast), 100–101
North Atlantic Treaty Organization (NATO), 5, 30, 33, 65, 115, **115**
nuclear triad, 38, 150, 210
nuclear warfare and weapons, 4, 36, 37, 38, 137, 195–96, **195**, 197–98, **197**
nuclear-powered vessels, 4, **54**, 58–59, **146**, 204, 210

Obama, Barack, 12, **33**, 79, 112, 122, **182**
ocean surveillance and reconnaissance, 39
oceans: areas of strategic importance, 4–5; oceanography and oceanographic research program, 3, 6, 88, **88**; political and technological importance of, 4; resources from and sea power, 6
officer of the deck (OOD), 216, 217–18, **217**, 220, **221**, 223
Ohio (SSGN 726) and *Ohio*-class ballistic-missile submarines, **38**, 57–58, **57**, **128**, **152**
operations, naval: combat support agencies, 52; command and control organization, 50–52, **50**; concepts and definition of, 49, 50
operations officer and department, 207–8, **207**, **208**
Organization of American States (OAS), 30, 110, 114–15
organizations for collective security, 113–15, **114**, **115**

P-3 Orion, **58**, **131**
P-8 Poseidon, 54, **54**, **153**
Pakistan, 182
petty officer of the watch (POOW), 220, 222–23
Phalanx close-in weapons system (CIWS), 146, **146**, 164
piracy and antipiracy operations, 45, 57, 127–28, **132**, 181–82
point defense, 138
Ponce (AFSB 15), 163–64, **163**
pyrotechnics, 69

quartermaster of the watch (QMOW), 219–20, 221

rail guns, 136, 162, 164–66, **164**, **165**, **166**
reactor officer and department, **207**, 210
readiness conditions, 204, 211–12, 215, **215**, 216–17, 223
Ready Reserve Force (RRF), 11, 19
Reagan Corollary to the Carter Doctrine and Ronald Reagan, 31, 73, 152
research and development, 49, 86–91, **86**, **87**, **88**, **89**, **90**
Rimland, 26–27, **27**
rockets, 135, 136, 149
Ronald Reagan (CVN 76), **5**, **146**
rules of the road, 120, 124–25

San Antonio-class LPDs, **46**
satellite systems, 61, **61**, 65, **65**
sea control, 36, 39–40
sea lines of communication, 36–37
sea power: concept and components of, 3; importance of, 3–8; inland reach of, 4; merchant marine, 3, 5–6, 9–23, **10**; mobility

of, 5, **5**; national security and, 3; naval strategy and, 26, 29; power projection by Navy, 36, 39–40
semaphore, 68, **68**, **69**
separation from the service, 104
sequestration, 32
shipbuilding industry, 9–10, 11, 12–13, 17, 21
ships: merchant vessels, 9–16, **10**, **12**, **13**, **15**; types and capabilities of naval ships, 39–40
ship's bills, 204
ship's mission center (SMC), 205, 212, 217, 218
Ship's Organization and Regulations Manual (*SORM*), 96, 204, 214
shore station watches, 223
side boys, 222–23, **222**
signal flags, 66, **66**, 67, **68**
smart weapons/bombs, 37, 149, 151, **151**, 158
sonobuoys, **58**, 59
sounding and security patrols, 221
sound-powered telephones, 212, 219, **219**
sovereign states, 110–12
space exploration, 6
space warfare, 61
Special Operations Forces (SOFs), 32, 39, **40**, **179**, 180–82, **180**, **181**, **182**
special warfare, 170, 179–83; current operations, 182, **182**; features of, 39, 45–46, 179; notable operations, **179**, 181–82, **181**
Spruance-class destroyers, 158
Strategic Defense Initiative (SDI), 162, **162**, 164
strategy: grand strategy, 24–25; maritime strategy, 5, 26, 32–33, **32**; military strategy, 24; national defense and grand strategy, 24, 29–33; national strategy, 24, 42; national strategy documents, 33–34; national strategy role of Navy, 36–40, **36**; preparedness and grand strategy, 28–29; schools of, 25–28; tactics compared to, 37; U.S. grand strategy evolution, 29–33
strike warfare, 39, 52–53
submarine warfare, 57–58, **57**, 131
supply officer and department, **207**, **208**, 210
surface warfare (SUW), 39, 56–57, **57**

