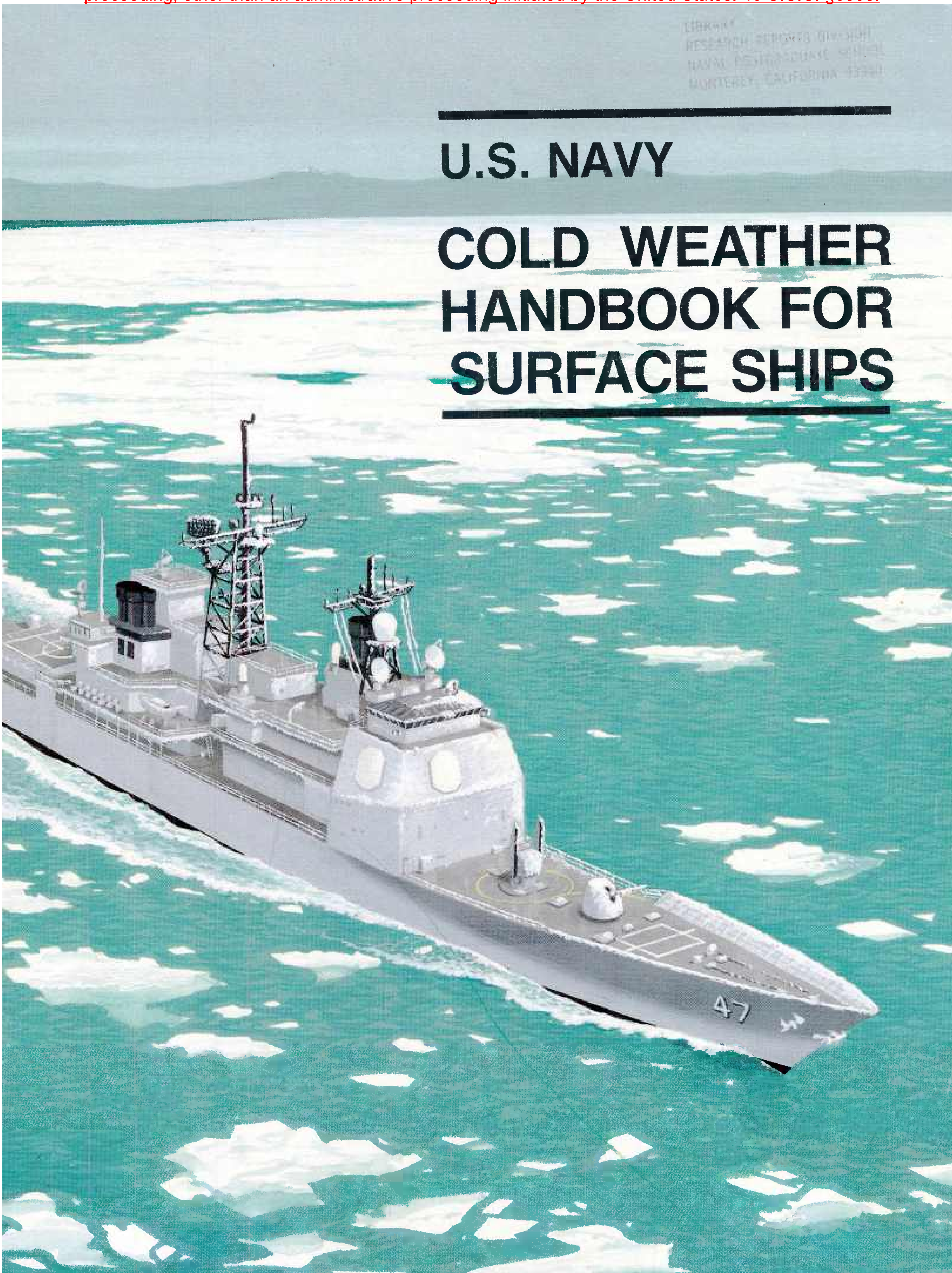
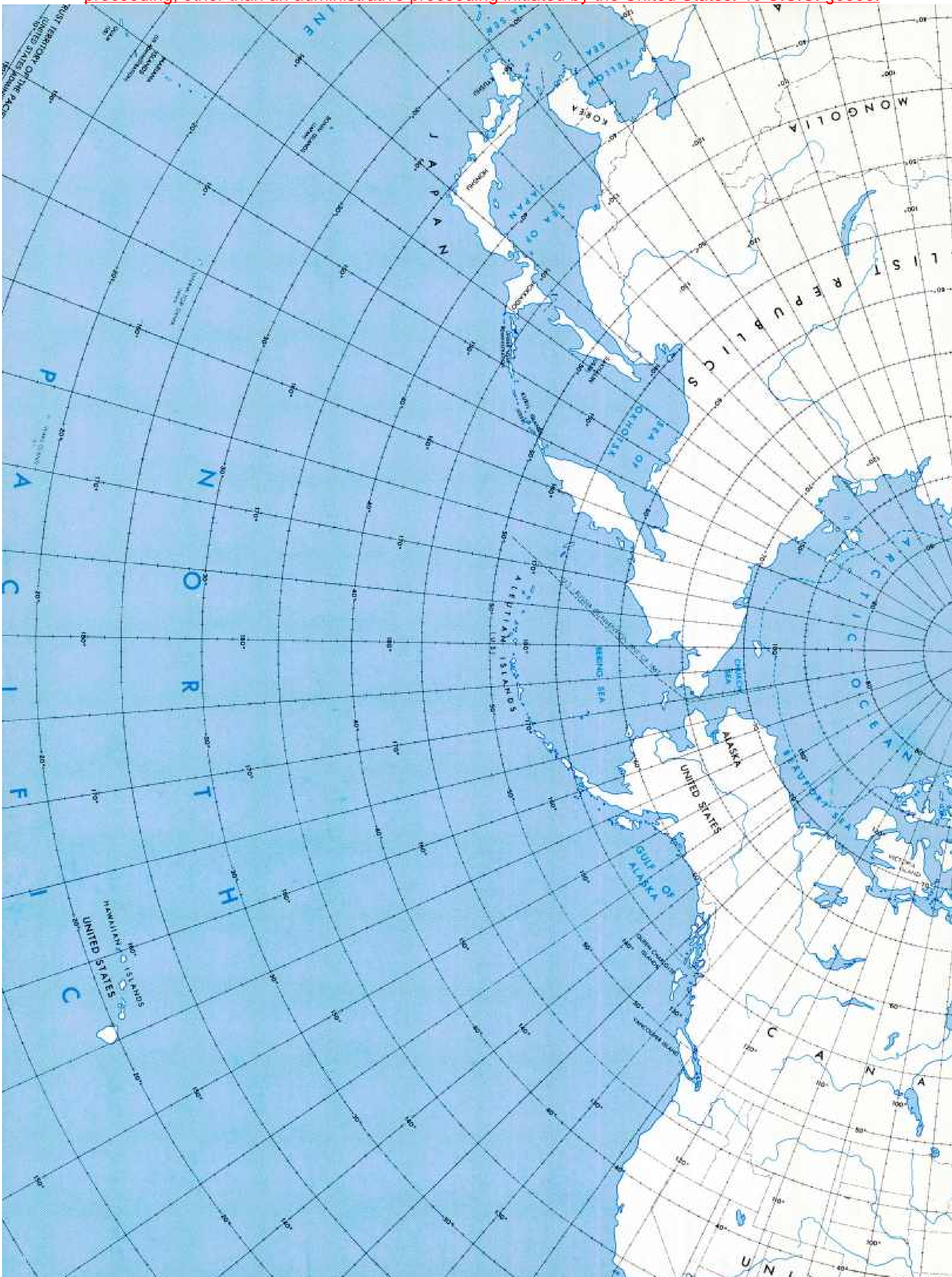
U.S. NAVY

COLD WEATHER HANDBOOK FOR SURFACE SHIPS

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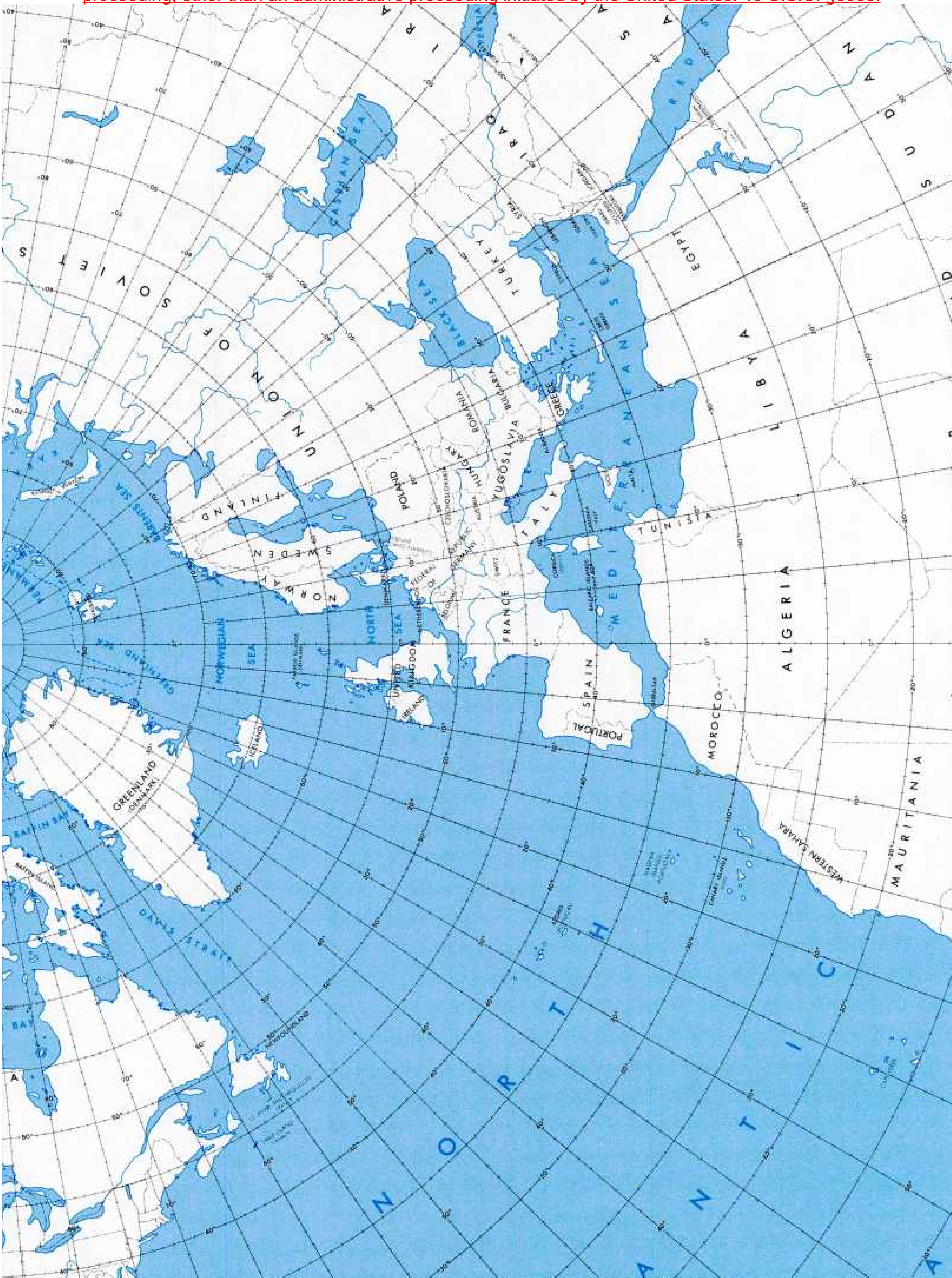
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U.S. NAVY
ae COLD WEATHER HANDBOOK
FOR
SURFACE SHIPS (title)

May 1988

Chief of Naval Operations
Surface Ship Survivability Office
OP-03C2
The Pentagon

PREFACE

The Cold Weather Handbook for Surface Ships has been published to ensure the fleet is provided information supporting operational preparation for deployments to cold weather areas. The U.S. Navy's Maritime Strategy outlines the extension of operating areas into high latitudes. CNO's instructions define the ship operational requirements for these areas. The contents of this Handbook provide a baseline for establishment of cold weather capabilities. It is arranged in a progressive manner providing a general overview of cold weather effects to support crew and ship material preparations including training. The chapter dealing with operational preparations highlights actions to be taken prior to deployment. This preparation is followed by information concerning recognition of cold weather phenomena and identification of cold weather clothing, including its use and care. The Handbook then addresses At Sea operational guidance for routine cold weather, ice accumulation, heavy weather ship handling, safety and medical considerations. Appendices covering the subjects of coatings, cold weather clothing, lubricants, predeployment checklists and an example Cold Weather Bill can be copied for ready reference around the ship or for specific areas of training. This publication is intended to augment fleet commanders' instructions on preparation for overseas movements and cold weather operations. The information relative to current product specifications, stock numbers and cost are correct at publication.

This Handbook is the result of information gathered from the best sources available in and outside the U.S. Navy. While all supporting individuals and organizations are not specifically identified, their efforts in the preparation of this publication are appreciated. The assistance of academia, industry, Army and Navy laboratories, systems commands and both Atlantic and Pacific fleets has significantly contributed to this fleet support document.

Captain Robert K. Barr
Surface Ship Survivability
OP 03C2

1988 edition

Published by

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CHAPTER 1

INTRODUCTION

PURPOSE

The purpose of this Cold Weather Handbook is to provide a consolidated training publication in support of the United States Navy's Surface Ship Fleet Arctic/Cold Weather Operations. The uniqueness of this Handbook is its explicit, single-source approach in addressing current problems facing the fleet in cold weather. It draws heavily upon lessons learned in recent operations and exercises and uses that collective experience to provide solutions to some critical cold weather operations problems.

This Handbook provides information and guidance which will be useful in fulfilling responsibilities laid out in Ships' Cold Weather Bills. (OPNAVINST 3470.1 series, found in Bills, Chapter VI). OPNAVINST 3470.5 series, United States Navy Policy Regarding Arctic Polar Region, provides general policy guidance for operating in the Arctic Polar Regions. OPNAVINST 3470.6 series, United States Navy Warfare Program, provides details for implementing Arctic policy. These documents are mutually supportive of the Department of Defense's Maritime Strategy. This Handbook does not replace manufacturers' technical manuals which specify cold weather operating procedures. Rather, it provides information which supplements those manuals and Cold Weather Bills to give a broader scope of the parameters for operations while in a cold weather environment.

As new data from operations, weather and icy conditions is acquired, it should be submitted, along with recommendations for improvements and/or alterations to:

Deputy Assistant Chief of Naval Operations
(Surface Warfare)
OP O3C2, The Pentagon, Room 4D537
Washington, DC 20350

BACKGROUND

The United States Maritime Strategy requires the operation of surface ships in northern latitudes. The Soviets also operate in the Arctic routinely, as shown in Figure 1-1.

Figure 1-1 Soviet naval exercise areas.

Quoting Admiral James D. Watkins:

> "It is important to recognize that these [exercises] encompass Japan, Norway and Turkey ... Allied strategy *must* be prepared to fight in forward areas. That is where our allies are and where our adversary will be ...

> "The goal of the overall Maritime Strategy is to use maritime power, in combination with the efforts of our sister services and forces of our allies, to bring about war termination on favorable terms."

The United States Navy's Arctic/Cold Weather Program for Surface Ships was undertaken in July 1985 at the direction of the Deputy Chief of Naval Operations, Surface Warfare, who stated: "The ability for our surface ships to operate under cold weather conditions as well as in the northern regions adjacent to the Arctic and in the Marginal Ice Zone (MIZ, Figure 1-2) is a necessary part of our Defense and Maritime Strategy." The decision to implement the Arctic/Cold Weather Program was based on the recognition of the need to provide the fleet with the necessary instructions and hardware to enable them to operate ships in the northern latitudes in accordance with the Navy's Maritime Strategy. The impacts of cold weather and topside icing were recognized as problems that the fleet must be prepared to cope with in order to operate safely and successfully in Arctic Regions.

For the purposes of this Handbook the terms "Arctic" and "Arctic Region" will refer not only to those areas above the Arctic Circle but also those seas in northern latitudes bordering on the Arctic Circle (66° 33′) which routinely experience cold weather conditions, at least on a seasonal basis. The North Atlantic, North Pacific, Bering Sea, Labrador Sea and Norwegian Sea are examples of areas not above the Arctic Circle but subject to cold weather operating conditions at least part of each year.

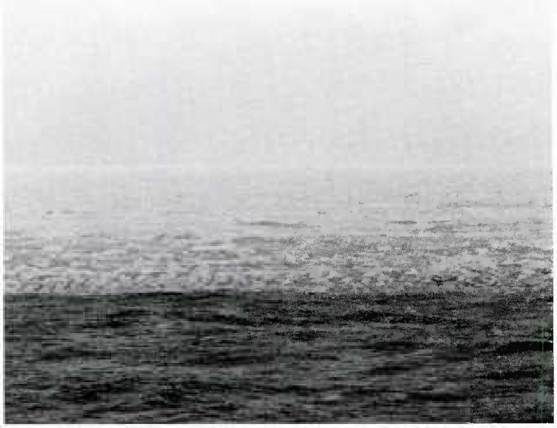


Figure 1-2 The marginal ice zone.

The Arctic Region is one of both strategic and commercial importance to the United States:

- Alaska has 1,060 miles of Arctic coastline.
- The Arctic is the only region where the United States shares a common border with Russia.
- The Arctic provides an important barrier to attack from the North.
- There is a need to protect economic interests including reserves of oil, gas, coal and strategic minerals that are present in Arctic Alaska.
- Six countries border the Arctic: the United States, Canada, the Soviet Union, Norway, Finland and Greenland.

Figure 1-3 illustrates the strategic value of the Arctic Region.

The United States Congress has recognized the importance in defending the Arctic Region and accordingly passed *The Arctic Research and Policy Act of 1984* signed into law 31 July 1984. Excerpts from that law, numbered as they appear in the law, include:

> "(1) the Arctic, onshore and offshore, contains vital energy resources that can reduce the Nation's dependence on foreign oil and improve the national balance of payments;
>
> "(2) as the Nation's only common border with the Soviet Union, the Arctic is critical to national defense;
>
> "(3) the renewable resources of the Arctic, specifically fish and other seafood, represent one of the Nation's greatest commercial assets;

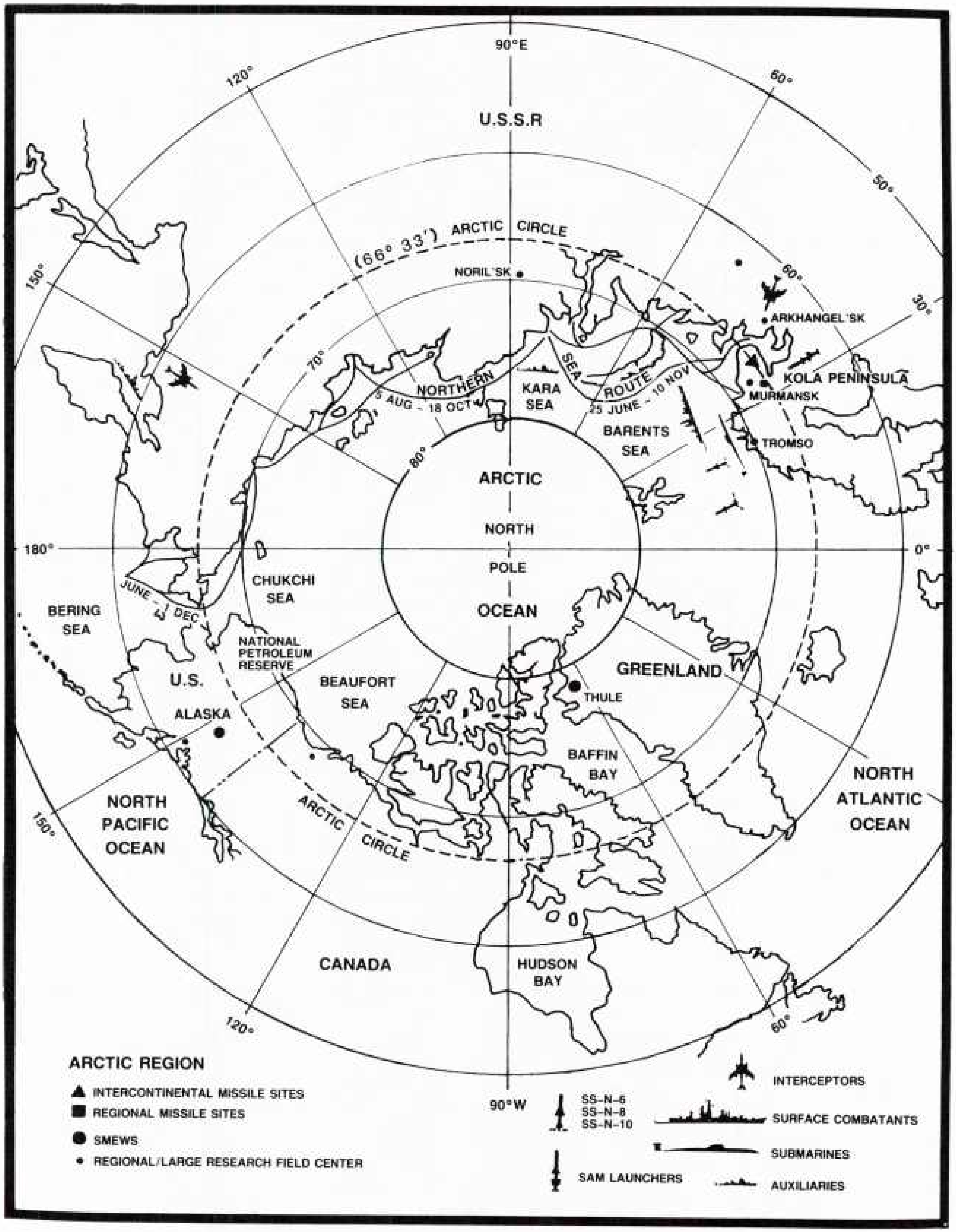


Figure 1-3 Strategic value of the Arctic Region.

"(7) atmospheric conditions peculiar to the Arctic make the Arctic a unique testing ground for research into high latitude communications, which is likely to be crucial for future defense needs;

"(8) Arctic marine technology is critical to cost-effective recovery and transportation of energy resources and to the national defense; and

"(10) most Arctic-rim countries, particularly the Soviet Union, possess Arctic technologies far more advanced than those currently available in the United States."

In support of the top level requirements from the Chief of Naval Operations specifying that surface ships must have "designs capable of cold weather operation," the Chief of Naval Research has stated:

"Advanced hull forms and control technologies are being developed for future surface ship designs. For today's fleet, techniques are being identified for increasing the operability of weapons and sensors, as well as the capabilities for underway replenishment in high sea states. The United States must, to the maximum extent practicable, support its northern allies. A strong, experienced surface fleet that can make things difficult for the Soviets in the northern sector and contain their northern fleet is a must. Preparedness on the part of the United States is mandatory."

HISTORY/OPERATIONAL EXPERIENCE

When considering the actual Arctic experience the U.S. Navy has logged, one's thoughts go back to Admiral Richard E. Byrd's Arctic and Antarctic expeditions. His successes in exploration were indeed astonishing and we have learned from his experiences. Historically, it is interesting to note that Admiral Byrd (then a Lieutenant Commander) was not assigned to a surface ship on any of his expeditions and he was, in fact, on leave of absence from the U.S. Navy on assignment to the National Geographic Society when he was the first to fly to the North Pole.

During World War II some U.S. cargo ships and tankers experienced grave difficulties, and not a few losses, in what has come to be called "The Arctic Convoys."

The Arctic Convoys were under the direction of the Royal Navy and their purpose was to carry arms, explosives, vehicles, fuel, tanks and aircraft to the Russian ports of Murmansk, Arkhangel and Molotovsk. Convoys operated frequently under conditions bordering on the limits of human endurance, when the cold was so intense that no amount of clothing would suffice. Sea spray froze on masts, rigging and decks and washed over the decks, creating a constant struggle to keep guns in working order and, in the case of small ships like trawlers, to prevent the ship from becoming top-heavy due to an accumulation of ice.

The convoys sailed through Arctic darkness, ice, fog, heavy seas, moving right past German airfields in occupied Norway. After January 1942, the convoys were frequently made up of mostly American vessels. Some were attacked by dive bombers, packs of U-boats and other surface ships. On one mission, of the 33 ships which began the journey, 11 reached port. The other 22 were sunk. Shipwrecked crews experienced abandonment, severe frostbite and extreme hunger.

Other operational experience was gained during World War II in the Pacific Arctic regions. From *The Thousand-Mile War*, a perspective of these cold weather events, comes the following:

"July 18, 1942: Theobald ran up his flag on heavy cruiser INDIANAPOLIS at Kodiak and steamed west at the head of a column made up of cruisers LOUISVILLE, HONOLULU, ST. LOUIS and NASHVILLE and nine destroyers. They set course for Kiska, intending with some misgivings to submit the enemy to a punishing bombardment.

"One day out, a sailor fell overboard. Rescue teams recovered him almost immediately; but the icy waters had already taken his life.

> "Scuttlebutt traveled from watch to watch: 'Jonah patrol'—it would be a jinxed voyage. The midsummer fog hid everything beyond the few yards of water around each hull. With alarming frequency, sister ships curtsied past each other, threatening collision. Westward the seas climbed—so rough they dumped water down the air intakes of rolling destroyers. Saltwater and vomit clung to every surface.
>
> "(At the same time, in the churning waters of Unimak Pass, the YP-74, carrying a crew of SeaBees, crashed head-on with a freighter in the fog. The boat sank in ninety seconds; four men were lost.)
>
> "The attack fleet kept moving. On July 22 Theobald was edging gingerly toward Kiska, but fog hung stubborn and thick and the island was never in sight. Weathermen could promise nothing. In the Aleutians, if weather was bad it would probably get worse."

More recently, the British had experiences in cold weather during the battle for the Falklands. At a recent conference on cold weather in Norway, a British physician who had been in charge of the Falklands field hospital said: "Let us not kid ourselves. If that war [the Falklands] had lasted one week longer, we would have lost it due to cold weather injuries." Some injured are still receiving medical care for trench foot and frostbite.

The Assistant Deputy Chief of Naval Operations, Surface Warfare, stated in 1985:

> "The United States Navy's limited operations in the Arctic have revealed a number of problems that must be overcome if we are to successfully send our ships into these waters on a routine basis... We realize that we must learn by our experiences in future operations in northern latitudes."

RECENT COLD WEATHER NAVAL ENCOUNTERS

The United States Navy's experiences in cold weather regions, although limited in duration, have provided valuable data. The Arctic environment is characterized by great variability of climate which results in ice formation, storms and fog conditions which can limit safe ship operation. Sea ice may exist in many forms including pack ice, icebergs and growlers. Significant sea ice in the North Japan Sea is shown in Figure 1-4. Figure 1-5 shows an iceberg on its way through Baffin Bay, off Jakobshaan, Greenland.

Figure 1-4 The severity of the sea ice.

The Oceanographer of the Navy expands the description of cold weather conditions:

> "The Arctic is dominated by rigorous cold and characterized by days to months of continuous daylight alternating with long periods of near or total darkness. Throughout Arctic winter, snow cover is persistent and blowing snow is a common hazard, but the amount of actual snowfall is light. Duration of snow cover varies from about 10 months over the central ocean to about 7 months in the subarctic. Summer conditions are quite different. Rain as well as snow can fall during this season. Weather is typically damp and frequently foggy. During windy weather the fog is often lifted to form a low ceiling of stratus clouds... The success of naval Arctic and cold weather surface ship operations will be dependent upon the effectiveness and completeness of our understanding, our planning and our

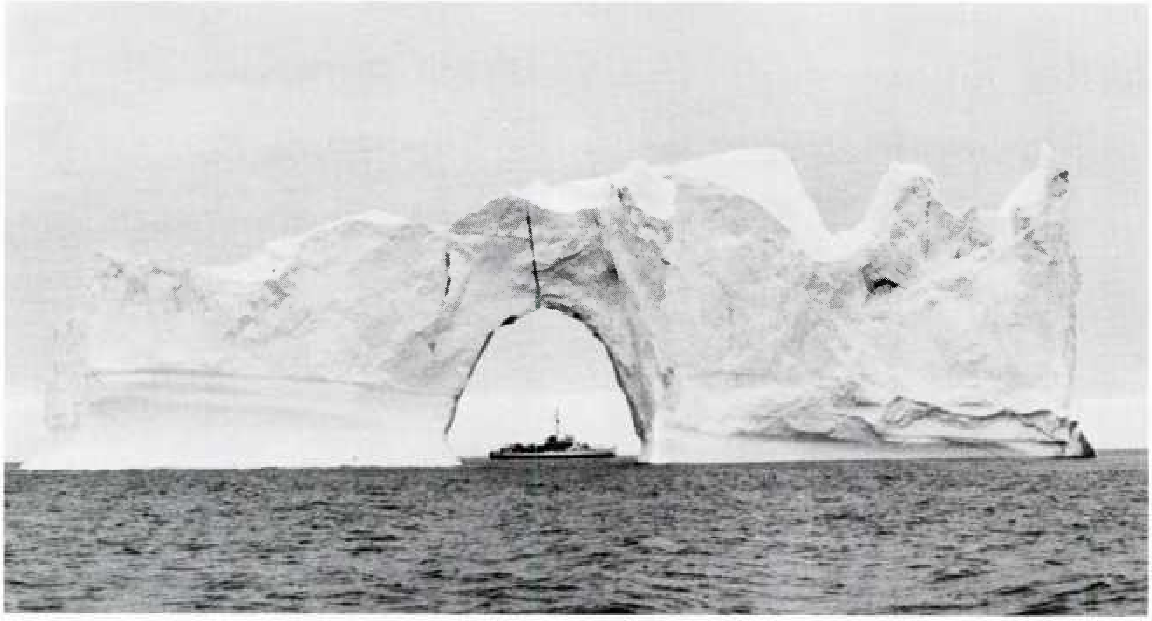


Figure 1-5 Natural arch in iceberg.

preparation... The Polar Regions are usually not forgiving."

Techniques for coping with cold weather and icing conditions need to be effectively transmitted to shipboard personnel for implementation. "Corporate memory" will be short or nonexistent because new crews will probably be first-timers in the Arctic. Effective training aids must be utilized to disseminate knowledge about cold weather.

General "lessons learned" from cold weather operations as well as port visits have provided valuable information. During a 1984 ASW operation in the North Atlantic, U.S. surface ships experienced some difficulty with cold weather and icing conditions, particularly in high sea states. Although snow and ice were minimal, the removal difficulties highlighted some potential problems that could occur under more severe conditions.

During the same year, two U. S. ships visited a port in the Gulf of Finland where they required assistance in moving through light sea ice. A knowledge of realistic operating capabilities would probably have eliminated the need for external assistance.

Heavy seas at high latitudes can cause many problems onboard ship, not only with ship and combat systems, but also with personnel performance. The debilitating effects of heavy ship motions on the crew drastically reduce their ability to carry out their duties, particularly if the heavy seas persist for long periods of time. In 1985, ships involved in a cold weather exercise were subjected to heavy seas for many days which resulted in a serious reduction in the crew's ability to function properly. Various deck equipment and antennas also sustained damage.

A surface combatant was subjected to heavy topside icing in January 1986 while deployed in the Pacific area north of Japan, as shown in Figures 1-6 and 1-7. Subsequently, she encountered significant amounts of new sea ice, but was able to perform the operation successfully and without damage.

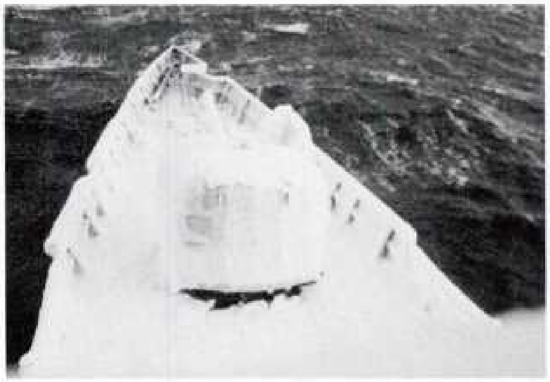


Figure 1-6 Heavy topside icing.

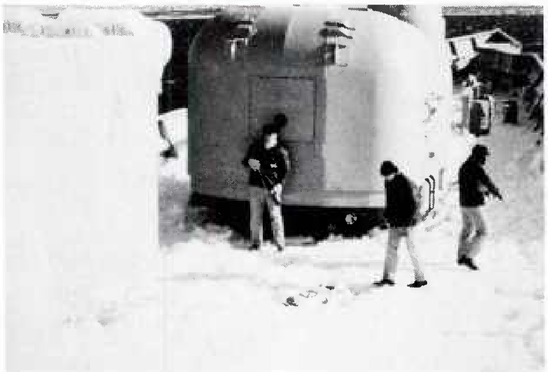


Figure 1-7 Topside icing, North Pacific.

Chapters 2 through 10 of this Cold Weather Handbook will discuss in detail the latest available information and application procedures for safe operation of surface ships and protection of personnel in the Arctic environment.

The arrangement of chapters corresponds to the Handbook's usage aboard ship, including preparations and training, implementation and operations. The Handbook can be used as an educational tool for people with little or no background in Arctic effects.

Additional information is contained in Appendices A through L, including Arctic terminology, cold weather lubricants, ice accretion reduction coatings, cold weather clothing photographs and procurement information, a checklist for procurement of cold weather gear prior to deployment, and Metric/English conversion charts.

CHAPTER 2

GENERAL COLD WEATHER EFFECTS

Operating a ship in cold weather means dealing with the combined effects of all cold weather factors. A typical situation might consist of air temperatures at or below freezing, water temperatures approaching freezing, a moderate to high sea state, winds of 20-30 knots, the presence of sea ice and reduced visibility due to fog, rain, freezing rain or snow. A common result of these weather conditions which adds to the challenge of cold weather operations is topside icing. The effects of these weather conditions and topside icing on ship systems, operations and personnel are covered in detail in the following sections of this chapter.

TOPSIDE ICING EFFECTS

Topside icing has long been recognized as a serious hazard to ships operating in cold region temperatures. Thick layers of ice can form on decks, sides, superstructures, hatches, masts, rigging, deck mounted machinery, antennas and combat systems. Soviet ships have reported ice accumulations 3 feet thick on decks with the guard rail covered completely to form a closed bulwark. Freighters have had to spend several days in port chipping foot thick ice accumulations off their hatches before they could be opened for unloading. Figure 2-1 shows guard rail ice accumulation which occurred during an exercise in the Arctic.

The presence of topside ice increases the ship's displacement, decreases freeboard, obstructs operation of deck machinery, impedes personnel movement on deck, may obstruct air intakes, restricts helo operations, disrupts operation of radio and radars, hampers the deployment of underwater sensors and may interfere with the use of deck mounted weapons.

The greatest danger of topside icing, however, is the loss of ship's stability. Soviets have reported that some 340 tons of ice formed on the decks and superstructure of a merchant ship during a two day storm of wind force 10 in the North Atlantic. As the weight of topside ice increases, the ship's center of gravity is raised and the ship can become top heavy. This, combined with increased wind resistance under storm conditions, has led to the capsizing of smaller vessels.

Spray icing is the most commonly encountered form of topside icing. It occurs at air temperatures below freezing when the spray of seawater hitting the ship's surfaces freezes and creates a shell of ice. Figure 2-2 is an example of bow spray icing in the early stages. Atmospheric icing, where ice forms on the ship's surfaces from drops of rain or damp snow, is less common and usually occurs simultaneously with spray icing. Freshwater icing merits attention because the ice forms on the highest parts of the ship—the masts, antennas and rigging—where it can immediately

Figure 2-1 Guard rail ice accumulation.

Figure 2-2 Bow spray ice accretion.

and very substantially raise the center of gravity and worsen the ship's stability.

The primary condition for producing topside icing is bow slamming, causing spray to be carried by subfreezing air to the superstructure. The lower the air and water temperatures, the faster the particles of seawater and atmospheric moisture cool to a subfreezing state. Supercooled drops impacting the ship under these conditions will freeze instantaneously. Spray icing may appear at air temperatures just below 32°F, but occurs most often at temperatures of 25°F and below.

Wind also is important in producing spray ice. The wind drives the waves, creating a cloud of spray which will strike the ship's hull. The rate of spray icing depends on the wind velocity and height of the waves. Spray can rise to the upper regions of the superstructure in a heavy winter gale.

EFFECTS ON SHIP SYSTEMS

SHIP HEATING DESIGN CRITERIA

The heating systems of most U.S. Navy ships are designed to supply enough heat to maintain manned interior spaces at a comfortable temperature (usually 68° to 72°F) while the outside air is at a specified design point ambient temperature (usually in the range of 10° to 20°F). Because only a small amount of excess heating capability is ordinarily provided, a drop in outside air temperature below the specified design point will eventually produce a similar drop in the interior temperatures. Lower temperatures will be most pronounced in spaces which have surfaces exposed to the outside air, or which contain little or no heat-producing equipment.

LUBRICANTS AND RELATED LIQUIDS

Low temperatures cause the viscosity (thickness) of most liquids to increase. Liquid lubricants and fluids used in exposed shipboard equipment will be significantly affected by the cold. These include:

- oils and greases
- hydraulic fluids
- diesel fuel

The stiffening of greases and thickening of oils may cause problems for the equipment in which they operate. Equipment exposed to cold temperatures may perform very sluggishly at first and should be allowed to operate at low speed and no load until the lubricant and machinery warm up to normal operating temperatures.

The thickening of hydraulic fluids at low temperatures increases the flow resistance of the hydraulic system, which causes the pump to work harder to circulate the fluid through the system. It may also impede flow into the pump, causing the pump to cavitate. Serious pump damage may result if it is allowed to operate in this condition for a long period of time. Very high fluid viscosity can also cause excessive back pressure to build up in hydraulic motor and pump case drains, causing the case to fail.