tactical action officer (TAO), 218, **218**
tactics, 37
terminology, 136–37, 142–43, 225–33
terrorism and counterterrorism, 32, 34, 169–70, 180–81, 182
Ticonderoga-class cruisers, 145, 154
torpedoes, 135, 149, 158, **158**
Trump, Donald, 32, **33**

unconventional warfare, 45–46, 169–70
undersea warfare (USW), 39, 58–59, **58**
Uniform Code of Military Justice (UCMJ), **96**, 97, 100, 103, 104
United Nations (UN), 4, 107, **110**, 111, 113–14, **114**
United Nations (UN) Convention on the High Seas, 123, 127–28, **127**
U.S. Cyber Command (USCYBERCOM), 171–72, 177
U.S. Special Operations Command (USSOCOM), 180
unmanned aerial vehicles (UAVs), 21, 37, **37**, 53, 54, 73, **73**, **89**, 90, **90**, 135, 140
unmanned surface vessels (USVs), 90, **90**
unmanned underwater vehicles (UUVs), 90, 135, 189, 190, **190**, 191

V-22 Osprey, **53**, 55, **59**
Victory ships, 10, **10**
violent extremism, 34
Virginia (SSN 78), **158**
visual communications, 66–69, **66**, **67**, **68**, **69**
Voluntary Intermodal Sealift Agreement (VISA), 20

warfare: conventional, 169; general rules of war on land and sea, 129–30; law of war at sea, 127–33; modern forms of armed combat, 44–46; naval warfare, 38–40; principles of war, 43–44; tactical innovations for, 37; unconventional, 45–46, 169–70. *See also specific types of warfare*
Watch, Quarter, and Stations Bill, 204, 211, 214
watch sections, 216–17
watches: concepts and definitions of, 214; general orders to the sentry, 214–15; personnel assigned to, 214; in-port watches, 220–23, **221**, **222**; procedures for, 216, **216**; shipboard watch routine, 216–23, **217**, **218**, **219**, **220**, **221**, **222**; shore station watches, 223
watchstanders, 214
weapon control systems (WCSs), 139–40
weapon systems, 138–39, 146, **146**
weapon types: laser weapons, 136, 162–64, **162**, **163**; rockets, 135, 136, 149; torpedoes, 135, 149, 158, **158**. *See also* chemical, biological, and nuclear warfare; guns; missiles/guided missiles
weapons: conventional, 149, 162, 195; evolution and history of, 135, 136; naval power projection with, 135; range of, 137–38, **137**; selection of for combat mission, 138; shipboard weapons organization, 137; terminology, 136–37
weapons of mass destruction, 32, 130–31, 170, 195–200, **195**, **197**
weapons officer and department, 137, **208**, 209
Weekes, Godfrey, **165**

Zumwalt-class destroyers, 163, 164, 166

Index, Leadership

Page numbers in **bold** text indicate a photo, line art, or map

ability, 250
achievement, 250
advancement: NROTC cadet officer selection, 250–51; performance evaluation as basis for, 250; personal and professional growth for, 252
aptitude, 250
arrogance, 243
ASVAB, 250, 251
audiovisual aids, 257, 258–59, **259**

blind obedience, 239–40
boredom, 256
Burke, Arleigh, 245–46

case studies, 261
challenge of naval leadership, 237, 238–41
clear-cut decisions, 244
commands, 239–40
conduct, 244, 245–46
confidence, 240, 243, **245**
control: discipline and, 245–46; loss of temper and control, 246–47; self-control, 246
cooperative learning, **262**, 262
corrective actions, 245
courage, 244
cyberbullying, 248
cyberspace: information permanence in, 248; personal privacy and privacy of personal information, 248; safeguarding cyber persona, 247–48. *See also* social media

decisions, 244
demonstration technique of instruction, 259–61, **260**
dependability, 245
devotion to duty, 242–43
discipline: concept and definition of, 246; importance of, 240, 245–46; purpose of, 246; rules of conduct for, 245–46; self-discipline, 240, 246. *See also* misconduct and punishment
discussion technique of instruction, 261–62

effective leadership, basis for, 238–39

failure, 256
fake news, 248
familiarity and friendship, 247
fatigue, 256
followership, 239
fraternization, 247
friendship and familiarity, 247
frustration, 256

goal-setting, 251, 252

honesty: dependability and, 245; moral courage and, 244

information permanence, 248
initiative and ingenuity, 243
instruction and learning, 254–63; capabilities of students and, 254–55; classroom preparation, 257; conditions that inhibit learning, 256–57; factors to facilitate learning, 255; interpersonal interactions and learning, 255–57, **256**; learning, definition of, 254; learning curve, learning plateaus, and process of learning a skill, **254**, 254–55; learning outcomes and instruction technique, 262; learning theory, 254–55; lesson plans, 257; motivation and goals for learning, 254, 255, 256; negative motivation, 255; preparation for, 257; techniques for, 257–62; types of learning, 254
integrity, 238
intimidation, 247, 256

knowledge, professional, 243

leaders: art and science of leadership, **238**, 239; challenge of naval leadership, 237, 238–41; confidence in, 240; effective leadership, basis for, 238–39; information sharing with new leader, 243; qualities of, 238, 240, 242–49; relationship with subordinates, 238–39, 244, 247
Leadership Academy cord, **247**
learning. *See* instruction and learning
lectures, 257–59, **258**, **259**
left-brain activities, 254
legal responsibility and obligation, 240
lesson plans, 257
loyalty, 242

misconduct and punishment: consistency in disciplinary action, 246; corrective actions for undesirable conduct, 245; obedience to avoid punishment, 239, 240; reasons for misconduct, 245
moral courage, 244
moral responsibility and obligation, 238, 240, 242
moral values, 238
motivation and goals for learning, 254, 255, 256

negative motivation, 255
NROTC cadet officer, performance evaluation for selection of, 250–51

obedience, 239–40; blind obedience, 239–40; in civilian life, 239; disobedience, appropriate action for, 246; importance of, 239, 240; in military services, 239–40; reasoned obedience, 239, 240
orders: commands, 239–40; obedience to, 239–40
organization, 238, 244

performance, 250
performance evaluations, 250–53; assessment of performance against criteria, 252; attributes evaluated during, 251; concepts associated with performance, 250; course of action for corrections following, 252; criteria by which to measure progress, 252; goal-setting, 251, 252; NROTC cadet officer selection through, 250–51; progress assessment, **251**, 251–52; ratings of leaders, 250; self-evaluation process, 251–52; social examples of, 250
personal example, 238, 244–45
personnel. *See* subordinates/personnel
philosophy of leadership, 238, 239
privacy of personal information and personal privacy, 248
professional knowledge, 243
progress assessment, **251**, 251–52

qualities of a leader, 238, 240, 242–49

rank, privileges and responsibilities of, 244
reasoned obedience, 239, 240
respect and mutual respect, 244, 245
right-brain activities, 254
role models, 238, 244–45
role-playing, 261
rules and regulations: discipline and following of, 245–46; disobedience of, appropriate action for, 246; living by, 240; moral courage and following of, 244; personal example of following, 244; personal initiative and ingenuity and, 243; responsibility for following, 245

safety precautions during demonstrations, 260–61
sarcasm, 256
scams, 248
Scholastic Aptitude Tests (SATs and PSATs), 250, 251
self-confidence, 243
self-control, 246
self-discipline, 240, 246
self-evaluation process, 251–52
sexual harassment, 247
social media: appropriate and inappropriate use of, 247–48; cyberbullying on, 248; information permanence on, 248. *See also* cyberspace
subordinates/personnel: information about, sharing of with new leader, 243; knowing, understanding, and taking care of, 240, 244, 247; moral courage of, 244; motivation of to accomplish unit mission, **239**, 240; personal attention to, 238–39; recognition of, importance of, **247**, 247; relationship with leaders, 238–39, 244, 247; supervision of, 238

teams and teamwork: cooperative learning, **262**, 262; discipline and conduct for, **239**, 240, 245; leadership role in motivation of, 238; trust and confidence in team members, 245, **245**
temper, loss of, 246–47
trust and mutual trust, 245, **245**