The reservoirs of most exposed hydraulic systems are equipped with heaters to allow the pumps and motors to operate properly in extremely cold weather conditions. However, the smaller dead end control lines (such as are frequently used in hydraulically released brakes and pilot operated directional control valves) will remain cold and the fluid in these lines may move very slowly. This may cause brakes to release slowly and then fail to set as quickly as expected. It may also cause control valves to shift slowly or fail to shift altogether.

In cold weather, diesel engines operating on regular diesel fuel may experience filter plugging and other fuel system problems. In very cold weather, this fuel may congeal (wax) making engines inoperative, or water in the fuel may freeze, clogging valves, lines and filters. In most cases, the use of aviation turbine fuel (JP-5) will eliminate these problems.

Information on lubricants, hydraulic fluids and fuels suitable for use in shipboard equipment exposed to the cold weather is provided in Chapter 3 and Appendix B.

BATTERIES

Cold temperatures drastically reduce the output of all types of batteries (both dry cells and storage batteries). For example, at 0°F, the ampere-hour capacity of a typical dry cell battery is reduced to about 25% of the 70°F rated capacity. At this temperature, capacities of lead-acid and nickel-cadmium storage batteries are down to about 35% and 50% respectively, for relatively slow discharge rates. For very high discharge rates, such as for engine cranking, the situation is worse. The lowest temperature for reliable cranking is usually around 0°F. The output of all batteries reaches essentially zero at about -30° to -40°F. The rate at which storage batteries can accept a recharge is also reduced in cold temperatures. To obtain a good recharge in a reasonable amount of time, the temperature of the battery should be about 60°F or higher.

The sulfuric-acid electrolyte in a discharged acid battery can freeze at +5°F. If the battery is fully charged, the electrolyte freezing point is depressed to -60°F or below. Freezing may damage the plates, crack the battery case, split the cover-to-case seal or the terminal-to-cover seal, thus leading to electrolyte spillage. Freezing of electrolyte may also form crystals which can pierce separators, eventually leading to internal short-circuits and premature failure of the battery.

The potassium hydroxide electrolyte in a nickel-cadmium battery does not vary significantly with the state of charge and the freezing point is essentially constant at -70°F. Freezing of this type of battery is not a problem.

To minimize the chance of storage batteries freezing in extremely cold weather, they should be kept fully charged and, if possible, be stored in a heated space or be equipped with heaters. Flashlight batteries and other dry cells should be kept warm to be ready for use.

SHIP COLD WEATHER SOAKING

Ship cold weather soaking is defined as long-term exposure of the ship to subzero temperatures and near freezing seas. The ship gradually reaches thermal equilibrium with its environment after about a two- to three-week exposure.

The ship is considered cold-soaked when the heat loss rate drops to the same point as the heat production rate. The net heat transfer rate is zero and therefore the amount of heat the ship contains is constant.

When a ship transits from a moderate climate to a cold climate, its exterior and topside equipment will cool down to ambient temperature. Low seawater temperatures may cause high vacuums in condensers, condensation on air and seawater pipes and low temperatures in cooling systems. Spaces near the skin of the ship and interior spaces containing seawater piping and/or unheated ventilation will cool rapidly, particularly unheated spaces. After an initial rapid drop, air temperatures in these spaces will stabilize into a slow downward drift until the soak is complete.

Spaces below the waterline have a low temperature limit of approximately 28°F. However, heat is lost more easily at the water/hull interface than at the air/hull interface. One effect of this is that ship's skin temperatures above the waterline may be higher than those below the waterline even though air temperatures are well below freezing. Topside exterior spaces, subject to solar heating, wind and weather, can experience temperatures far below seawater temperatures and wider, more frequent temperature variations.

As temperatures in the outer spaces fall, temperature drops will progress toward the ship's interior. In general, once soaking is complete, the spaces farthest from the exterior of the ship will be the warmest; however, the locations and sizes of heat sources and/or whether the fresh air supply is heated will have the greatest effect on which parts of the ship will have cold problems.

Exterior Effects of Soaking

The exterior of the ship (and all equipment located there) is essentially at the temperature of the environment.

Non-Arctic internal combustion engines, such as those found on small boats, will be difficult to turn over without Arctic-grade oil. Engine fuels will thicken and suffer from wax formation. Water in the fuel will freeze causing fuel flow blockage. Diesels, in particular, become increasingly harder to start as the weather gets colder. High fuel viscosity may prevent proper oil flow through the engine, once it has been started. Tighter clearances due to cold-induced contraction can exacerbate these effects. The film of lubricant protecting engine internals and separating surfaces such as journal/bearing and piston ring/cylinder breaks down more quickly at cold temperatures, allowing adhesion (engine seize) and corrosion to occur.

Unprotected freshwater engine cooling systems may experience fractured heat exchangers and/or popped freeze plugs.

Interior Effects of Soaking

UNHEATED SPACES - Because many unheated spaces are infrequently occupied, damage to items in those spaces could go unnoticed. Cold spaces containing low- or no-flow water lines are of particular concern. An example of such a space is an unused head, often found on ships designed to carry embarked troops. Prolonged cold weather could also cause damage to the contents of storage spaces.

HEATED SPACES - Ships have reported that typical heated space temperatures reached the 50°F range during long-term Arctic exposure. Living and working in temperatures of around 50°F increases fatigue, as has been reported from previous ships operating in a cold-soaked condition. The constant discomfort has generally diminished ability of the crew to perform at its best.

ENGINEERING SPACES - Under normal conditions, engineering spaces do not require additional heat to maintain acceptable living temperatures. However, during cold weather operations, a number of ships have experienced the need to shut down part of engineering space ventilation in order to keep ambient temperatures above freezing.

Ships have reported the need to make impromptu modifications to the ventilation system line-up in order to keep engineering space air above freezing temperatures. Only the waste heat emanating from the various engineering systems keeps conditions in these spaces from being as severe as the exterior of the ship.

CONDENSATION/STANDING WATER - During prolonged cold weather operations condensation can occur on the coldest interior surfaces of the ship, leading to preservation problems, water damage and slippery surfaces. Freshwater in contact with the hull will freeze, including bilgewater and condensation. Ice build-up can occur on the inside, especially in humid spaces. Frozen bilges will impair the ship's dewatering capability if the bilge suctions are covered. Hatches and scuttles will become frozen shut from the inside.

Condensation will occur on any piece of equipment taken from a cold storage area into a warm space. Of particular concern is electronic equipment. Condensation hazard to electronic gear arises when a cooling medium operates at temperatures below the design point. Significant delays can be expected during start-up while electronic gear warms up and stabilizes.

Condensation occurring inside fuel tanks can freeze.

In-Port Effects of Soaking

A ship tied to the pier in a cold weather environment gets colder faster than when it is at sea. A large amount of heat-producing equipment is normally shut down. Likewise there can be a lack of sufficient shore power and use of the ship's own resources means use of fuel and watchstanders. The in-port effects of cold-soaking can be dramatic. A Spruance class destroyer tied up in Norfolk during an east coast cold snap experienced extensive freeze damage to its waste heat boilers.

FLUID SYSTEMS

Operating with outside air temperatures of 32°F or lower and seawater temperatures several degrees below the freezing point of freshwater (32°F) can have a significant effect on the various fluid systems aboard ship. Some common problems are discussed in this section.

Freshwater, seawater and other lines running through unheated spaces can freeze and burst.

Some auxiliary system heat exchangers containing freshwater or seawater are located in areas where the surrounding air temperatures are below the freezing temperature of seawater. In some heat exchangers, internal leakage paths may develop when very cold seawater enters the tubes and causes them to contract away from the tubesheet.

Very cold seawater entering the main condenser of a steam powered ship may overcool the condenser producing excessively high condenser vacuums and low condensate temperatures.

When seawater temperatures are below 32°F, the seawater service system or firemain system flow rates needed to cool various equipment are correspondingly low. To obtain these low flow rates, the temperature control regulator valves must operate near their closed position. Long-term operation under these conditions may produce erosion/corrosion damage to the valve and adjacent piping. Additionally, the valve may freeze due to the low temperature and low flow rates.

Plumbing drains and overboard discharges above the waterline are likely to freeze in cold weather, especially those with intermittent discharge. Air escapes, overflows and vent terminals for the ship's tanks may become covered or plugged with ice. Serious structural damage could result if the tanks are used (pumped into or out of) with the lines blocked so that the internal pressure cannot continuously equalize with the atmosphere.

On ships with main or auxiliary steam systems, warm distillate may be cycled to heat feedwater tanks which might otherwise freeze.

When operating in floating ice, small particles of sea ice may be drawn into the seawater service or firemain systems and cause clogged strainers. Frequent strainer cleaning may be necessary. Ice particles or chunks of ice in the seawater may be drawn into sea chests and clog them. Blowout connections are provided on some ships to permit deicing of these sea chests with steam or compressed air.

COMBAT SYSTEMS DEGRADATIONS

Under certain cold weather conditions, a warship can be rendered completely incapable of conducting any type of offensive operations. Figure 2-3, taken aboard a Knox class frigate, demonstrates the effects of topside icing. It is not hard to imagine hundreds of pounds of ice holding the doors of a vertical launch system shut. However, it takes far less ice to bind gears, shafts, hinges and pedestals. Frequently, this ice and its effects are not noticed until an attempt is made to rotate an antenna or train a gun. Icing will make maintaining combat systems readiness more difficult. Anticipation of icing is the best way to stay prepared. Assume that "if it moves, it's going to freeze."

Many greases and oils will not perform properly in cold weather. Ships have reported damage such as burned-out motors, fractured shafts and wiped bearings. At best, systems

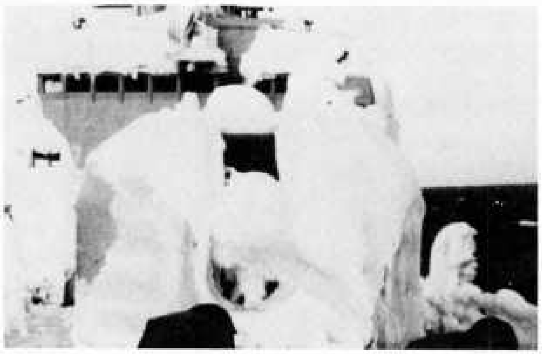


Figure 2-3 Topside icing effects.

without the proper lubricant or fluid will perform sluggishly. Long warm-up times will be needed, sometimes even when the proper lubricant or fluid is used.

Other common weapons systems cold weather problems include:

- Increased failure rate of seals, plugs and O-rings
- Frozen cooling systems or systems running below temperature limit
- Frozen magazine sprinkler systems
- Heaters or heater power left off or inoperative
- Excessively long electronics or weapon internals warm-up times
- Freeze up of compressed-air-operated components or associated valves, fittings, etc.

Guns

Guns, due to their relative simplicity, tend to be the most reliable weapons systems in a cold weather environment. Gun directors/director mounts, training and elevating mechanisms and loader mechanisms will need to be checked and warmed up prior to firing. Small arms and aircraft guns, brought into and out of a warm environment, need to be checked for condensation which can cause corrosion. Ordnance publications should be consulted for ammunition performance in cold weather.

When firing a gun in cold weather, consideration must be given to the tendency for metals to fracture at cold temperatures and effects on propellants, lubricants and fluids in recoil, cooling and transmission systems. Barrel expansion and contraction will be greater than in warmer weather. Special Arctic-grade recoil fluid may be necessary before a gun can be satisfactorily fired. Gun directors can experience icing of antennas and radomes, binding of mounts and excessively long warm-up times.

Missiles

GENERAL - Missiles are designed for all-weather operation and are well protected until launch. However, missile internals such as gyros and electronics might suffer start-up problems if the missile becomes cold-soaked. Cold weather problems manifest themselves primarily in the load and launch parts of the systems.

LAUNCHERS/ LOADERS - Box and rail launchers suffer most from exposure-related problems such as icing, improper lubrication and air/hydraulic system failures. The rail launchers' connection with the missile should be watched for icing. Vertical launch systems are relatively warm and protected except for their muzzle hatches.

Generally, missile launch/load hatches and hinges have heating systems designed to prevent hatches from freezing shut and ice building up under normal conditions. The heating system will not, however, remove heavy ice once it is in place. Heating systems of box launchers, assuming they are operational and turned on, may not be able to maintain the weapon inside above its minimum temperature. The heating systems will draw significant power.

The hatches and scuttles through which the missiles must pass, if unheated and if no preventive measures are taken, could be frozen shut when most needed.

A helpful aspect of missile systems in cold weather is the tremendous amount of heat the missile produces when launched. Rail systems should be free of ice trouble after the first launch. Nearby hatches of box and vertical launchers can be freed. This launch heat factor may influence which missile is selected for the first launch in a cold weather environment.

Combat Information and Control

Although fire control and combat information systems are mostly nonmechanical and are contained in warm protected areas of the ship, they must depend on exposed electromechanical sensors and emitters. Sonar sensors, due to their locations, are vulnerable to floating ice damage. Constant pounding seas, high winds, vibration and, in some cases, mast sway combine with ice loading and cold embrittlement to fracture structures such as antennas, wave guides, insulators and mounts. Electrical solder joint failures will also increase. Even slight icing of antennas/radomes can cause serious degradation of performance. Phased array radars, for example, have a very low tolerance for ice.

Torpedoes

Torpedoes are protected by their launchers. On many ships the launchers are exposed and therefore subject to icing, especially muzzle doors and training mechanisms. Torpedo internals could suffer start-up problems if the weapon is allowed to cold-soak.

Towed Arrays

Towed array operations require personnel on deck and will take longer in cold weather. Hydraulic fluid will require warm-up time. Once the array is deployed, the fluid will have to be maintained warm in the event retrieval or adjustment in scope is required. The drum is subject to freeze up. The array could be damaged by floating ice if allowed to remain near the surface. The cable and the array can suffer ice build-up which will impede or prevent retrieval.

Weapons Handling

A difficult operation under normal circumstances, weapons handling becomes much more complicated in Arctic conditions. Typical weapons-handling evolutions involve movement of heavy weights on the weather decks into and out of the ship's interior. The danger of such evolutions is increased due to factors such as slippery surfaces and working in numbing cold.

Some common weapons handling problems include:

- Icing of access hatches and doors
- Icing of fastenings on ready service locker doors
- Icing of small mechanical fixtures
- Freezing of air lines
- Icing on decks

Weapons handling often requires the use of mechanical assist rigs. Icing of limit switches in these rigs can result in safety hazards, improper operation or nonoperation. Air- or hydraulic-assisted rigs can suffer from freeze up and/or sluggish operation. Unprotected handling rigs stored topside can become coated with spray ice.

HIGH SEA EFFECTS ON STOWAGE

Although ship structures are designed to withstand heavy weather, stores and equipment carried onboard (such as cargo, ordnance and aircraft) can come adrift if not properly stowed. The high waves encountered in cold weather operation can lead to water damage of onboard equipment. On smaller ships, waves can break on the weather deck and against the ship superstructure. Seawater and spray driven by high winds against doors, hatches, scuttles and portholes will leak through any openings that are not tightly sealed and can freeze externally, effectively blocking other operations.

The keys to preventing these problems during heavy weather operation are:

- Make sure all equipment and stores aboard ship are stowed and lashed down to prevent toppling or sliding.
- Make sure all exterior doors, hatches, portholes, scuttles, etc., are secured and watertight.

MOISTURE (CONDENSATION) ACCUMULATION

Moisture will condense on interior surfaces of the ship during extreme cold weather operations. Condensation will be especially prevalent in locations with high relative humidities (shower rooms and galleys) and those with extremely cold surface temperatures (exterior hull or bulkheads and internal tank surfaces).

The formation of condensation on overheads, walking surfaces and electrical/electronics gear can be dangerous. Condensation on overheads, or unlagged seawater piping which can drip onto electrical/electronics equipment or condensation which forms within the equipment cabinet can short out the gear. Condensation that forms on walking surfaces can make those surfaces extremely slippery. Fog, frost and ice may form on the insides of windows and doors due to condensation.

Condensation can be prevented by either insulating or lagging the cold surface. In small, closed spaces a desiccant may be used to lower the relative humidity of the space to prevent condensation.

Equipment that can be cold-soaked should be allowed to do so and not be taken back into a warm moist environment. This is especially true for metal implements with small, hard-to-clean parts such as small arms. Alternatively, equipment can be secured in insulated carrying cases. The insulation allows the enclosed equipment to warm slowly (over a period of 6 to 8 hours) avoiding condensation.

SPARE PARTS AND SUPPLIES

General

Cold weather operations require that spare parts and extra supplies be added to the onboard inventory. Some are needed to make up for the increased failure rates resulting from the severe conditions. The remainder are needed specifically for dealing with cold weather related problems.

Although many supplies may be simple in nature (e.g., grease), their lack may prove critical to the proper operation of a major system or equipment. Since most cold weather operating areas are far from normal supply lines and refit facilities, ships will have to make do with what is onboard. Preventive maintenance could be affected by lack of parts or equipment.

Locating stowage space for the extra clothing, food and equipment required for a cold weather deployment will be a serious problem on U.S. Navy surface ships. Decisions will have to be made regarding how much of each item will be needed and can be carried based upon mission requirements and stowage capacity. Innovative creation of temporary stowage facilities will usually be required.

Machinery

Cold weather oils, fluids, fuels and greases are essential. Seals, gaskets and O-rings in general have much shorter life spans in cold weather. Cold embrittlement will claim items such as ceramic insulators, fiberglass or plastic covers, rubber boots and hydraulic seals. Any-thing subject to extreme cold and routine shock or vibration is more likely to fail, particularly if it is plastic, rubber or ceramic. Incandescent light bulbs have much shorter life spans in the cold. Many of these bulbs have critical applications, including landing lights and navigation lights.

Waterproof covers are the best prevention for many exposed equipment cold weather problems.

Anti-ice and heating systems which may not have been operated since new construction trials will suddenly be required to perform under severe conditions. The chances are good that spares for these systems are not routinely carried onboard.

Experience has shown that ships operating in cold waters for extended periods will suffer internal valve disc erosion due to throttling with the valve barely open. This occurs in chill water and seawater valves which control flow to affect temperature and can lead to increased demand for rebuilt parts and replacement valves.

Ice Prevention and Removal Equipment

The ship's inventory will need to include equipment and materials for topside icing prevention and removal. Examples include baseball bats, glycol and methanol solutions and experimental ice-phobic coatings. Detailed lists and discussions of these items are provided in Chapter 3.

EFFECTS ON UNDERWAY REPLENISHMENT

EQUIPMENT

Most equipment used during UNREP operations is located on deck. Consequently, it is affected by both low temperatures and ice ac-

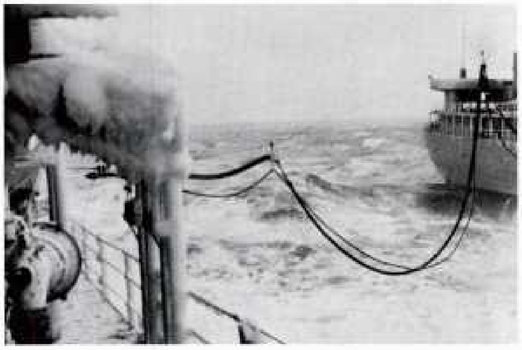


Figure 2-4 UNREP.

cumulation. Ice and snow covered decks and hatches also cause problems during UNREP operations. UNREP during a cold weather exercise is shown in Figure 2-4.