values, moral, 238

Index, Naval Skills

Page numbers in **bold** text indicate a photo, line art, or map

Abraham Lincoln (CVN 72), **354**
advancement and seamanship skills, 306, 307
aids to navigation, 363–68; beacons and daymarks, **364**, 364–65, **366**, 366–67; buoys and buoyage systems, 364–66, **365**, **366**; color schemes of, 365–66, **366**; depiction of on charts, 363, **364**; Intracoastal Waterway marks, 367; navigation lights, 362–63, **363**, **364**; numbering and light schemes of, **365**, **366**, 366–67; types of buoys, 365, **365**
alarms, 291
anchoring: anchors, 315, 316, **316**; chain stoppers, 317, **318**; chains and cable, **315**, 315, **317**, 317; ground tackle, **315**, 315–18, **317**, **318**; process for, 318–19, **319**; scope of chain, 319; weighing anchor, 319, **320**; wildcat, 315, **315**, 317, **318**; windlass, **315**, 315, 317, **318**
Arleigh Burke–class destroyers, 277–78, 280
atomic clocks, **373**, 374
azimuth circle, **342**, 342

barge, 329
battle dressing stations, 294
beacons and daymarks, **364**, 364–65, **366**, 366–67
beam, 269, **328**, 328
bearings and relative bearings, **342**, 342–43, **343**
Benavidez (T-AKR 306), 286
bends, knots, and hitches, **307**, **311**, 311–13, **312**
bilge keel, **269**, 270, **274**
Blue Ridge (LCC 19), **276**
boarding and leaving boats, 334
boat handling, 305, 330–33; making a landing, **332**, 332–33, **333**; propeller forces, **330**, 330–33; twin-screw boats, 333; wind, current, and, 330, **332**, 332–33, **333**
boat seamanship. *See* small boat seamanship
boatswain's chair, **324**, 324
boatswain's mates, 306
bombs, GPS-guided, **352**, 352
booms, 325, **325**, 328
bow, 269, 328, **328**
Boxer (LHD 4), **299**, **327**
bridge, **271**, 271
brow, **276**, 276–77
bulkheads, **269**, 269, 273, 275
buoys and buoyage systems, 364–66, **365**, **366**

Camden (AOE 2), **325**
cardinal points, 341
cargo handling, 305–6, 315, 325
Carl Vinson (CVN 7), **321**
cavitation, 280–81
celestial navigation, 355–56, 358–60, **359**
central control station (CCS), 291, 292, **294**, 300
chafing gear, 313
Chart No. 1 (*Nautical Chart Symbols, Abbreviations, and Terms*), 346, 362, 363, 364
chartplotters, **353**, 357
charts: compass rose on, 341, **345**, 345–46; distance measurements on, **340**, 340; features on, **345**, 346–47; projections, 343–44, **344**, **345**; purpose of and information on, 337, 343–46; scales, 344
chemical, biological, and radiological (CBR) warfare, 289
christening and launching ceremonies, **283**, 283–84, **284**
circumference and circular measurements, 339
closest point of approach (CPA), 388, 390–93, **391**, **392**
clothing on fire, response to, 301
coiling down line, 310
collision avoidance, 377, 385
collision bulkhead, 275
COLREGS (*International Regulations for Prevention of Collisions at Sea*), 378. *See also* rules of the road/navigation rules
commissioning ships, 284, **285**
communications: date/time group for, 374; emergency alarms, 291; emergency communication systems, **291**, 291–92; messengers, 291–92; sound-powered telephones, 291, **292**
compasses: cardinal points, 341; deviation, 341; gyrocompass and gyrocompass repeaters, 341, 346, **355**, 355; magnetic compass, 341, **341**, 346; use of, 337; variation, **341**, 341, **345**, 345–46
connected replenishment (ConRep), **323**, 323–24, **324**, **325**
conning tower, 271, **271**
constant bearing, decreasing range (CBDR) situation, 382, 393, **393**
Coordinated Universal Time (UTC), 372, 373–74
coxswain, 330, **330**
cruising range, 268
current, wind, and boat handling, 330, **332**, 332–33, **333**

damage control: concept and definition of, 289; drills and training for, 289; flooding and dewatering, 293, 295–96, **296**, **297**, 300;