Among the most seriously affected UNREP equipment are winches, ram tensioners, sliding padeyes, sheaves and wire ropes. Other problems associated with the operation of UNREP equipment in very cold weather include:

- Hydraulic fluids, lube oils and greases become thick and stiff at very low temperatures even when the recommended cold weather materials are used. This may cause some hydraulic winches, ram tensioners and other hydraulic or pneumatic equipment to operate sluggishly and erratically. Winch sheaves may not turn freely due to the stiff grease.

- Ice may cover the surface and get inside the mechanisms of the on-deck equipment. This may produce such problems as jammed sheaves, ice-fouled wire ropes and fittings and frozen lines.

- Low temperatures reduce the performance of all batteries including those used in pallet and forklift trucks. Operating time will be shortened and more frequent recharging will be necessary. Flashlight batteries will also have a shorter lifetime in cold weather. Chemlites will lose intensity after an hour or two and may become useless at very low temperatures.

- Ice and snow covered decks may become too slippery for personnel and/or for the operation of pallet and fork lift trucks.

- Moisture in compressed air lines or other pneumatic equipment may freeze causing equipment damage or faulty operation due to flow blockages.

- Motors may overheat or burn up due to increased resistance.

PROCEDURES

Because of the high sea states which commonly exist in cold weather regions, the normal UNREP procedures frequently must be modified for improved safety.

The large ship motions which occur during rough weather will make the handling of heavy cargo on deck more dangerous. Waves may be high enough to damage or carry away cargo suspended between two vessels. Because sea ice damps wave action, UNREP may be accomplished easier near the ice edge if floating ice does not present a hazard.

To minimize the chance of collision, the replenishment distance should be increased. Also, for easier handling, the size of the loads transferred should be reduced. In general, because UNREP crews will be working slower and more carefully in cold, rough weather, UNREP operations will take longer than normal.

In cold weather, more men are needed to provide 2 or more complete crews of rig personnel and line handlers which can be rotated to limit exposure time. The off-duty crew members should stay in a heated waiting area inside the ship until needed on deck. In extreme cold weather, the number of UNREP rigs may have to be reduced to allow for adequate rotation of exposed personnel.

EFFECTS ON FLIGHT OPERATIONS

Flight operations that are second nature can become extremely difficult, time consuming and tricky in cold weather conditions.

SEA STATE CONSIDERATIONS IN AIRCRAFT HANDLING

Aircraft sliding on the deck due to the high seas and ice/snow covered slippery decks is not uncommon. On one occasion, an E-2 slid out of control, but the pilot used differential propeller thrust to control the skid and stopped the plane just short of hitting another aircraft. Air crewmen, flight deck personnel, shiphandlers and pilots must be aware of this dangerous condition and should maneuver and operate in a manner that will reduce the risks. Aircraft movement and elevator operation can be frequently interrupted by unacceptable ship motions due to high seas.

In Arctic weather areas, storms and sea squalls arise suddenly, and without warning. On one recent exercise, 11 aircraft were launched just prior to noon. A front with 45 knot winds suddenly came through and because of poor visibility the aircraft could not be recovered. One plane made 7 unsuccessful approaches. Advanced planning paid off, however, because an Air Force KC-10 had been asked to come out "just in case" and it was able to refuel the Navy craft, using 68,000 pounds of its 130,000 pounds of fuel. All 11 aircraft were able to return successfully after weather conditions improved.

Whiteouts (the loss of depth perception due to the scattering of daylight by snow, fog or ice crystals) should be expected. Heavy snowfall or fog can also reduce visibility to zero, sometimes suddenly and unexpectedly. In general, launch and recovery schedules must be flexible to work around these periods.

WIND

Wind induced sea spray broke over an aircraft carrier's bow in one recent operation and caused icing on the forward aircraft positions, which rendered them unusable. Conditions like this necessitate a change in the spotting arrangement. Unusually high winds can be anticipated.

Figure 2-5 Snow-covered flight deck.

Figure 2-6 Icy flight deck area.

FLIGHT DECK CONSIDERATIONS

The flight deck is the area affected most by cold weather conditions. It can often be covered with snow and spray ice forward as shown in Figures 2-5 and 2-6. Snow and ice accumulation on catwalks and elevators will also affect flight deck operations.

Temperature variations have a great effect on flight deck operations. At 24°F the deck will not be slick from snow. At 28° to 32°F the deck is very slick due to the brine and slush which will form. Under slush conditions, the deck can be treacherous because traction is so poor. Aircraft can slide around. The ship can expect to experience 9° rolls much of the time which makes operations even more difficult.

Normal aircraft maneuvers may not be possible in many conditions. Padeyes become packed with snow and slush, or both, then freeze, making them unusable. Sea states that are high enough to suspend elevator use occur more frequently in the Arctic. Restricted elevator use (sometimes up to several days) should be anticipated and limited operation of the elevator should be expected. Special runway deicing fluids are currently being evaluated to assist in keeping the deck ice-free.

Due to the hazards of aircraft movement, some repairs and systems checks normally done in the hangar will have to be done on the exposed deck.

Deck scrubbing with normal soap/detergent will be ineffective when the air temperatures are below freezing. Deicing can take hours if ice build-up is heavy. Doors, hatches, the ammunition elevator, cockpits and anything with openings to the weather can freeze in position.

OPERATIONS

Extremely cold temperatures and high winds have a dramatic cooling effect on all equipment. The wind will carry any residual heat away very quickly, and equipment will be cold-soaked much quicker, creating the need for additional back-up equipment, aircraft and personnel.

Aircraft engines will be harder to start in the cold. More warm-up time will obviously be required, and the Alert 5 and Alert 15 (aircraft prepared for launch in 5 and 15 minutes, respectively) programs will need to be modified. External heaters, covers and positioning will also reduce the possibility of equipment failure.

Aircraft hydraulics become cold-soaked, brake failures are very common and hydraulic problems may occur frequently. Seals and unions will contract and leak in the extremely cold temperatures.

The colder, denser Arctic air makes engines more powerful. Higher residual thrust at ground idle in the cold combined with slick decks makes taxiing and stopping more difficult. Sliding sideways is not uncommon. Simply turning the aircraft around can be a precarious ordeal. In some cases, the high winds will catch the side of the aircraft and cause maneuvering, stability and positioning problems. Wings may not be able to be spread in a crosswind. This may require leaving wing locks in place until the aircraft approaches the catapult.

Aircraft turnarounds can become time-critical events. Barricade stanchions may take 10 to 15 seconds longer than normal to operate. Ice forming in the wing slats can freeze them in position. The possibility of maintenance related foreign object damage (FOD) increases due to loss of manual dexterity, additional debris from high winds and FOD hidden in ice, snow and frozen padeyes.

Operational problems greatly increase in cold weather due to moisture in the fuel system. At lower temperatures, condensation will result in more water accumulation (as much as several gallons of water to 1,000 gallons of fuel). At below freezing temperatures, the water will crystalize. Water accumulation will settle to the bottom of the tanks and freeze up the fuel lines.

When refueling at low temperatures, care should be taken because objects become charged with static electricity more readily than at normal temperatures. All activities that could cause a build-up of static electricity, (e.g., sweeping frost and snow from an aircraft) must be followed by complete dissipation of the static charge before fueling is attempted.

The aircrew will become fatigued more quickly in cold weather. Flight operation cycles and sorties may have to be reduced due to personnel limitations. Anyone exposed to the severe conditions out on deck will be more vulnerable to frostbite in subfreezing temperatures.

Recognition of cold weather and its effects must be on the minds of all personnel prior to and during cold weather operations. Caution and special attention to detail will improve the safety of both personnel and equipment.

EFFECTS ON PERSONNEL

Not only do the ship's systems have to function in the cold, but the crew must also function reliably. When subjected to the combined effects of wet, cold and high sea states, it is very important to ensure the crew is cared for so they are able to carry out their duties safely and completely.

TEMPERATURE AND WIND

Everyone has experienced being cold at one time or another, whether it be as simple as a "Navy Shower" or as grueling as subfreezing temperatures in a blinding snowstorm. Therefore, operating in a cold climate presents the challenge of keeping people warm enough to tolerate the cold and to effectively carry out the ship's mission. As the temperature drops, more insulation is required to keep the body from losing its heat. Excessive loss of body heat, which can occur even in mild temperatures, may lead to death by hypothermia. Cold temperatures are clearly not to be taken lightly.

Wind also affects body temperature. Those parts of the body exposed directly to the wind will lose heat quickly, a phenomenon commonly referred to as "windchill." On bare skin, wind will significantly reduce the temperature of the skin (through evaporation) to below the ambient air temperature, making it feel colder than the temperature alone indicates. Windchill is discussed in greater detail in Chapter 9.

PROTECTIVE CLOTHING

Many articles of clothing for cold weather are very simple and ordinary, while others have been designed specifically for use in unique situations found aboard ship. Hats, boots, gloves, jackets and pants are standard operating equipment in the cold. Special items, such as anti-exposure suits and dry suits, are needed to perform particular tasks. Detailed clothing information is provided in Chapter 5 and Appendix D.

NUTRITION

Due to the increased physical demands of operating in the cold, it will be necessary to increase caloric intake. Allowances are made for ships to increase crew provisioning. The types of food consumed may also need to be altered, primarily in the areas of hot liquid drinks and high calorie snacks.

HIGH SEA STATES

Sea conditions can be extremely severe for extended periods of time, and can lead to sea sickness, nausea and vomiting. The physical condition of personnel will greatly affect the operating tempo of the ship. Plans should be made to provide for proper medical care, diet adjustments and watch rotations. Chapter 10 provides more information regarding cold weather medical concerns.

CHAPTER 3

PREPARATION FOR FLEET COLD WEATHER OPERATIONS

CREW INDOCTRINATION

Few aspects of cold weather operation are as important as having a well-indoctrinated crew. Everyone onboard, from the commanding officer to the newest seaman, must have a good understanding of the cold weather environment with which they will be faced and what will be expected of them.

PERSONNEL SAFETY

Personnel safety is of paramount importance. Freezing temperatures and icy decks compound the safety problems normally encountered onboard. An intensive safety campaign should be organized and executed to heighten everyone's concern for safety. All hands should be on the lookout for possible safety-related problems which should be brought to the attention of ship's safety officer. Chapter 9 covers personnel safety in detail and should be the guideline, at a minimum, to indoctrinate the crew.

COLD WEATHER CLOTHING

Personnel should be well-informed on all aspects of cold weather clothing, including variety and usage. Clothing acquired from cold weather clothing pools should be in sufficient quantity and properly sized to adequately protect the crew.

Fleet cold weather clothing pools have been established to stock the heavy clothing items which ships would not be expected to purchase individually. Additional items may be necessary for complete outfitting which can be obtained from the supply system or other sources. Appendix D contains descriptions, stock numbers, prices and pictures of available clothing items. The crew should review Chapter 5 prior to deployment for cold weather operations.

NUTRITION AND DEHYDRATION

Good nutrition is always important, but it deserves particular emphasis in the cold because the body's needs will change. When people are exposed to the cold, more calories are required to sustain body temperature. Routine tasks will be more strenuous in severe weather, increasing the need for additional calories.

Everybody exposed to the cold will need to increase fluid intake. Greater amounts of water must be consumed. Warm, sweet drinks that replenish nutrients and provide heat are particularly important. Caffeine drinks can cause dehydration and should be used in moderation in the cold.

Sea sickness can contribute to malnutrition and dehydration, especially in a cold environment where more calories are needed to maintain good health. When people are unable to keep food down for extended periods, the threat of dehydration and malnutrition always increases.

SPECIAL PROCUREMENTS REQUIREMENTS

Preparations for operating in a cold weather environment will involve procuring a number of unusual items, or unusual quantities of items, which may not be available through normal supply channels. Large quantity orders can deplete supply system stock levels resulting in partially-filled orders.

The key to being well-outfitted for cold weather operation is keeping the ship's supply department informed. The status of ordered items may need to be checked daily. The supply department which processes hundreds of chits daily from throughout the ship will not necessarily know that a cancelled chit for two dozen snow shovels is a big deal and that the cancelled chit for Christmas lights is not. The division or department concerned will need to know and evaluate the status of their requisitions.

All requisitions get requisition status codes. So, let's say that snow shovel order has a supply code of CP. This means the system has cancelled the chit and directed that the shovels be procured locally. Supply will make up a purchase order and get them at the local hardware store. However, if the ship is in Hawaii, the division must make up another requisition with an advice code informing the system that snow shovels cannot be obtained locally. Other problems such as incompletely filled orders and expected delivery after underway date should also be caught early.

Many Arctic operation items are so unique that what may seem an acceptable substitute to the supply system is actually not acceptable to the ship. For a regular requisition this is handled by an advice code. For an open purchase a note such as "Only requested item will suffice. No substitutions" is needed in the Remarks section.

An item not handled in the normal supply system sometimes can be available in the Federal Supply Schedule (FSS) System. Catalogs are published listing items in this system and if not onboard should be found at the local Navy Supply Center. The FSS does not use National Stock Numbers (NSN). When ordering an item, the FSS number is substituted for the NSN.

An alternative to buying the items is borrowing. Permanent stowage space for such infrequently used items may not be available. A nearby ship may have recently performed a cold weather operation or a nearby Army base may have stockpiles of cold weather gear not currently in use.

PROCUREMENT CONSIDERATIONS

PROTECTIVE COVERS

Protective covers are relatively simple and extremely effective for combating Arctic effects on exposed equipment. Sizes and shapes required will be varied and diverse. Examples of covers range from small electrical junction boxes to boats and fire control directors.

Due to possible severe conditions in the northern latitudes, old worn covers should be replaced. Because of their numerous applications, some protective covers must be custom-made. Lead time must be allowed for measurements, fitting and manufacture. Protective covers are usually made in-house. Larger ships have their own sail lofts and can make covers while underway. Smaller vessels must rely on the sail loft in their repair ships or intermediate maintenance activity (IMA). All covers and spares on such ships should be procured prior to deployment to the Arctic. Still, even with proper planning, wear and tear on some covers will be enormous if the ship experiences heavy cold weather.

Almost any material needed to manufacture the covers - including needles, thread and fasteners - is in the supply system. The Illustrated Listing (microfiche version of the Illustrated Afloat Shopping Guide no longer published) will detail available materials, including ordering information. To use the IL, one needs to know the Federal Stock Class (FSC) number, found by using one of the cross reference indexes available. (For example, "Cloth, Duck" is listed in the Item Name Index as FSC 8305.) The IL entry will also give the Mil Spec number. Mil Specs and associated indexes can be used in the same way.

When selecting cover materials for cold weather operations, the most important characteristics to look for are strength, durability and water-resistance. Each cover should be chosen based on characteristics of the equipment it will protect, the environment it will be used in and the type of protection needed. Although it is an inexact process depending a great deal on experience, judgement and trial and error, many options will work quite well. Experienced crewmen aboard will have good ideas about what to use.

Experience has shown that water absorbent covers become very difficult to remove once the water freezes. These covers should only be used as a last resort during wet cold weather operations. Impervious materials such as polyurethane should be used because they are lightweight, strong and waterproof. However, they must be firmly tied down to prevent damage from wind and ice.

For guns, all openings into mountings or breech mechanisms should be fitted with removable covers including separate covers for gunsights and exposed breeches of guns.

Nonporous, fire retardant covers are recommended for (at a minimum):

- Ship's boats - entire boat should be covered
- Davit winches
- Capstan/windlass and associated controls
- Unheated combat systems equipment
- Sound powered phone boxes
- All outside (exposed) command, control, communication stations

LOW ICE ADHESION COATINGS

These coatings, sometimes referred to as icephobic coatings, are being investigated by the Navy to reduce ice build-up on ship structures. Generally, the coatings are applied by brush or spray under warm weather conditions. They will eliminate icing under moderate conditions and will facilitate ice removal by mechanical means if there is a significant build-up.

Appendix C contains a list of coatings which are undergoing suitability testing.

ICE REMOVAL EQUIPMENT

Many types of ice removal equipment will not necessarily be available in the supply system. In some instances, more lead time will be needed to acquire items.

Since battling ice is an area open to human ingenuity, ice removal equipment should include but not be limited to the equipment listed in Table 3-1.

DEICING MATERIALS

Use of salts and chemicals for ice melting is common practice. (Chemicals are effective in that they depress the freezing point of water, causing the ice to melt at much lower temperatures.) Common freezing point depressants are rock salt, calcium chloride, ethylene glycol, ethanol, urea and approved liquid runway deicer.

Figure 3-1 is a graph of the freezing point of some commonly-used ice melting solutions. This graph shows the percentage requirement for each chemical needed to produce a given drop in freezing point. Depending on the chemical, a minimum freezing point will be reached where adding additional chemical will produce no further change. Ethylene glycol and calcium chloride are very effective at low temperatures. To a temperature of -5°F, common salt (sodium chloride) closely parallels calcium chloride. This fact is significant from a cost standpoint since calcium chloride is more expensive than salt. The line for urea shows that on a pound-per-pound basis, it is not as effective as the salts, but is less corrosive.

In addition to their effects on the freezing point of water, these chemical compounds have other properties which affect their use.

- Ethylene glycol creates a very slippery surface and utilization should be after consideration of availability of alternate products.
- Calcium chloride can produce irritation or burns when in contact with eyes, mucous membranes or skin. Dust can be harmful to the lungs. Heat is produced when it comes in contact with water which can cause spattering of acidic solution.
- All the salts are corrosive to metals. Urea is relatively non-corrosive and is often used around aircraft. Urea gives off ammonia gas which may cause corrosion of copper alloys.

Table 3-1 Ice Removal Equipment

ITEM	QUANTITY(1)	SOURCE
Baseball Bats*	48	Sporting Goods Stores
Brooms, Fiber	30	Serve Mart or Commercial
Brooms, Wire	30	Commercial
Hose Lay, steam deicing, 3/4 x 50 feet	2, when steam source is available	1HS0000-LL-CJ6-9113
Mallet, Nylon*	12	9N-5120-00-239-3399
Mallet, Rawhide* (2)	12	9N-5120-00-222-2220
Mallet, Wooden* (3) (4)	12	9N-5120-00-926-7116
Portable Hair Dryers (For spot thawing - Do not use on glass)	2	Commercial
Portable Heat Gun (Use Hair Dryers above if cannot obtain)	2	1HS0000-LL-CJ7-1299
Sand, sharp, 100 pound bag	10	Commercial
Shovels, steel, grain scoop - use as alternate or in combination with snow shovels below	24	9Q-5120-00-224-9326
Snow Shovels	24	9Q-5120-00-494-1685
Special Ice Footgear	20 pair large 20 pair medium	Bass Pro Shops "Korkers" or equal
Steam Lance	1-2	Ship Manufacture

(1) The quantities listed above are based on the anticipated needs of a CG 47 class cruiser and are rough estimates only.

(2) Rawhide Mallet listed: Round head cross section; 2.75 inch nominal face diameter; 4.75 inch nominal head length. Two smaller sizes shown in Illustrated Listing under FSC 5120.

(3) Wooden Mallet listed: Round head cross section; 6 inch nominal face diameter; 8 inch nominal head length. A number of other sizes are available. Check Illustrated Listing under FSC 5120.

(4) Rubber Mallets also available listed under FSC 5120.

*Impact devices require extreme care in their use to avoid damage to the underlying equipment/structure.

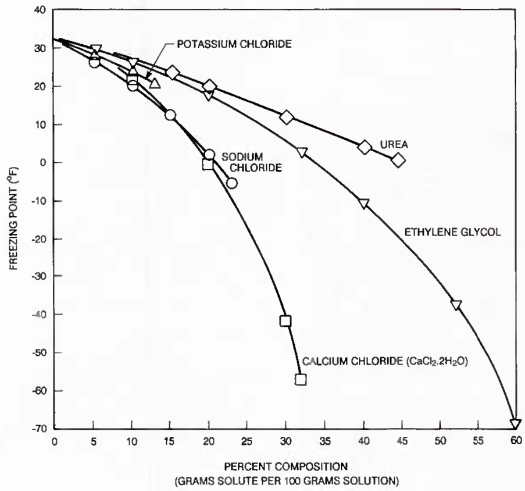


Figure 3-1 Freezing point of aqueous solutions.

When ordering chemical supplies it is important to remember that they are slow acting (they just lower the freezing point) and huge quantities are needed to completely melt relatively little ice (Figure 3-2). Chemicals are just part of the ice removal effort. The main idea is to keep a melting layer at the snow-/ice- to-deck interface. This will facilitate easy removal by mechanical means. Order large salt grains, if possible, since small grains will not easily penetrate down to the deck when applied on an ice/snow layer.

Table 3-2 lists some deicing materials available in the supply system in various quantities and forms. Information and stock numbers can be easily found in the IL by looking under FSC numbers 6810 and 6850.

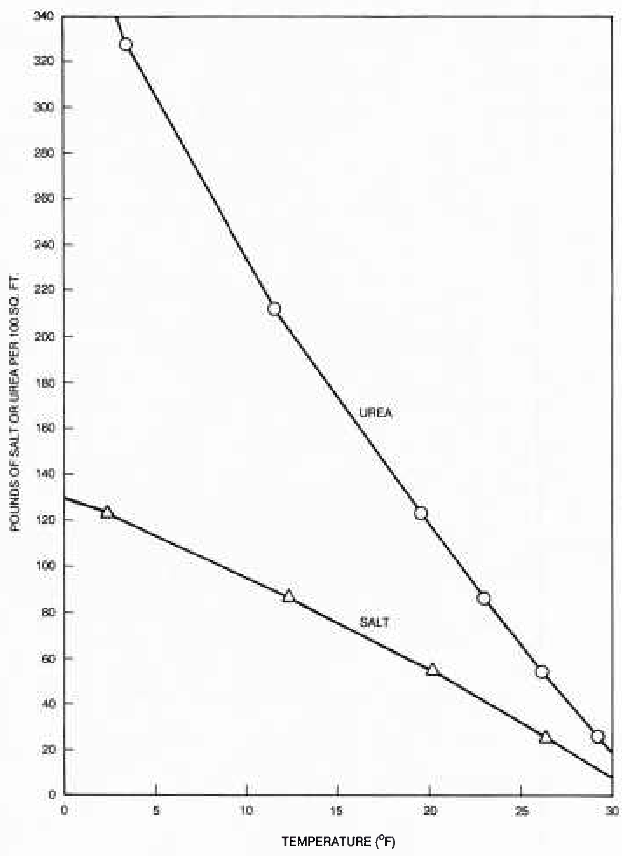


Figure 3-2 Weight of solute to completely melt 100 sq. ft. of 1-inch dense FW ice.

Table 3-2 Deicing Materials

ITEM	QUANTITY(1)	SOURCE
Calcium Chloride, flake, 30 pound pail	15	9Q-6810-00-656-1036
Denatured Ethyl Alcohol*, 1 pint bottle	4	9G-6810-00-201-0906
Ethylene Glycol (2), 1 gallon bottle	20	9G-6850-00-181-7929
Ethylene Glycol, 5 gallon can	20	9G-6850-00-181-7933
Ethylene Glycol (2), 55 gallon drum	2	9G-6850-00-181-7940
Fog/ice preventive compound, 1 quart bottle	4 quarts	MIL-STD-1210B
Garden Sprayers (Fill with ethylene glycol)	12	Commercial
Isopropyl Alcohol (3), 1 gallon can	10	9G-6810-00-286-5435
Rock Salt, coarse, 100 pound bag	20	9Q-6810-00-227-0437
Safety Equipment for handling Calcium Chloride: Rubber Gloves Rubber Boots Safety Goggles	 20 pair large 20 pair large 20 pair	 9D-8415-00-266-8673 9D-8430-00-262-8759 9G-4020-00-190-6432
Urea Pellets (4), 100 pound bag	3	9G-6810-782-6521
Deicer, 55 gallon drum (5)		MIL-D-83411A 6800-00-237-4304 9G-6850-01-234-3397

(1) The quantities listed above are based on the anticipated needs of a CG 47 class cruiser, and are rough estimates only.

(2) Ethylene Glycol is slick and oily. When used on decks it hinders ice build-up and makes ice removal easier, but can be very slippery and difficult to remove in cold weather.

(3) Isopropyl Alcohol is excellent for window cleaning and reducing window icing. It leaves no residue on the glass.

(4) When used on flight decks, pellets or large granules could become missile hazards or drawn into intakes.

(5) One gallon covers approximately 500 square feet.

*Flammable.

LINE MATERIALS

Frost and ice may cause breakage of small steel wire rope. The ship should carry extra supplies of essential small diameter steel wire rope.

Ships operating in Arctic waters should be equipped and ready to tow or be taken in tow, since operations in ice can be hazardous to propulsion appendages. An adequate length of towline in good condition and of proper size should be available.

The severity of the weather will necessitate carrying additional life and safety lines. In past exercises it has proven useful to make up additional lines before reaching Arctic waters.

Natural fiber lines, such as cotton and hemp which soak up water, will be difficult to handle when the water freezes and should be avoided, where possible. Polypropylene and polyethylene lines pick up little water, but can become stiff and brittle in the cold. Nylon and dacron lines, particularly the braided type, pick up more water but remain relatively easy to work.

Information for all lines can be found in the IL under FSC 4020.

STOWAGE AND DISTRIBUTION OF COLD WEATHER SUPPLIES

Plans will need to be made to accommodate additional cold weather supplies described above. Available spaces and lockers should be identified in advance. Some items may have to be relocated or left behind to make room for necessary cold weather supplies.

Smaller ships will probably not have room without making changes in compartment use or leaving other things behind. Choosing the space(s) to store the gear involves consideration of the volume taken up, organization of the items stowed, and with a minimum of difficulty, access by those who need the supplies.

Issuing items in advance is another method which makes the gear more readily available for use. Individual stowage facilities may lack the additional capacity for bulky cold weather items. A third option is to provide ready-issue type stowage using appropriate stowage aids. The gear is then presorted and easy to access.

Navy requirements for stowage and stowage aids are found in Gen Specs Chapters 670 and 671. NAVSEA has also developed Design Data Sheets (DDS) which give more detail.

Personnel protective gear will require the most stowage space. The gear is bulky and comes in multiple parts and different sizes. A one-piece exposure suit will take up approximately 2 cubic feet. Typical jackets, trousers and boots will use up approximately 1 cubic foot. Usual stowage for personnel cold weather protective gear includes B bins (NAVSEA DWG 804-4563098) and Type A lockers (NAVSEA DWG 805-1626365).

As a general guideline, a ten percent increase in food consumption will be experienced, so more space may have to be allotted for food storage. Additionally, quick energy, snack-type food will be in greater demand. Most ships make these items available via the ship's store, vending machines and/or snack bar. These outlets will need to identify this food as it comes in and make room for it in their associated storage areas.

Drums, bags and bottles of antifreeze, deicing and ice accretion prevention chemicals will be bulky and heavy and some will need to be kept dry. Space will be needed for stowage of sand used on deck which will likely come from the supplier in 50- or 100-lb. bags. Space and secure mounting will be needed for 55-gallon drums. Ice removal tools take up relatively little space, but come in a range of difficult-to-stow shapes and dimensions. All items should be kept as near to topside areas as possible, stored for ready access.

SHIP SYSTEMS REQUIREMENTS

The widespread effects of cold weather operations on ship systems will require division level, watchstation and general ship's force training.

Division training should address preparations and effects particular to the spaces and equipment under that division's cognizance.

Technical publications, MRCs and operating instructions should be reviewed.

Training sessions for specific watchstations will enhance ship's readiness and decrease the chances of casualties due to personnel error. Many systems will be in unfamiliar line-ups and/or will require unfamiliar operating procedures. A good example of this situation is the firemain. External connections will need to be isolated and drained or kept on a trickle flow. Hoses and fittings will likely be stored inside to prevent being carried away by the sea, as is common in the Arctic. Additionally, dead ends or low flow spots such as magazine or cargo storeroom sprinklers on the firemain should be watched closely to prevent freezing. If sprinkler systems need to be isolated and drained, damage control personnel will need additional training briefing. Ship compartmental bills will need to be updated to reflect new cold weather line-ups.

General training from the captain to the new seamen will be needed because of the complex interrelationships and interdependencies of warship systems. For example, during a drill or casualty involving loss of electrical busses, an awareness should exist that certain cold weather critical circuits and equipment may be lost. Many circuit breakers, such as those in weapons heater circuits, require manual reactivation of the system after a power interruption. Other examples include the need to emphasize the extra time required to operate topside items, need to secure plumbing and problems which can result from condensation.

LUBRICANT CHANGEOUTS

Some shipboard equipment may need to have the normal lubricants or other fluids replaced by cold weather materials before the ship enters the cold weather environment. The technical manuals and PMS Maintenance Requirements Cards (MRCs) for each system or component should be consulted to find the specific materials recommended for that equipment.

Most of the lubricants and hydraulic fluid authorized for use in shipboard equipment are described in NSTM Chapter 262 and/or MIL-HDBK-267 (SH). These documents describe the general applications and limitations of lubricating greases, lubricating oils, hydraulic fluids and miscellaneous lubricants used aboard ship under all temperature conditions. For reference, the names, specification numbers, intended usage, minimum operating temperatures and NSNs of those materials most suitable for use at low temperatures are provided in Appendix B of this Handbook.

In general, the lubricating greases and oils prescribed for normal service in most shipboard equipment (except for diesel and gas turbine engines) are also satisfactory for operation at low temperatures. Consequently, the installation of special cold weather lubricants is usually not necessary for operation above -20°F. In special cases where equipment operation at temperatures consistently below -20°F is anticipated, lubricant recommendations should be requested from NAVSEA Code 05M.

The petroleum-based hydraulic fluids that are normally used in most exposed systems are also capable of operating at temperatures down to -20°F. In very special cases where operation at lower temperatures is required, the petroleum-based fluids may have to be changed to a synthetic or partially synthetic based material. This should not be done unless specifically authorized by NAVSEA Code 05M.

In cold weather, diesel engines and gas turbines may experience plugging of fuel filters and other fuel system problems when using Naval distillate fuel (NATO symbol F-76). In very cold weather, this fuel may congeal making the engine inoperative. When diesel engines and gas turbines are exposed to temperatures that consistently fall below 32°F, aviation turbine fuel (JP-5) should be used instead of Naval distillate.

At temperatures below 32°F, the lubricating oil normally used in shipboard diesel engines (MIL-L-0900) becomes too viscous and may cause hard starting and sluggish performance. This oil should be replaced with MIL-L-2104 Grade 10 when ambient temperaures drop below 32°F and JP-5 is used as fuel.

ANTIFREEZE INSTALLATION

Before entering cold weather, all liquid cooling systems containing water should be checked for proper antifreeze content. Again, consult the cooling system technical manuals for type and quantity of antifreeze to use.

BATTERY MAINTENANCE

Storage Batteries

Periodic maintenance procedures for batteries are the minimum requirements for cold weather operating conditions. Prior to leaving on an extended cold weather cruise, all of the PMS requirements (i.e., daily, weekly, monthly, quarterly and semi-annually) should be completed. Batteries which are found to be in poor or marginal condition will need to be replaced. Detailed PMS requirements are set forth in Appendix F.

Dry Batteries

Dry batteries cannot be recharged and should be discarded after their useful output has been exhausted.

Since dry batteries deteriorate even when not in use, storage conditions which minimize deterioration will need to be provided. Where possible, dry batteries should be stowed at temperatures less than 35°F. When refrigeration is not available, dry batteries should be stowed in the coolest available space not subjected to excessive dampness or large temperature fluctuations. Any battery taken from refrigerated storage should be allowed to warm up to between 65° and 80°F before use to obtain maximum capacity.

If it is anticipated that dry-battery operated equipment will be idle for two weeks or longer, the batteries should be removed from the equipment to prevent the possibility of rupture or expansion, thus making its removal difficult. Batteries that have been extensively used should be removed and scrapped.

CHECK OF WINDOW HEATING AND WASHING SYSTEMS

Windows on the bridge and other locations are equipped with electrical heaters for defogging, defrosting and deicing. Before encountering cold weather the heating systems, especially the heater control systems and window temperature sensors, should be checked. Malfunction of heater control systems could cause overheating and consequent delamination or cracking of the glass, as has occurred on previous cold weather deployments.

Heated bridge windows are usually equipped with window washers to prevent their being obscured by salt. These systems should be functionally checked prior to operating in cold weather. Filling the window washers with a 50/50 water/methanol mixture will prevent the washer system from freezing and will be an effective window deicer. The window heaters should be turned on well in advance of turning on the windshield wipers to ensure the wipers are not frozen in place.

HEATING, VENTILATION AND AIR CONDITIONING SYSTEM (HVAC) CHECK OUT

Before entering the cold weather environment, the following HVAC preparations should be carried out:

- Perform all required preventive maintenance on the HVAC system. Hydroblast the A/C unit condensers, inspect and clean the heat transfer surfaces of steam heating coils and electrical heating elements. Check the operation of all heating system thermostatic controls. Test the heating system for operation at maximum design output.

- Inspect and clean all air filters. Ensure that the dirt load indicator meters in the air conditioning recirculation ducting (if installed) are working. Adjust the ventilation system to maintain a slight positive pressure within the ship to minimize the infiltration of outside air.

- Check insulation installed on the inside of bulkheads or overheads which are exposed to the cold weather. Replace or repair any damaged or missing insulation to help maintain acceptable interior space temperatures.

- Supplementary heaters may be installed in spaces where the heating capability of the HVAC system is insufficient to maintain acceptable temperatures. Ensure that high amperage portable heaters are not wired to the same circuit breakers as vital electronic equipment.

- To minimize the infiltration of cold outside air, check to ensure gasketing material on all doors, hatches and other openings is in good condition and free of paint.

- Provide briefings for ship's force to familiarize them with the problems and procedures for operating the system in very cold weather.

- To ensure that the HVAC system distributes heating evenly throughout the ship, set all thermostats at 68°F.

- In unheated spaces where the temperature is likely to fall below freezing, chilled water lines and coils should be drained or equipped with commercially-procurable electrical heat tapes (using manufacturer's installation instructions to prevent damage).

FLUID SYSTEMS

Before embarking on a cold weather cruise, all temperature control valves in the seawater service system and firemain system need to checked to ensure that when the valve is fully closed the seawater flow is effectively shut off. The pressure regulator valves should be checked to ensure they are able to maintain proper pressure conditions at low seawater flow rates. All bypass valves installed in parallel with temperature control valves, pressure regulating valves or flow control orifices need to be effectively leaktight when closed. Any valves found to be in poor or marginal condition should be overhauled or replaced.

Some auxiliary system heat exchangers and piping containing freshwater or seawater are located in unheated or inadequately heated spaces where the surrounding air temperatures may fall below freezing. To prevent damage due to freezing, all such equipment should be drained of freshwater and seawater when not in use. Alternatively, electric heat tapes may be installed on the system, or the space can be heated with portable heaters.

Plumbing drains and overboard discharges above the waterline are likely to freeze in cold weather, especially those with intermittent discharge. Electric heat tapes may be used to protect the piping inside the hull from freezing, but ice may still form at the hull penetration. If possible, these discharges should be secured in very cold weather.

Air escapes, overflows and vent terminals for the ship's tanks may become covered and/or plugged with ice. Electric heat tapes should be installed on the overboard discharge piping inside the hull, whenever possible.

Potable water lines on the weatherdeck should be isolated and drained or covered with duct tape.

EXPOSED FIREMAINS AND FIREPLUGS

Exposed firemains and plugs must be protected from freezing when the ship is in cold weather. In general, there are four methods of protection:

- Provide continuous seawater flow
- Isolate and drain
- Isolate, drain and backfill with antifreeze
- Provide auxiliary heaters

If the firemain is exposed to the weather and must be kept charged, a small flowrate of water must be maintained continuously from the extremities of the system. One or more fireplugs can be kept open slightly and an old piece of fire hose may be used to carry the flow across the deck and over the side.

If it is undesirable to have seawater flowing continually from a fireplug, the fireplug can be isolated by closing an isolation valve inside the ship, then draining the fireplug and exposed piping, using existing drain lines or fittings. Compressed air can be used to blow out lines which cannot otherwise be drained. The isolation valve must be absolutely leaktight to maintain the piping in a dry condition. If it is not leaktight, it should either be overhauled or the drained line between the isolation valve and the fireplug must be filled with antifreeze (equal parts ethylene glycol and water). The fireplug should then be tightly capped to ensure the antifreeze is not gradually forced out of the fireplug.

A fourth method of protecting a fireplug from freezing is to install auxiliary heaters such as steam tracing or electrical heat tapes. This approach is probably less reliable than the others since the fireplug could freeze and rupture if the heaters fail or are accidentally de-energized.

Other measures which should be taken to prepare the exposed fireplugs for cold weather conditions are:

- Procure extra fire hoses, operating tools and covers for exposed fireplugs.
- Store fire hoses and fireplug operating tools in a heated space near the fireplug.
- Those fireplugs which may become ice covered should be equipped with covers to facilitate deicing.
- Stow tools for removing ice from exposed fireplugs inside the ship near the fireplug.
- Train fire party personnel to operate a fireplug in its prepared condition. Several of the party should be familiar with the location and procedure for opening the fireplug isolation valve. All personnel should know the location of the fire hoses and related equipment.
- Check exposed fireplugs and associated equipment frequently in cold weather to ensure they remain operable. Periodically verify that isolated and drained lines do not gradually refill with water.

EXPOSED EQUIPMENT/STOWAGE

The cold weather stowage of equipment in exposed areas may or may not be possible depending on the ship's loaded capacity and the equipment's operational, defense or emergency necessity. All items that are normally stowed on the weather decks that can be either moved to a protected area or can be weatherproofed in place should be taken care of prior to deployment. Those items that cannot be weatherproofed by changing lubricants, checking of the seals and proper maintenance will need to be monitored and deiced.

Exposed equipment cold weather measures are not limited to shipboard gear. Having a vehicle or aircraft down because of poor cold weather preparation or preventive maintenance can limit the ship's operational ability as much as having an inoperable gun mount or ASROC launcher.

Compartments adjacent to the outer bulkheads not included in the ship's heating system must be prepared for cold weather. Items which cannot tolerate freezing must be removed and stowed in heated spaces.