material readiness conditions and watertight and airtight access fittings, 276, 289–91, **290**, 300; organization for, 267, 292–95, **293**, **294**, **295**; protective suits and gear for personnel, 294, **294**, **295**, **296**; repair lockers, 294, 296. *See also* fire and firefighting
damage control assistant (DCA), 292, **294**
damage control central (DCC), 291, 292, **294**, 300
date/time group, 374
daymarks and beacons, **364**, 364–65, **366**, 366–67
dead reckoning (DR) positions, 356–57, **357**
deck and pier fittings, 315, **315**, **320**, 320–21, **321**
deck department, 305, 306
deck division, 306, 315
deck seamanship: anchoring, 305–6, **315**, 315–19, **316**, **317**, **318**, **319**, **320**; cargo handling, 305–6, 315, 325; mooring and mooring lines, 305–6, 307–8, **308**, 315, **320**, 320–22, **321**, **322**; personnel for, 305, 306; skills for, 305, 306; towing, 315, 325; underway replenishment, 305–6, 309, 315, **323**, 323–25, **324**, **325**
decks: definition of, 269; locations, names, and types of, 270, **272**, 272–73, **274**; numbering of, 272–73, **273**; small boat parts, **328**, 328
Denver (LPD 9), **319**
depth finder, 358
design and construction of ships, 268
dewatering and flooding, 293, 295–96, **296**, **297**, 300
displacement, 268
displacement hulls, 328
distress signals, **385**, 385–86
dock landing ships (LSDs), **276**, **281**, **316**, **359**
dogs (latches), **275**, 275, **276**
doors, 273, 275, **276**, 328
draft, 270, **274**, 328
dry docks, 281, **281**

Earth: circular measurements on, 339; hemispheres, 339, **339**; meridians of longitude, **338**, 338, **339**, 339–40, 370–72, **372**; parallels of latitude, 338, **338**, **339**, 339–40; time and arc around, 370–71
eductors, 296, **297**
electronic chart display and information system (ECDIS) plotters, 357, **357**
electronic chart system (ECS) plotters, **353**, 357
emergency alarms, 291
emergency escape breathing device (EEBD), 299, **300**
endurance, 268
England, Gordon, 271
equator, **338**, 338
etiquette, boat, 333–34

faking down line, **310**, 310–11
fantail, 269, **272**
fire and firefighting, 296–301; classes of fires, 297–98, 301; clothing on fire, response to, 301; equipment for firefighting, 298, **299**, 301; extinguishing agents, 297–98; fighting a fire, 299–300, **300**; fire triangle and tetrahedron, **297**, 297; prerequisites for a fire, 296–97; prevention of fires, 296, 301; protective suits and gear for personnel, **295**, **298**, 298–99, **299**, **300**; training for, **299**, **300**
fire watches, 300
first aid and battle dressing stations, 294
first lieutenant, 306
fixes and lines of position (LOPs), **355**, 355–56, **356**, 358, **359**, 359–60
flag bridge, **270**, 270
flags: boat flag etiquette, 334; First Navy Jack, **271**, 271; national ensign, 271, **272**, 334; Navy Union Jack, 271; personal flags and pennants, 334
flagstaff, 271, **274**
flemishing line, **310**, 310
flooding and dewatering, 293, 295–96, **296**, **297**, 300
fog signals, 385
forecastle/forecastle deck, 269, 272, **272**, **274**
Fort McHenry (LSD 43), **276**
freeboard, 268, 270, **274**
Freedom (LCS 1), **272**, **283**

George Washington (CVN 73), **270**, **280**
Gerald Ford (CVN 78), **282**
gig, 329
Global Positioning System (GPS), 340, **350**, 350–53, **351**, **352**, **353**, 354
great circles, **338**, 338–39
Greenwich Mean Time (GMT), 373–74
Greenwich meridian, **372**, 372–73
Gunston Hall (LSD 44), **316**
gunwale, 270, 328

hatches, 273, **275**, 275, 328
hitches, knots, and bends, **307**, **311**, 311–13, **312**
hull: definition of, 268; rupture or hole in, 295–96; small boat hulls and parts, 327–28, **328**; speed and design of, 268; structure of, **269**, 269–70
hybrid electric drive (HED) system, 278, 280
hyperbolic radionavigation systems, **349**, 349

Illinois (SSN 786), **271**
Independence (LCS 2) and *Independence*-class littoral combat ships, **278**, 316
International Date Line, **339**, 339, **372**, 373
International Regulations for Prevention of Collisions at Sea (COLREGS), 378. *See also* rules of the road/navigation rules
Intracoastal Waterway, 367
island, **270**, 270

jackstaff, **271**, 271, **274**
John Flynn (DDG 113), **284**
John McCain (DDG 56), **283**

Joint Direct Attack Munition (JDAM) guidance, **352**
jubilee patches, 296, **296**

keel, 269, **269**, 328, **328**
knots, bends, and hitches, **307**, **311**, 311–13, **312**

ladders, 269, **274**, **276**, 276–77
landing craft utility (LCU), 329, **329**
landlubber, 268
latitude, **338**, 338, **339**, 339–40
launching and christening ceremonies, **283**, 283–84, **284**
leaving and boarding boats, 334
lieutenant, first, 306
lighthouses, 363, **363**
lights, navigation, 362–63, **363**, **364**
lights and shapes on vessels, 378, **379**, 379–82, **380**, **381**
line: construction of, 309, **309**; handling and storing, **310**, 310–11; inspection of, 311; materials and fibers for, 307–9, **308**; parting under a load, 311; rope compared to, 307; sizes, diameters, and measurements, 309–10; whipping ends of, 310, **311**
lines of position (LOPs) and fixes, **355**, 355–56, **356**, 358, **359**, 359–60
littoral combat ships (LCSs), 277, **278**, 278, 281, **283**, 316
longitude, **338**, 338, **339**, 339–40, 370–72, **372**
Los Angeles–class attack submarines, **274**, 281

maneuverability of ships, 268
maneuvering board, 377, 388–94, **389**; closest point of approach, 388, 390–93, **391**, **392**; course and speed vector, 390, **390**, 393; plot/polar plot, **389**, 389–90; problem solving on, **388**, 388; relative motion and relative motion plot, 388–89, 393; rules of thumb for, 393
marlinespike seamanship: advancement and skills for, 307; concept of, 305, 307; knots, bends, and hitches, **307**, **311**, 311–13, **312**; line, 307–11, **308**, **309**, **310**, **311**
masts, **270**, 271, **274**, 328
material readiness conditions, 276, 289–91, **290**, 300
McCampbell (DDG 85), **307**, **355**
meridians of longitude, 338, **338**, **339**, 339–40, 370–72, **372**
messengers, 291–92
Michigan (SSGN 727), **271**
Military Sealift Command (MSC), 286
mooring and mooring lines: deck and pier fittings for, 315, **315**, **320**, 320–21, **321**; materials and fibers for lines, 307–8, **308**, 321; Med-type moor, **320**, 320; names and patterns for lines, **321**, 321; pier, mooring to, **321**, 321–22; rat guards on lines, 322, **322**; ship, mooring to, 322, **322**; skills for, 305–6
morning colors, **271**, **272**
motor sailers, 327, 328

Nautical Chart Symbols, Abbreviations, and Terms (Chart No. 1), 346, 362, 363, 364, 367
nautical measurements, **340**, 340–43, **341**, **342**, **343**
Naval Ship's Technical Manual (NSTM), 289
navigation, marine, 349–61; celestial navigation, 355–56, 358–60, **359**; chartplotters, **353**, 357; ECS plotters, **353**, 357; evolution of, **349**, 349–50, **350**; piloting, 357–58, **358**, **359**; plotting positions, **354**, 354–57, **355**, **356**, **357**, 358, **359**, 359–60; satellite navigation systems, 349–53, **350**, **351**, **352**, **353**
navigation, nautical, 338–48; bearings and relative bearings, **342**, 342–43, **343**; concept and definition of, 337; directions, **341**, 341–43, **342**, **343**; distance measurements, 340, **340**, 370–72, **372**; magnetic and true directions, 341, **345**, 345–46; speed unit and measurement, 340
Nimitz (CVN 68) and *Nimitz*-class aircraft carriers, **285**, **298**
nuclear power plants and reactor compartments, 268, **274**, 278, **279**, 279–80
nylon line, 307–8, **308**, 309

officers' boats, 329
Ohio (SSGN 726) and *Ohio*-class nuclear-powered submarines, **271**, 286