YELLOW GEAR

Operational yellow gear in cold weather is very important. Failure of vehicles which move aircraft equipment, supplies or ammunition could interrupt ship's operation.

Normal greasing, filter cleaning, electronics and hydraulic checks are extremely important. Just as essential are the use of fuel, oil and lubricants designed to allow the vehicles to operate effectively and efficiently in cold weather. The vehicle specification manuals will recommend the proper lubricant and oil grade, and the MPA should assist in the choosing of the correct fuel mixture. Open purchase of engine oil heaters or engine block heaters that are certified safe for shipboard use can also be considered.

The use of ether starting systems already installed on the vehicles or manual applications of ether to the air intake regions will provide the necessary cold weather starting assistance. Ether canisters should be stocked in sufficient quantities to ensure quick starts throughout the deployment. Excessive use of ether can damage the internal seals and gaskets of the engine. The engine may need to be overhauled in warmer temperatures after being started with ether.

CAUTION

Ether is a very flammable material and its use must be restricted to responsible personnel. Store ether in the paint locker.

Air tanks on all yellow gear vehicles should be drained daily. The air drain should be left open to allow all condensate to drain and to prevent freezing the air lines. Use of air dryers and their maintenance will be covered in vehicle maintenance manuals.

Cold weather affects pneumatic equipment as much as diesel or gas equipment or vehicles, so preventive maintenance and daily checks for moisture in the system need to be accomplished. Pneumatic systems should be fitted with dryer units which use methanol.

As noted earlier in this chapter, one of the most frequent problems with equipment or vehicles in cold weather is poorly maintained batteries. Proper water levels and a full charge will minimize problem starts in cold weather. The life of each battery should be checked prior to deployment, and any marginal batteries should be replaced.

Cold weather can cause severe stress on metal. Inspections of the yellow gear stress points, the fork lift carriage and points where hydraulic cylinders attach to the frame need to be completed to ensure no corrosion or stress fractures are evident prior to deployment.

NAVIGATION EQUIPMENT AND PREPARATION

Preparing to navigate in cold weather is essentially the same as for any other voyage, with a few additional requirements.

CHARTS

As with any operation, areas of required chart coverage will need to be identified. Chart availability for Arctic and Antarctic regions is not as extensive as for most regions of the world. Five sources for Arctic charts are:

Defense Mapping Agency
Hydrographic/Topographic Center
6500 Brookes Lane
Brookmont, Maryland 20315-0030

Catalogue of Nautical Charts
and Publications
Defense Mapping Agency
Combat Support Center
Washington, DC

Catalogue of Nautical Charts
and Publications
Queen's Printer
Ottawa, Canada

Catalogue of Admiralty Charts and
other Hydrographic Publications
Ministry of Defence (Navy)
London, England

For Barents Sea:

Norwegian Polar Institute
Rolfstangveien 12 PA
1300 Bearum, Norway

Mapping agencies of individual countries in or near the intended operating area can also be contacted.

ELECTRONIC NAVIGATION

All electronic navigation systems must be completely up-to-date on planned maintenance and tuned for optimum accuracy. Spare parts and consumables for PMS as well as spare parts for electronic navigation systems will need to be procured. Electronic navigation system antennas need to be prepared for cold weather in accordance with the guidance provided in this chapter. The maintenance technician for each electronic navigation system should review the maintenance status, operating condition, antenna preparations and spare parts status.

CELESTIAL NAVIGATION

The only special preparation for cold weather operations in the area of celestial navigation might be the procurement of an artificial horizon sextant if it is anticipated that operation will include the Arctic during Arctic night. The sextant can be used to obtain sightings to heavenly bodies when there is no period of dusk or natural horizon normally used for celestial sightings.

TRAINING

Training navigation, bridge watch and lookout personnel is important prior to navigating in cold weather. A sufficient number of people must be trained as lookouts and bearing takers to permit the frequent rotation of watchstanders during cold weather operations.

The effects of high latitudes on gyro and magnetic compasses and the importance of taking frequent azimuths to the sun to monitor gyro error and magnetic compass deviation will be important information for navigation and bridge watch personnel. The possible effects on Omega reception due to magnetic anomalies near the poles and variable signal attenuation over large bodies of ice should be reviewed. These topics are covered in more detail in Chapter 6.

WEATHER FORECASTING

The navigator should contact the Naval Polar Oceanography Center for procurement of Arctic region weather forecasting products.

The address is:

Commanding Officer
Naval Polar Oceanography Center
4301 Suitland Road
Washington, DC 20390

Address AUTODIN to:

NAVPOLAROCEANCEN
SUITLAND MD

The navigator should obtain the Navy/NOAA Joint Ice Center *Pre-Sail Information Booklet* prior to departure and review it to determine the types of weather forecasting products that would be most beneficial for the upcoming operation. The forecasting products, which are selected based on mission, location and time of year, should be formally requested by letter or message as directed in the Pre-Sail Booklet. The Joint Ice Center's *Ice Observation Handbook* will be extremely helpful with ice observations and log keeping.

The commanding officer, executive officer, navigator, OOD/JOOD, watchstanders and quartermasters should study the Pre-Sail Booklet to be familiar with the weather forecasting products. They should also be trained to watch for sudden changes in barometric pressure and wind direction and speed (the same indicators of impending weather change as in any environment) and to be prepared for the sudden onset of cold weather conditions that may be signaled by these indications.

COMMUNICATIONS

ANTENNAS/SENSORS

Spare antennas and insulators will be needed since it is likely that insulators and antennas will become damaged from heavy weather and/or ice. SPAWAR field commands have been of assistance in obtaining spare 35-foot fiberglass whip antennas and spare insulators.

A complete inspection and PMS of all antennas and topside equipment should be completed prior to Arctic operations to minimize need for personnel to work aloft in the actual cold environment. Following is a checklist for antenna inspection prior to cold weather deployment:

- Check operating mechanisms on all communications antenna safety switches.
- Check operating mechanisms on all antennas with lowering systems installed.
- Insulate anemometers as much as possible. Have at least two-per-ship hand-held anemometers available.
- Inspect wire antennas (HF broadband fans) and tighten turnbuckles, if required.
- Coat whip antennas with silicone to prevent ice build-up.

- Ensure that all antenna connectors are properly attached, taped and scotch-coated to prevent excessive transmission losses.

The WSC-3 FLTSATCOM antenna pedestal may freeze, preventing the antenna from tracking in azimuth. The following pre-deployment preventive actions may be helpful:

- Place a temporary heat strip around the pedestal.

- Place fiberglass insulation and a cover around the pedestal.

- Place desiccant bags inside the pedestal to absorb moisture.

- Rotate the antenna in azimuth/elevation every 30 minutes in the event of extreme icing conditions.

RECEIVERS/TRANSMITTERS

Overall Operation

Transceivers/receivers and other radio equipment should be brought up to technical manual standards prior to deployment. When not in use, portable transceivers and spare batteries should be kept inside heated spaces to prolong battery life.

Lengthy warm-up periods under no-load or light-load conditions are recommended. If equipment must operate in a cold ambient condition, the flow of cooling air should be judiciously restricted.

Weather Station Contacts/Frequencies

Reliable environmental support is essential to Arctic operations. As environmental data in the Arctic is sparse, it is recommended that a communications receiver be dedicated to copying the environmental broadcast. LMHH should be copied in the Norwegian Sea and LMOO in the Baltic. GMHH should be copied in the western North Pacific and GMOO in the Bering Sea/North Pacific.

Auroral Zones and RF Interference

Zones of extreme RF interference and "electronic storms" become increasingly prevalent and severe in higher latitudes. Such "auroral zones" are due to charged particles ejected from the sun and deflected by the earth's magnetic field.

It has been noted that the frequency and severity of electrical storms vary directly with the number of sun spots observed on the sun. Communications in high latitudes are affected both by electronic storms and ionospheric disturbances. In HF/MF frequency bands propagation becomes erratic; the highest usable frequency decreases and the lowest usable frequency increases. Transmitters and receivers will fade. At times, communications will black out completely and may remain out from a few minutes to several days. On the other hand, communications on VHF/UHF circuits may extend beyond line of sight. Radar may similarly be rendered useless for brief periods or its range extended by ducting.

A communications coordinating circuit should be included in all communications plans for cold weather. This circuit should be available for maintaining reliable voice and record circuits. The coordination circuit should be covered using Parkhill (HF) and Nestor (UHF/VHF) or Vinson (UHF/VHF) cryptographic systems. Frequency changes will be numerous and a communications coordinating circuit will be invaluable in providing direct coordination to maintain full-time circuits. The use of a geo-stationary satellite coordination net south of latitude 75°N, or a polar-orbiting satellite should also be considered.

UHF Communications

Effective UHF ranges are significantly reduced. During heavy snow, absorption and fading are common, further reducing UHF ranges. With unrestricted visibility conditions maximum UHF ranges may be 15-16 NM; when visibility is reduced to 1-2 NM, UHF ranges may be reduced to 10-12 NM.

Few incidents of apparent UHF blackout have been noted. On some occasions, however, UHF communications may be good with a ship

10 miles away while there is no ability to communicate with a closer ship.

Satellite Communications

In the case of UHF SATCOM broadcast and Low Data Rate (SS-101) circuits, minor reception problems may be noted in daytime while significant interference may occur at night, particularly between the hours of 1900-2100Z.

A major concern is the potential for the satellite receiver antenna to freeze. Communications which depend on satellites in geostationary equatorial orbit will be degraded above 70°N because the satellite is near or below the horizon. Affected circuits are UHF FLTSAT broadcast, UHF SATCOM SEVOX and teletype circuits.

SEA ICE

The navigator will need to contact the Naval Polar Oceanography Center for sea ice location information. The addresses and the *Pre-Sail Information Booklet* are the same as for weather forecasting information detailed earlier in this chapter. The commanding officer and navigator will need to review the Pre-Sail Booklet to determine which sea ice information will best serve the ship's purposes. Sea ice products should be formally requested from the Naval Polar Oceanography Center either in writing or by message.

Training will be required prior to operating in or around sea ice since it will be new to most navigation and bridge watch personnel. The commanding officer, executive officer, navigator, all OOD/JOOD, navigation and lookout watchstanders must be trained to recognize the approach of sea ice and to distinguish between the various types of sea ice and their differing degrees of damage potential for the ship. This is covered in detail in Chapter 4. Trained ice observers and forecasters are available from the Naval Polar Oceanography Center as ship riders for any ships anticipating operating in the Marginal Ice Zone (the MIZ is defined as the region from where any floating ice is first encountered to a point where solid ice exists. The MIZ can encompass from several miles up to 50 miles, depending on wind and currents). A pre-sail briefing is also available upon request.

UNDERWAY REPLENISHMENT

TRAINING

Before a cold weather cruise, personnel should receive training on special aspects of cold weather UNREP operations, including:

- Cold weather hazards of hypothermia and frostbite
- How to function in special cold weather clothing
- Proper relieving procedures
- General cold weather UNREP operations

PREPARATION FOR UNREP

As a preventive measure, covers for deck equipment should be provided, where possible, to reduce the penetration of water and subsequent formation of ice.

Because of cold weather effects on UNREP equipment, more time and manpower must be devoted to getting the equipment ready to begin UNREP operations.

- Ice and snow must be removed from covered and uncovered equipment, including decks and hatches.
- Covers must be removed and stowed.
- Deicing chemicals will be needed to remove ice from equipment and decks.
- Equipment must be started and operated at low speed to check for proper operation and to allow warm-up prior to full speed operation.
- Batteries must be fully charged.
- The non-skid surface should be extended to cover as much deck area as possible.

The technical manuals for all UNREP equipment exposed to the weather should be reviewed to determine what cold weather lubricants and hydraulic fluids will be needed.

Some specific preparations:

- Grease wire ropes and sheaves.
- Put cold weather hydraulic fluid in winches and cold weather lubricating oil in the winch gear boxes.
- Drain the water and purge the moist air from compressed air systems to prevent freezing of on-deck pneumatic equipment. Check air dryers to ensure that the dew point temperature of the compressed air is maintained within the proper range.
- Make room below decks to store all small equipment and fiber ropes used during UNREP operations. Break equipment out when needed and replace it below when the operation is completed.
- Procure winch covers to protect UNREP equipment from spray and to facilitate deicing without damage to equipment by ice removal tools. These covers should be part of the ship's "Cold Weather Kit."
- Check the gaskets in refueling probes and bellmouths to preclude leaks during refueling operations. Stock extras because gaskets may become brittle and crack in cold weather.
- Stock a large supply of chemlites because they will lose intensity after an hour or two in cold weather, and because of the reduced number of daylight hours.
- Stock alkaline flashlight batteries rather than the ordinary cells. Alkalines are degraded less by cold temperatures.
- Fiberglass reinforced plastic traction mats may be obtained which give effective traction even when partially iced over.

WEAPONS SYSTEMS PREPARATION

To keep the ship's weapons ready in the cold, preparations must be made before the ship enters the cold:

- Check weapon technical manuals for specific cold weather requirements.
- Check the condition of weapon mechanical systems.
- Make certain that weapon anti-icing systems are working properly.
- Identify equipment which requires removal from the weather. Identify systems which will require water-resistant covers if they are to remain in the weather. Prepare or procure the necessary covers.
- Change fair weather oils and greases to cold weather oils and greases.
- Prepare a schedule for routine operations, such as for rotating machinery, including preventive maintenance. Particular care should be taken to expose personnel to the weather only when necessary.
- Prepare a plan for ammunition handling, with special regard to shorter crew work shifts and alternate access paths inside the ship. These evolutions should be performed to the maximum extent possible during periods of relatively calm seas and warm weather.

WEAPONS MECHANICALS CHECKLIST

- Check all weapons for water tightness.
- Make sure that window heaters work.
- Make sure that installed heater systems can maintain hydraulic fluid temperatures above 60°F and identify those which will require supplemental heaters.
- Check all fluid systems for leaks.

- Identify those spaces, such as magazines, which require additional heating or insulation for piping, such as for magazine sprinkling systems.

ANTI-ICING SYSTEMS

Missile launchers and gun mounts are provided with anti-icing systems, listed in Table 3-3 and Table 3-4, respectively. These tables show the equipment covered by each type of anti-icing system. The anti-icing systems are designed to keep weapons operating in temperatures down to -20°F with a 40 knot wind and snowfall at a rate of 6 inches per hour. (The Mk 75 76mm/62 cal. gun anti-icing system is designed for a 1-inch-per-hour snowfall.) By preventing ice build-up, anti-icing systems allow a weapon to be fired without first having the ice cleared off. In order to prevent ice build-up, these systems must be continuously active throughout operations in cold weather.

Electric blankets and heating element type anti-icing heaters use electrical resistance to produce heat. Steam heaters use steam to heat ethylene glycol which is then distributed. In immersion type anti-icing heaters, ethylene glycol is heated and distributed. The weapons technical manuals should be checked for the correct operating procedures for the heaters and for the correct ethylene glycol mixtures to use, if required.

If an anti-icing system is not provided for a gun mount, it will be necessary to remove any accumulated ice before firing the gun.

Harpoon canisters and SRBOC launchers need to be protected from direct ice formation with water-resistant covers. The openings in gun mounts exposed to the weather need to be covered to prevent ice formation inside the mounts. Separate covers for gun sights and breeches should also be available. Exposed hydraulic lines, high pressure air piping, gas ejection piping and electrical cabling should be wrapped so the covers do not interfere with the movements of the gun mount.

Exposed torpedo launchers should be covered to protect the breech, training mechanism and muzzle doors from direct ice formation.

CAUTION

If cold weather covers are installed on the launching system, always ensure the covers are removed before firing the weapon.

LUBRICATION

Under cold weather conditions, certain lubricants prescribed for normal use in warmer temperatures tend to congeal and cause unsatisfactory operation. In general, lubricants aproved for use in ordnance service should meet specification requirements at temperatures down to 10°F. For cold weather service, the lubricants in some ordnance equipment should be replaced with a suitable low temperature lubricant. The cold weather re-lubrication of ordnance should be completed before temperatures drop to 0°F. However, if cold weather is encountered before re-lubrication has been completed, special methods for removing the congealed lubricant must be employed, as described in Chapter 6.

GUN MOUNTS

Mk 75 76mm/62 Cal. Gun

The Mk 75 gun mount has a seawater cooled gun. The gun cooling water should be drained to prevent its freezing inside the gun jacket.

CIWS

CIWS weapon mounts without the Mk 156 or Mk 157 maintenance enclosure conversion kit installed have the gun barrels, ammunition belt and heat exchanger exposed to the elements. Covers must be provided for the gun barrels and exposed ammunition to prevent direct ice formation.

The cooling water flow to the heat exchanger must be regulated to maintain fluid temperatures within required limits. Mounts with the bypass valve installed under ORDALT 15185, ECP 4270 will have automatic regulation of coolant flow. Mounts without the valve will require manual flow regulation. If it is impossible to maintain temperatures above the required minimum, or the CIWS mount is deactivated for maintenance, the cooling system should be secured and the heat exchanger should be drained.

Table 3-3 Launcher Anti-icing Systems

LAUNCHER	SHIPS	ANTI-ICING METHODS	ANTI-ICING LOCATIONS	POWER
Mk 10	CGN 9, 25 CG 16-24, 26 DDG 37-46	Steam Heat (Ethylene Glycol)	Guide Arm Dud Jettison Area Blast Door Stand Seal	340#/hr Steam 25-50 PSI 1.5 KW
Mk 13	CGN 36-37, DDG 15-24, 31-36	Steam Heat (Ethylene Glycol)	Guide Arm Base Rind/Blow Out Hatches Blast Door Trunnion Supports	340#/hr Steam 1.5 KW
Mk 13 Mod 4	FFG 7 class	Immersion Heaters (Ethylene Glycol)	Guide Arm Base Ring/Blow Out Hatches Blast Door Trunnion Supports	101.5 KW
Mk 22	FFG 1-6	Steam Heat (Ethylene Glycol)	Base Ring/Blow Out Hatches Blast Door Guide Arm	340#/hr Steam 25-50 PSI 1.5 KW
Mk 26	CGN 38-41, CG 47-51, DDG 993-996	Steam Heat (Ethylene Glycol)	Guide Arm Platform/Blast Door Stand Seal Blow Out Hatches Dud Jettison Area	340#/hr Steam 25-50 PSI 1.5 KW
Mk 29 NATO Sea Sparrow (Mk 132 Lnchr Box)	Carriers, Destroyers, Frigates, Amphibious Ships, Auxilliaries	Internal Heater Heating Strips	Inside Launcher Box Box Seals	
Mk 41 VLS	CG 52 and follow, DD 963 class	Heating Elements	Cell Hatch Cover Cell Hatch Hinge Uptake Hatch	192.5 KW
Tomahawk ABL	BB 61-64, DD 963 class	Ship's HVAC Heating Strips	Inside Launcher Box Box Seals	

Table 3-4 Gun Anti-icing Systems

GUN	SHIPS	ANTI-ICING METHODS	ANTI-ICING LOCATIONS	POWER
Mk 42 5"/54 Cal	DDG 2-24, 31-34, 37-46, DD 931-951, FF 1052-1107	Heating Elements Immersion Heaters (Ethylene Glycol)	Base Ring Gun Port Shield Case Ejector Door	18.2 KW
Mk 45 5"/54 Cal	CGN 36-41, CG 47 class, DDG 993-996, DD 963-992, 997, LHA 1-5	Electric Blankets Heating Elements	Base Ring Gun Port Shield Case Ejector Door	14.2 KW
Mk 75 76mm/62 Cal.	FFG 7 class, PHM 1-6	Heating Elements	Base Ring Gun Port Shield	5.8 KW

Note that these protective measures will severely limit the CIWS' availability in the cold weather region. If it is to be fired in cold temperatures, the mount should be activated well in advance of (at least two hours prior to) the expected time of operation to allow the electronics package to reach thermal equilibrium.