parallels of latitude, **338**, 338, **339**, 339–40
Pearl Harbor (LSD 52), **281**
pier and deck fittings, **315**, 315, **320**, 320–21, **321**
piping systems, 275–76, 295, 296, **296**
planing hulls, 328
port (direction), 269
port (window), **274**, 328
powerboats, 327, **327**, 328–29, 330
primary flight control (PriFly), **270**, 270–71
prime meridian, 339, **339**, **372**
propeller forces and boat handling, **330**, 330–33
propellers and propeller shafts, **274**, **277**, **280**, 280–81, 328
propulsion plants: diesel engines, 280; electric engines, 280; engines on small boats, 328; gas turbine engines, 268, **277**, 277–78, **278**; hybrid electric drive system, 278, 280; nuclear power plants, 268, 278, **279**, 279–80; pump-jet propulsers, 281; steam propulsion plants, 268, **278**, 278–79; water-jet propulsers, 278, **278**, 280, 281, 329
protective suits and gear, **294**, 294, **295**, **296**, **298**, 298–99, **299**, **300**

radar, 358, **358**, **359**
range, cruising, 268
relative bearings and bearings, **342**, 342–43, **343**
repair lockers, 294, 296
repair parties, 290–91, 292, **293**, 293–95
Repair Party Manual, 289
rigging, 325, **325**, 328
rigid hull inflatable boats (RHIBs), **329**, 329, **330**
Ronald Reagan (CVN 76), **285**, 286, **294**
rope, 307. *See also* line
rudder, **274**, 328, **330**, 330–33
rules of the road/navigation rules: applicability of, 378; collision avoidance, 377, 385; distress signals, **385**, 385–86; fog signals,

385; inland rules, 377, 378, **379**, 379–86, **384**, **386**; international rules, 377, 378, **379**, 379–86, **386**; lights and shapes rules, 378, **379**, 379–82, **380**, **381**; purpose and scope of, 377, **378**, 378–79; safety rules, 377; steering (whistle) signals, 382, 383, 384, **384**, 385; steering and sailing rules when vessels are approaching each other, 378, 382–85, **384**

safety: heavy weather and securing equipment, gear, and people, 313; rules of the road, 377
sailboats, 327, **327**, 328–29, 330
salutes and rendering honors, 333–34
satellite navigation systems, 349–53, **350**, **351**, **352**, **353**
scuttles, 275, **275**
sea trials, 284
Seahawk helicopters, **325**
seamanship: advancement and seamanship skills, 306, 307; boat etiquette, 333–34; components of, 305; importance of to all personnel, 305–6; learning skills, 305. *See also* deck seamanship; marlinespike seamanship; small boat seamanship
Seawolf-class attack submarines, 281
seaworthiness, 268
self-contained breathing apparatuses (SCBAs), 294, **299**, 299
sextant, 355–56, **359**, 359
shapes and lights on vessels, 378, **379**, 379–82, **380**, **381**
shipbuilding, **281**, 281–83, **282**
ships: complexity of, 267; design and construction of, 268; directions on, 269; names and designations, 284–86; structure of, **269**, 269–75, **270**, **271**, **272**, **273**, **274**, **275**
ship's inertial navigation system (SINS), 353, 354
small boat seamanship: boat handling, 305, **330**, 330–33, **332**, **333**; courtesies and procedures for boarding and leaving boats, 334; etiquette, 333–34; nomenclature and boat parts, **327**, 327–28, **328**; salutes and rendering honors, 333–34; types of boats, 328–29, **329**; upperworks, **327**, 328
small craft, 328–29, **329**, **330**
smoking, 301
soft patches, 296, **296**
sound-powered telephones, 291, **292**
South Dakota (SSN 790), **282**
spaces and compartments: berthing compartments, 273, **273**; compartment checkoff list, **290**, 291; definition of, 268–69; designation/numbering systems for, 274–75, **275**; habitability, 268; locations and types of, 273, **273**, **274**; material readiness conditions, 276, 289–91, **290**, 300; watertight compartments and watertight integrity, 273, **275**, 275–76, **276**, 289–91, **290**
speed triangle, 390, 391, **392**, 393
stability, 268
stack, 271–72, **274**
stadimeter, 355, **356**
starboard, 269
steering (whistle) signals, 382, 383, 384, **384**, 385
stern, 269, 328, **328**
Stetham (DDG 63), **320**
STREAM (standard tensioned replenishment alongside method), **323**, 323–24, **324**, **325**
submarines: design and construction of, 268; names and designations, 284–86; propellers on, 280–81; propulsion plants on, **279**, 279–80, 281; spaces and compartments on, 273, **274**
superstructure, **270**, 270–72

telescopic alidade, 342, **342**
terminology, 268–69, 395–401
Theodore Roosevelt (CVN 71), **273**
Ticonderoga-class cruisers, 277, 280
time, 369–74; apparent time, **371**, 371; arc around the Earth and, 370–71; date/time group, 374; equation of time, **371**, 371–72; hourglass and ship's bell time, 370, **370**; mean time, **371**, 371–72; military time and twenty-four-hour clock, 369–70; types of, 370–74; zone time, **372**, 372–73
Tortuga (LSD 46), **295**
towing and towlines, 315, 325
transom, **328**, 328

underway replenishment (UpRep), 305–6, 309, 315, **323**, 323–25, **324**, **325**
uniforms, battle dress mode for, 299
Universal Coordinated Time (UTC), 372, 373–74
utility boats, **329**, 329

Vella Gulf (CG 62), **300**
ventilation systems, 275–76, 300
vertical replenishment (VertRep), 324–25, **325**
Virginia and *Virginia*-class attack submarines, **271**, 281, **282**
vulture's row, **270**, 270–71

Warner, John, 284
waterline, 270, **274**, 328
watertight compartments and watertight integrity, 273, **275**, 275–76, **276**, 289–91, **290**
whistle (steering) signals, 382, 383, **384**, 384, 385
wildcat, **315**, 315, 317, **318**
wind, current, and boat handling, 330, **332**, 332–33, **333**
windlass, 315, **315**, 317, **318**
wire rope, 307, 309

yard patrol (YP) training craft, 280
Yukon (T-AO 202), **325**

Zulu time, 372, 373–74
Zumwalt (DDG 1000) and *Zumwalt*-class destroyers, 277, **278**, 286

About the Author

Com. Richard Hobbs has been involved with the Navy's NJROTC program for more than thirty years as a writer and editor of many of its instructional textbooks and other materials. A graduate of the U.S. Naval Academy, Commander Hobbs has thirty-plus years of service as a former Sailor, midshipman, and surface line officer in the regular and reserve Navy. He has also worked in industry as a ceramics engineer and production manager; in publishing as an editor for the Naval Institute Press; and in education as a navigation instructor at the Naval Academy, part-time community college astronomy instructor, and high school AP and honors physics teacher.

In addition to the *Naval Science* series textbooks for the NJROTC program, Commander Hobbs has also written the widely acclaimed *Marine Navigation: Piloting, Celestial and Electronic*, a standard text and reference book in the field for many years, and is a contributor of several articles on marine navigation and other related topics to *World Book Encyclopedia*. A certified tennis instructor, he retired after twenty years of teaching physics and coaching tennis at a local high school near Annapolis. An avid sailor, after many years living aboard their motorsailor *R n R*, he and his family now reside in Maryland and in Florida.

The Naval Institute Press is the book-publishing arm of the U.S. Naval Institute, a private, nonprofit, membership society for sea service professionals and others who share an interest in naval and maritime affairs. Established in 1873 at the U.S. Naval Academy in Annapolis, Maryland, where its offices remain today, the Naval Institute has members worldwide.

Members of the Naval Institute support the education programs of the society and receive the influential monthly magazine *Proceedings* or the colorful bimonthly magazine *Naval History* and discounts on fine nautical prints and on ship and aircraft photos. They also have access to the transcripts of the Institute's Oral History Program and get discounted admission to any of the Institute-sponsored seminars offered around the country.

The Naval Institute's book-publishing program, begun in 1898 with basic guides to naval practices, has broadened its scope to include books of more general interest. Now the Naval Institute Press publishes about seventy titles each year, ranging from how-to books on boating and navigation to battle histories, biographies, ship and aircraft guides, and novels. Institute members receive significant discounts on the Press' more than eight hundred books in print.

Full-time students are eligible for special half-price membership rates. Life memberships are also available.

For a free catalog describing Naval Institute Press books currently available, and for further information about joining the U.S. Naval Institute, please write to:

Member Services
U.S. Naval Institute
291 Wood Road
Annapolis, MD 21402-5034
Telephone: (800) 233-8764
Fax: (410) 571-1703
Web address: www.usni.org