MISSILE LAUNCHERS

Mk 13 GMLS

The launcher can operate in temperatures as low as -84°F. The window is heated, but the lack of windshield wipers may cause visibility problems.

Harpoon

The harpoon canisters (Mk 140 and Mk 141) are unheated. Cold temperatures and ice may crack the canister seals and degrade the electrical connections inside the canisters. The canisters should, therefore, be covered with water-resistant covers.

Tomahawk Armored Box Launcher

The internal environment of the Tomahawk Armored Box Launcher (ABL) is maintained by the ship's HVAC system to prevent freezing of the missiles and the electrical connections. Seal heaters are provided to prevent icing and cracking of the box seals.

ASROC Launcher

The Mk 112 ASROC launcher HP air system should be secured. When subjected to cold temperatures, the moisture in the air will freeze, icing up piping and valves. Note that securing the air will lock the snubbers and the retaining latch, causing a delay while the air is reactivated before firing can commence. Ships with an ASROC direct reload capability must keep their reload doors deiced.

NATO Sea Sparrow

The NATO Sea Sparrow (Mk 132) Box Launcher is provided with internal heaters and deicers. These will prevent cracking of the box seals and icing of the missiles and launcher/missile electromechanical interfaces located at the removable rails.

FIRE CONTROL RADARS

Prior to entering cold weather, the antenna drive motors should be tested and lubricated with cold weather grease (MIL-G-238277: NSN 9G-9150-00-0985-7247). Grounding straps must be properly insulated with RTV compound. The old grease should be purged, and the cold weather grease should be applied before getting underway.

Inspection and PMS of antennas/topside equipment should be completed prior to Arctic operations to minimize the need for personnel to work aloft. Specifically:

- Check rotating antenna heater circuits and cooling systems.
- Verify weather tightness of exposed antenna components.
- Check illuminator deicing circuits. The only reliable indication that deicing is working is to send a man aloft to check.

Slow-moving mechanical parts such as shafts and bearing surfaces will operate more satisfactorily if the surfaces are buffed and polished. Such surfaces should be lubricated sparingly.

Oil in the pedestals of rotating radar antennas should be replaced with oil that will not congeal at low temperatures.

The radar antenna pedestal heater should be connected to a circuit that will remain energized when the radar set itself is disconnected.

The Mk 38 Mod 0 Radar Antenna Scanner (the stinger on the director) may ice over on the inner rotating axis, holding the scanner in the conical scan pattern and preventing the spiraling motion in automatic track mode. To plan for prevention of such an occurrence:

- Keep a coating of antifreeze, MIL-0-1-548 on the areas between rotating and non-rotating areas.
- Park the director at 180 degrees relative with elevation depressed during freezing conditions.
- Install a lightweight, non-reflective cover on the antenna, when Arctic operations are planned.

The AN/SPG-55B radar cooling system may leak some distilled water due to the contraction of the tubes caused by low seawater inlet temperatures. Methods of preventing this are:

- Add antifreeze to the cooling system.
- Drain the water from the system if the system is screened for any length of time.
- To maintain proper temperature in the AN/SPG-55B radar barbettes, reheat the interior air and recirculate.

TORPEDO LAUNCHERS

The Mk 32 SVTT torpedo launcher is provided with an internal heater to maintain the torpedo temperatures at an adequate level. The heater should be checked periodically to be sure that it is working. Also, air slugs should be fired periodically to prevent severe ice accumulation.

CHAFF LAUNCHERS

The SRBOC chaff launcher may be fired in freezing temperatures. A cover should be provided to prevent direct ice formation on the launcher. This protective measure will delay the firing of chaff. In addition, ready service lockers exposed to the weather should be routinely checked for icing of doors, locks and hinges.

SMALL ARMS

For reliable operation at low temperatures, small arms must be clean and properly lubricated. All traces of solvent used in cleaning must be removed before reassembly. Incomplete removal of bore cleaning solvent may result in the gun malfunctioning at low temperatures. If guns are to be stored after cleaning, a suitable preservative should be applied. Consult the weapon technical manual for the proper cold weather lubricant and preservative to use.

Oil should be applied sparingly. Never dilute lubricating oils with kerosene. Cold temperature tests have shown that gun operation at low temperatures is not improved by diluting oil. At temperatures warmer than -20°F, oil-kerosene mixture is not a satisfactory lubricant.

Guns rust rapidly from condensation when taken from the cold into a warm space. After guns reach the temperature of the space, they should be disassembled. Gun parts must be thoroughly dried, cleaned and lubricated. This procedure must be repeated every time guns are brought from the cold into a warm space. This can be minimized by allowing small arms to remain cold-soaked by stowing them in weatherproof containers in the ambient temperature or by stowing them in insulated containers to slow the warming process and prevent condensation when brought into heated spaces.

AMMUNITION

Ammunition must be kept in protected storage and at temperatures not below the minimum safe values prescribed for the explosives concerned. Warheads and fuses cannot be exposed to temperatures lower than -65°F. Any warheads which experience temperatures colder than this need to be set aside for return to an ammunition activity.

MISSILES/ROCKETS

Missiles should be stowed in the controlled environment of their magazine until immediately before firing. In extremely cold weather, or under icy conditions, a missile should not stay on the launcher for more than two minutes. Should this time be exceeded, the round should be struck below and another selected.

Propellants should be maintained at a temperature above 0°F. Rocket motors are subject to the same storage temperature requirements as smokeless powder cordite. Some rocket motors are susceptible to cracking if handled at low temperatures. Safe firing temperatures for rockets and jet-assisted takeoff (JATO) should be stenciled on the rocket motor or the JATO unit (representing the minimum temperature at which the rocket motor or JATO unit should be used and is not necessarily the current ambient air temperature). If the temperature of the JATO unit has been permitted to drop below the prescribed minimum, it cannot be considered safe for firing at any temperature.

Since not all magazines and weather deck ready service lockers are heated, wet ammunition should be wiped dry before it is stowed to prevent icing.

SPARE PARTS

Since cold temperatures increase failure rates, additional seals, plugs and O-rings for gun mount and missile launcher mechanical systems will be needed.

SURVEILLANCE DETECTION SYSTEMS

TOWED ARRAYS

Cold weather should not pose any major problems to the towed array systems. They are extensively tested to temperatures below what will be encountered in most cold weather operations. At most, a five-minute warm-up may be needed for the heading module. If possible, any work or fluids change-out should be done in an enclosed area. There are, however, some areas where extra care should be taken in the release and recovery of the arrays.

Like any rubber or plastic material, the rubber hose will tend to become stiff and possibly brittle in cold temperatures. If possible, the hose should be warmed before movement. There should not be any problems when the array is in the water because the water temperature will not drop below 28°F.

The hydraulic system release has a built-in heater and interlock that will not allow it to be used unless up-to-temperature. The fluid should be allowed to circulate until warm.

Cautionary notes:

- When retrieving the array in Arctic heavy weather conditions, and the tow line becomes slack, it can snap back taut very quickly, so extra care should be exercised.

- Towing an array or VDS in a floating ice region can be dangerous, since ice impacts can damage the array.

PRAIRIE/MASKER

The PRAIRIE/MASKER system contains a seawater cooler. When gas turbine ships use bleed air to preheat turbine intakes, the airflow available for PRAIRIE/MASKER systems is reduced; therefore, minimum deicing air should be used to maintain a proper ASW posture.

While navigating in waters with floating ice present, there is the chance of damage to the MASKER belts, especially at higher speeds.

ECM/ECCM

Specifications call for the AN/SLQ-32 antenna to operate with an ice layer no more than one inch thick.

SLQ-32 antennas should be operated with 60/40 glycol/water mix in the cooling system.

SONAR

Sonar domes should be full of saltwater, not freshwater.

Unheated or inadequately heated sonar spaces should be identified to determine which lines (air, cooling water, saltwater) could freeze and burst. The lines should be insulated, heaters installed or portable items subject to freezing moved to heated spaces. Examples include the SONAR/Switch Gear Room and the SONAR/Radar Cooling Gear Room.

Additionally, the following preventive measures should include:

- Verify operability of installed heaters.

- Ensure that hydraulic oil is maintainable above 60°F, obtain supplementary heaters or replace with low-temperature oil.

- Strive to maintain interior spaces water-free.

- SQS-26 sonar may develop condensation in the cooling system because of cold temperatures. Transmitters should be dried before applying full power.

RADARS (SURFACE SEARCH, AIR SEARCH, AIR TRAFFIC CONTROL)

Prior to entering the cold environment, antenna drive motors must be tested and greased. Grounding straps must be properly insulated with RTV compound.

Inspections and PMS of antennas/topside equipment should be completed prior to Arctic operations to minimize the need for personnel to work aloft. The rotating antenna heater circuits and cooling systems should be checked and weather tightness of exposed antenna components should be verified.

Slow-moving mechanical parts such as shafts and bearing surfaces will operate more satisfactorily if the surfaces are buffed and polished. Such surfaces should be lubricated sparingly.

Oil in the pedestals of rotating radar antennas should be replaced with oil that will not congeal at low temperatures.

Variable speed antennas should be operated at low speed for a short period before increasing rotation speed. Direction of rotation must not be changed, nor antenna rotation accelerated or decelerated rapidly, until gear trains and drive motors are thoroughly warmed. Installation of electric heaters in antenna pedestals is recommended.

During cold weather operations, all antennas should be left rotating with their pedestal heaters on. Some antennas may require three times the normal warm-up time if shut down.

AMPHIBIOUS OPERATIONS

The surface area of external bulkheads on amphibious ships is sometimes double that of other ships. This, naturally, will increase the demand on the ship's heating systems. Additionally, firemains and cooling drains are more exposed to cold weather elements.

EXTERIOR CRANES

Exterior cranes must be thoroughly checked for wear on all pivots and for stress cracks along the boom. A lift capacity test should be conducted prior to deployment if the certification of load capacity is scheduled to run out during or just after the completion of the deployment. Preventive maintenance should be completed and all lubricants, oils and grease should be changed to meet cold weather operating specifications. Cables, gears and gear rings need to be properly greased to prevent corrosion and all hydraulic or air lines must be inspected for leaks.

The following checklist will help in preparing the crane for deployment:

- Gauges
- Controls
- Direction indicator
- Boom angle indicator
- Platform
- Access ladder secure
- Hoist wire
- Topping wire
- Sheaves
- Slack wire device
- Interlock switches
- Electric brake
- Hook
- Machinery spaces
- Hydraulic unit
- Hoist/top/train brakes
- Cradle
- Fire extinguisher
- Storage pins
- Limit switches

TURNTABLES

Turntables on deck and below decks should be completely inspected for wear and maintenance. All areas that require greasing should be cleaned and filled with grease to prevent water from getting inside rollers or gears. All manual-operation equipment should be on site and in top working condition.

The following checklist will help in preparing the turntables for deployment:

- Electric brake
- Turntable wells
- Clutch for hand operations
- Limit switch for manual operations
- Hand crank for manual operations
- "T" wrench for manual operations
- Drive sprocket
- Machinery room, coupling/mount
- Turntable rollers

WELL DECKS

All planking and batterboards on amphibious ships with well decks should be in good condition and all illumination control lights should be checked for operability. The pumping system must be completely checked, all drains must be free of debris and when not in use, the pumps should be cycled periodically to ensure that the water in the lines is not freezing.

RAMPS

Ramps, both exterior and internal, must be inspected prior to deployment to assure there are sufficient traction bars. Traction between the bars should also be checked. Most of the exterior ramps will not be adversely affected unless there is severe icing which encompasses the entire surface. In such an event, large commercially-obtainable space heaters (Torpedo heaters) will do a quick job of clearing the ramps. The use of approved deicing solutions on ramps and decks will minimize the hazards of icing.

All ramp lifting mechanisms need proper lubrication to prevent water from damaging joints.

A complete electrical check should be conducted to make sure traffic lighting and other necessary control measures are operational.

The following checklist will assist in preparing the T-ween Deck Ramps for cold weather:

- Vehicle ramp electric brake
- Manual brake
- Winch controls
- Gypsy heads run independently at winch
- Stop limit switch
- Over travel switch
- Audible alarm
- Emergency hand gear for ramp
- Electric brake
- Stack cable interlocks
- Inflatable seal
- Ramp dogging mechanism
- Locking paw on winch
- Ramp hinges
- Winch wire ropes fall
- Traction bars on ramp
- Air exhaust mufflers
- Air filter on L.P. air system
- Electrical dogging system

The following checklist will be helpful in preparing the bow ramps and doors for cold weather:

- Guide rollers
- Track sensors
- Bow door actuators
- Bow door turnbuckles
- Securing pins to ramp
- Bow ramp traction bars
- Grease manifold (bow doors)
- Bow ramp room controllers
- Bow ramp p/s controller
- Outrigger
- Hand operated winch
- Bow ramp deployed
- Bow ramp seating fork
- Wires to ramp

GATES

The following checklist will assist in preparing the stern gate for cold weather:

- Stern gate controls
- Operational instructions
- Dogs greased and functional
- Emergency hoisting equipment
- Gasket
- Hoisting wires
- Hinge pins
- Access ladders
- Gasket retainer bar
- Marriage
- Alignment

Common sense and thorough preventive maintenance will provide the necessary insurance that all of the problems that could have been avoided, in fact, will be.

MARINE CORPS PREPARATION ASSISTANCE

The embarking unit is responsible for preparing its vehicles, equipment and personnel. Preparation of their equipment should not vary much from the overall ship's preparation. All gear and equipment should be stowed in a protected area, wherever possible. The remaining equipment needs to be weatherproofed.

Use of tarpaulins and plastic to cover vehicles and equipment will prevent the severe effects of at-sea icing. Vehicles should be parked to minimize surfaces exposed to the wind to prevent freezing.

The Marine Corps or any detachment will not bring items to protect them from shipboard icing or extreme cold temperatures unless there is also use for it during the land cold weather operation.

The ship is not responsible for the condition or preparation of vehicles and equipment of embarking units, but once onboard the vehicles and equipment become part of the ship's mission. At that point, the ship's crew should take preventive measures to ensure that the mission is successful. Early communication with embarking amphibious units to ascertain loading requirements, additional or restricted space, cold weather items, ramp gate or crane serviceability can greatly enhance the embarkation process.

AIR OPERATIONS

PROCUREMENT

Following is a list of suggested equipment that should be carried in extra supply and a brief explanation why it will be needed during cold weather operations. Chapter 6 provides more detail about air operations.

- More tie-downs and chains will be needed due to the high winds and sea states. The full 125% allowance should be obtained.
- Deicing fluid and equipment will be used much more frequently. (During recent expeditions, it was found that detergent dispensers work better and hold more than the backpack dispensers.)
- Materials needed for steam hoses, (hose, lance tips, valves and nozzles) will be used for deicing, thawing and additional spot heating. Areas on deck should be mapped out and enough hose and fittings to access those areas should be obtained.
- Materials needed for fabricating exhaust deflectors and plows, as well as snow shovels, will be needed for clearing the deck.
- The cold exposure can shrink O-rings, gaskets and unions in fluid systems. The leaks caused by shrinkage will necessitate having more replacement fluid. Rings, gaskets and unions should be aboard to replace cold-damaged items.
- Proper clothing will obviously be necessary. Workers on deck will be the most susceptible to frostbite. The clothing needed is detailed in Chapter 5 and Appendix D.

MAINTENANCE

Deck equipment will need to be properly tuned, due to rough cold starts, cold lubricating oil and extended periods of use. Any planned maintenance should be done in warmer temperatures, if possible. Antifreeze should be checked and changed, if necessary, and proper cold temperature oil installed. Batteries should be checked and replaced, if necessary. If radiator heaters are available, they will need to be installed as early as possible. Proper electrical power supplies, connectors and cables should be verified. Work that can be done ahead of time or in the hangar should be accomplished since it will take less time than in the cold.

On the flight deck, safety nets and hangar fittings should be lubricated with proper cold weather greases. If possible, the flight deck or designated areas should get a fresh coat of nonskid. Steam lines and connections that will be used for steam lances or heating should be checked to ensure their proper working order.

The cold temperatures shrink connections and can cause leaks in fluid systems. Any seals or joints on both aircraft and machinery that are known, or have a tendency, to leak should be replaced ahead of time. Brakes should be given particular attention.

The cold, dry air builds up static charges very quickly. Explosive gas mixtures will still exist at cold temperatures. All static electricity discharging gear should be checked and in good working order to prevent possible explosions or electrical shock.

Painting and corrosion work should be done before cold temperatures are encountered. The drying process will slow considerably in the cold and sealants can take days to dry.

PLANNING

The most important areas of concern for proper planning are flight deck operations and upkeep (preparation). Proper equipment for clearing the deck of snow and ice include shovels, plows, exhaust deflectors, steam lances and personnel.

The spotting arrangement and flight deck usage will be affected and will need to be modified. One section should be designated for deicing measures. More space will be needed between aircraft to facilitate both safe parking and work. Cat 4 may not be usable because of its closeness to the deck edge, leaving no room for error in slippery conditions. The bow cats may be susceptible to green water. Aircraft and support equipment will be less than the normal full complement.

Aircraft Alert programs will have to be modified to compensate for effects of cold weather operations. What needs to be done to keep aircraft at Alert 5 or Alert 15 will depend upon the air temperatures as well as the weather. Extra time may be needed in rough seas to turn the ship into the wind. Proper steps should be taken ahead of time to keep the aircraft and crew at their respective Alerts, including more frequent equipment starting and warming, additional cold weather clothing and, in extreme cases, personnel rotation.

Due to aircrew fatigue, two aircrews should be anticipated, trained and available ahead of time. This will facilitate rotation of crews to ensure safety and efficiency in aircraft operations. The maximum time for crew members on deck and directly exposed to cold weather conditions is generally no more than 30 minutes.

The airstaff should be aware of not only what and when weather situations may arise, but also the consequences and how they can be counteracted. More information on weather is contained in Chapter 4.

CHAPTER 4

RECOGNIZING AND PREDICTING COLD WEATHER PHENOMENA

METEOROLOGICAL CONDITIONS

GENERAL

We normally associate cold weather operations with operations in northern latitudes near or above the Arctic Circle. Much of the information provided in this Handbook is based upon experiences from operations in the Arctic Region. Cold weather can be experienced in latitudes far below the Arctic Circle as well. This Handbook, although designed for Arctic operations, applies also to Southern Hemisphere cold weather operations. The British experiences in the Falklands campaign where prolonged cold, damp weather directly contributed to many severe cases of trench foot and frostbite graphically illustrate the necessity of being prepared to operate in cold weather.

TEMPERATURES

Air

In general, air temperature over water is moderated by the stabilizing effect of the open water acting as a heat source. The temperature of air when in port, at anchorages or alongside piers will be considerably colder than over open water. Air temperature in the Marginal Ice Zone will, in general, be lower than the air temperature over open seas yet not as extreme as in-port air temperatures. During a cold weather exercise off the coast of Greenland it was noted that both air temperature and humidity dropped suddenly as a ship approached the MIZ. Figure 4-1 shows the MIZ, loosely concentrated.

During winter, Arctic temperatures drop far below freezing, and can remain as low as -30°F for days or weeks at a time. Mean air temperatures of below 0°F are not uncommon at the Arctic Circle during January.

As a matter of interest, the coldest temperatures in the Arctic are observed in the central region over the polar ice cap and on land well away from the ocean. The coldest temperature ever recorded, -90°F, occurred at Verkhoyansk, Siberia, U.S.S.R., near the Arctic Circle in 1957.

The mean annual temperature at the geographic North Pole is -9°F. Summer temperatures over the ice pack usually range between 32° and 36°F. The Antarctic is generally colder than the Arctic, because of its land mass and higher elevation.

A peculiar temperature characteristic common in the Arctic is the temperature inversion (temperature increases with higher altitudes above the earth's surface). As a result of this temperature inversion, a steady breeze in the

Figure 4-1 Typical MIZ, loosely concentrated.

Arctic tends to cause surface level air temperatures to increase as the breeze causes the warmer air at higher altitudes to mix with the normally cooler air on the surface.

Personnel can encounter cold weather effects such as hypothermia by prolonged exposures to air temperatures as high as 50°F if proper protective clothing is not utilized. Temperatures in this range may also have a minor effect upon ship systems, increasing the need for heating and decreasing the need for cooling from the ship's HVAC and cooling water systems.

The major cold weather effects for ship systems and the ship as a whole will not, however, set in until air temperatures approach freezing. With the addition of precipitation or sea spray, freezing or subfreezing air temperatures can result in topside icing. This, in turn, affects ship's stability, crew footing and ability to operate topside machinery or electronics systems with topside sensors or antennas. Mean air temperatures for selected Arctic areas in winter and summer are shown in Table 4-1, at the end of Chapter 4.

Water

The water temperature in the Arctic and Antarctic remains relatively constant at or near freezing all year long. In the Arctic open water near shore may reach 37°F during summer. The surface layer, known as Arctic water, down to 150 meters, remains near 29°F.

The seawater temperatures at which the cold weather effects become apparent vary for personnel and ship systems. Personnel can be adversely affected with seawater temperatures as high as 55° to 60°F. Personnel immersed in water at these temperatures for extended periods of time without protective equipment such as exposure suits will become hypothermic, a particular concern during UNREP or small boat operations. Persons accidentally entering the water must be rescued as rapidly as possible to prevent death by hypothermia.

Seawater temperature will never go below freezing (approximately 28.6°F) but near-freezing temperatures will have significant effects upon the operation of machinery which utilizes seawater as a cooling medium. The flow rate will have to be adjusted to compensate for increased cooling capacity due to low temperatures. Near-freezing seawater temperature may contribute to topside icing if low air temperature and sea spray conditions exist.

SEA STATES

Extreme latitudes in the Northern and Southern Hemispheres are known for rough weather. High sea states can be experienced frequently and for extended periods of time. These sea states contribute to deck wetness which, in turn, contributes to topside icing in freezing weather conditions. In the fall of 1985 U.S. Navy ships participating in SHAREM 62 exercises in Notre Dame Bay, Newfoundland, found 16- to 20-feet wave heights to be common.

WINDS

In the Arctic Region winds tend to be relatively light and consistent and are, typically, in the range of 8-10 knots. When stronger winds do occur in the Arctic they tend to persist for several days. Strong offshore winds may be experienced by ships operating near shore, particularly in the vicinity of mountains, as has been noted in the Beaufort, Chukchi and Bering Seas. Rapid changes in the weather and high winds have frequently been encountered in Aleutian operations.

Strong winds are a bigger factor in latitudes outside the Arctic and Antarctic Circles where cold weather is an operational factor. Strong weather systems which bring cold weather conditions tend to bring high winds as well. Ships caught by an Arctic weather system in the VACAPES operating area experienced 35-45 knot winds over a 12-hour period. These winds were a major contributing factor in the accumulation of more than 8 inches of topside icing on the ships. Rapidly developing low-pressure systems along the southwestern coast of Greenland occasionally produce winds of up to 60 knots. Trends and forecasts in northern latitudes need to be watched very closely since powerful, rapidly developing weather systems are characteristic. Further, because there are very few, widely separated reporting stations and satellite images are frequently obscured by cloud cover, northern latitude forecasts are less reliable than weather forecasts for most parts of the world.

Fast moving storms, called Polar Lows, are difficult to predict, result in high wind levels, frequently include snow and sleet and cause poor visibility.

BAROMETRIC PRESSURE

Monitoring the barometric pressure can help in predicting and recognizing the onset of cold weather conditions. By sensing the approach of a low-pressure system, the approach of a storm bearing low temperatures and high winds can be more easily predicted. A sudden drop in the barometric pressure should be taken as a warning that a storm—possibly with lower temperatures, higher sea states, high winds and precipitation—is approaching. Some very intense Arctic weather systems will approach so rapidly that detection by barometry will provide very little warning.

CLOUD COVER

Low widespread stratus clouds with a ceiling of below 1,000 feet are common in the Arctic Region, more so in the summer (70-90% of the time in July) than in winter (40-80% of the time in January). This frequent, heavy cloud cover significantly impairs the use of celestial navigation.

As a ship approaches the Arctic, weather observers should note a change in overall cloud heights. Due to reduced temperatures throughout the atmosphere the reduced height of middle clouds is especially noticeable. Cloud type may also change depending upon season and location. Special briefings for meteorological personnel by the Naval Polar Oceanography Center before any Arctic or sub-Arctic deployment is highly desirable. Percentages of cloud cover in January and July for selected Arctic areas is included in Table 4-1.

PRECIPITATION

The central Arctic Region receives very little precipitation and is classified as a desert based on annual precipitation. Precipitation falls during the summer months as a fine rain. Precipitation is heavier in some marginal seas in the Arctic Region, such as the southern Bering, and the MIZ receives a greater amount of snow and rain. Snowfall is rare, but when there is snowfall it accumulates, during the 9-10 months of subfreezing temperatures. The snow blows in the wind, giving the impression of greater snowfall than actually occurs and can reduce visibility to practically nothing.

Although there is very little precipitation in the central Arctic Region, precipitation often accompanies weather systems which bring cold weather conditions to the lower latitudes. Locally heavy precipitation occurs in the marginal seas but is usually of short duration. Rain, snow and sleet are all possible during cold weather conditions. All three forms of precipitation can contribute to a topside icing incident since the precipitation will freeze to the skin of the ship or to previously accumulated ice upon contact if the air temperature is at or below freezing. Mean monthly precipitation in winter and summer for selected Arctic Regions is shown in Table 4-1.

HUMIDITY

During the winter the Arctic atmosphere is very dry due to persistently low temperatures. During summer, even near the pole, some openings in the ice exist causing a flux of water vapor to enter the atmosphere. Still, due to relatively cold temperatures (30s) the specific humidity is low although relative humidity may be quite high. It has been observed that a sudden drop in humidity can signal the approach of the MIZ.

FOG

A high relative humidity is the major contributor to the formation of fog, since no condensation will occur unless the relative humidity is more than 90 percent. A light wind causes a gentle mixing action which tends to promote a deeper and thicker layer of fog. A very light wind usually generates a shallow layer only about 6 feet deep. Most fogs evaporate after sunrise.

Fog is possible when there is a large gradient between air temperature and sea surface temperature. It can last for over a week at a time covering significant areas of the Arctic and the marginal seas. The presence of fog ahead can signal a sudden air temperature drop or a sudden drop in the sea surface temperature, as might occur in the presence of a large ice floe. The appearance of a fog bank ahead should be taken as a warning of possible topside icing conditions, possible sea ice ahead or both.

In the winter a type of fog known as Arctic sea smoke occurs when extremely cold air passes over relatively warm water. Although less frequent than summer fog, Arctic sea smoke can reduce visibility to 200 yards. Sea smoke is shown in Figure 4-2.

Figure 4-2 Arctic sea smoke.

ICE

SEA ICE

Sea (pack) ice presents a significant challenge and hazard to U.S. Navy Ships operating in the Arctic. It is more likely to be encountered by surface ships operating in northern latitudes than are icebergs.

FORMATION - The first sign of the freezing of seawater is an oily appearance on the surface of the water. Next, slush with a thick, greasy consistency begins to form. The slush then separates into round and oval-shaped pancakes, illustrated in Figure 4-3. As the freezing process continues, the pancakes begin to adhere to one another to form a sheet of ice, shown in Figure 4-4. This sheet of ice can grow to 3-4 inches in thickness in the first 24 hours. As the thickness of the ice increases, the rate of thickening slows.

Figure 4-3 Beginning pancake ice.

The strength and damage potential of pack ice depends on the age of the ice and its thickness. Generally speaking, older and thicker ice represents a high damage potential due to an increase in strength. Some pack ice remains in the Arctic basin for several years and becomes extremely hard and thick. This ice is known as multi-year ice. Other floes drift out of the polar region after their first year of formation. Due to its thickness and strength, the multi-year ice is far more hazardous to ships than the first-year ice. First-year ice is generally white in color. Multi-year (more than two years) ice is blue in color and any surface features tend to be rounded by exposure to summer melting.

Figure 4-4 Advanced pancake ice.

LOCATION AND MOVEMENT - The central region of the Arctic is covered by permanent ice. Seasonal ice in lower latitudes subtends from about 65° to 80°N (extending down to about 40°N off Newfoundland and the Sea of Japan). The presence of pack ice in these latitudes depends upon geographical location, the season and annual variations in weather factors such as temperature and wind. Pack ice motion is driven primarily by surface winds. Figure 4-5

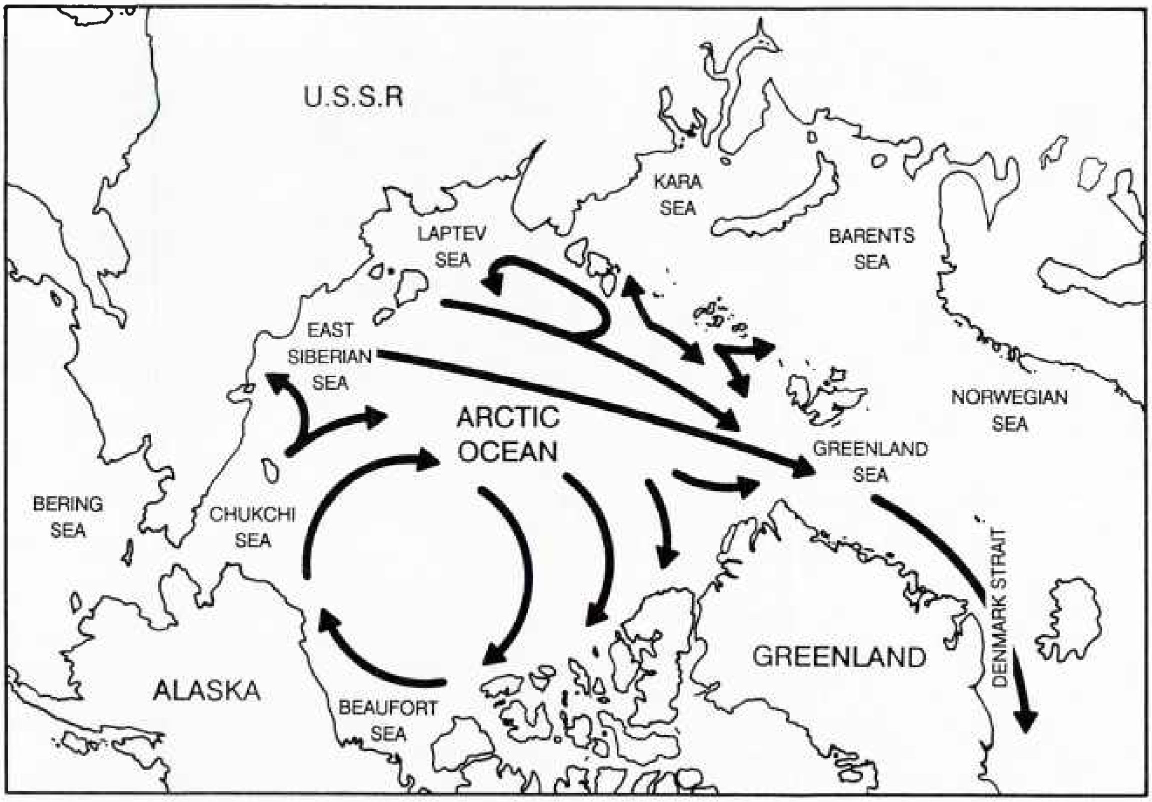


Figure 4-5 General pattern of ice movement in the Arctic Ocean.

shows the general pattern of ice movement in the Arctic Ocean. The Pacific Gyre is an area where ice travels in a clockwise motion, sometimes for many years, before it enters the Trans Polar Drift Stream which carries it from the eastern Siberian Sea across the pole and generally down the eastern coast of Greenland. The Pacific Gyre accounts for some ice floes remaining in the Arctic. Ice edge position, major concentration boundaries and ice ages are delineated for the Arctic by the Naval Polar Oceanography Center.

HAZARDS TO SHIPPING - Most surface ships (except for battleships) are not ice-strengthened in design and construction and run the risk of hull damage. Pack ice can cause damage to screws, rudders and other appendages even when ice concentration, strength and ship speed are not sufficient to cause major hull damage. As pack ice concentration increases, ship's speed and maneuverability become more restricted. A ship could become beset in pack ice, unable to free itself to return to open water if it ventures too far into the MIZ. Depending upon weather trends and the availability of assistance from an ice breaker, becoming beset in the ice could cause anything from a minor schedule delay to loss of the ship and its crew.

TYPES OF SEA ICE

Sea ice is classified by concentration, stage of development (age) and floe size. Concentration is reported in tenths and describes the amount of ice present in a given area. Stages of development (age) generally fall into four categories: new, young, first-year and multi-year ice. New ice extends from unconsolidated crystals (a soupy consistency) to thin flexible sheets (nilas) up to 4 inches thick. Color of new ice is dark grey. Young ice extends from 4-12 inches in thickness and is either grey or grey-white in color. Topographic features of young ice include rafting (ice sheets overlaying one another) and some ridging in the thicker grey-white ice. First-year is of no more than one winter's growth with a thickness range of about 1-6 feet. Topography includes sharp ridges and melt puddles of a bluish hue. Old ice (second- or multi-year ice) has survived at least one summer's melt, generally is thicker than 6 feet and has weathered ridges. Melt ponds often have a darker blue color.

Multi-year ice is mechanically stronger than first-year ice because the salt impurities have been expelled from the ice. With the exception of the East Greenland Sea, multi-year ice is generally confined to the Arctic Ocean and the northern portions of adjoining seas. Thus, in most marginal seas only first-year ice will be encountered.

The deformation process (rafting, in which one floe rides up on another and ridging, in which pressure causes ice floes to buckle, break and pile blocks up on the surface and down below the surface as seen in Figure 4-6) causes substantially thicker sea ice to form. Icebreakers have frequently been forced to stop or ram pressure ridges in order to continue on course. Non ice-strengthened ships should therefore avoid ridges and heavy concentrations of ice whenever possible. Note that pressure ridges near the ice edge may be substantially weakened by warm water and may break.

Size classification of sea ice is as follows:

- Ice less than 6 feet across is a small ice cake.
- Ice between 6 and 60 feet across is an ice cake.
- Ice between 60 and 300 feet across is a small floe.
- Ice 300 to 1,500 feet across is a medium floe.
- A big floe is ice 1,500 feet to 1 mile across.
- Vast floes are from 1 to 5 miles across.
- A giant floe is greater than 5 miles across.

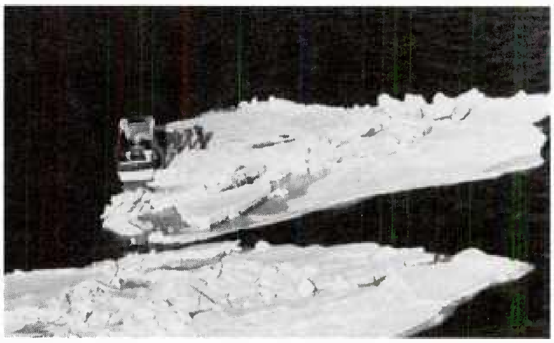


Figure 4-6 Ice floes.

Sea ice can be either fast ice, which is attached to the shore, or drift ice, which is drifting freely. Fast ice tends to be relatively flat on the surface although it may be rafted and therefore several times thicker than one might expect. Fast ice freezes to the sea bottom in shallow areas and can be nearly immobile. The seaward edge of fast ice is frequently characterized by impressive ridges caused by the action of the moving drift ice against the fast ice. These ridges often extend over 60 feet below sea level to the sea floor. These grounded ridges effectively anchor the fast ice edge. Note that grounded ridges may be found in water over 100 feet deep.

FORECASTING SEA ICE

The primary source of data on sea ice location is the Naval Polar Oceanography Center in Suitland, Maryland. The Center prepares and disseminates global, regional and local sea ice location products. Sea ice information is encoded according to the World Meteorological Organization (WMO) symbology known as the egg code due to the oval shape of the symbols. The egg code shown in Figure 4-7 provides information on the types and concentrations of ice in each area of the chart. Figures 4-8 and 4-9 are examples of charts distributed by the Naval Polar Oceanography Center using egg code symbology.

While a more complete guide to all of the codes used is found in the *Ice Observation Handbook*, a short description follows.

THE BASIC EGG

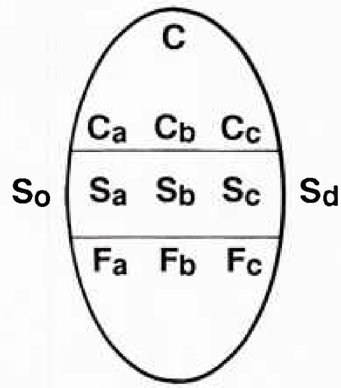


Figure 4-7 Egg code symbology.

1. The Total Concentration (C) is reported in tenths and is the uppermost group. This may be expressed as a single number or as a range (i.e., 3-5).

2. Partial Concentrations (C_a, C_b, C_c) are also reported in tenths but must be reported as a single digit. These are reported in order of decreasing thickness. That is, C_a is the concentration of the thickest ice and C_c is the concentration of the thinnest ice.

3. Stages of Development (S_a, S_b, S_c, S_d) are listed in decreasing order of thickness. The following codes are directly correlated with the partial concentrations above. That is: C_a is the concentration of stage S_a.

New Ice	1
Nilas	2
Young	3
Gray	4
Gray-White	5
First Year	6
Thin First Year	7
Thin First Year (First Stage)	8
Thin First Year (Second Stage)	9
Medium First Year	1·
Thick First Year	2·
Old	7·
Second Year	8·
Multi-year	9·

S_o is used to report a trace concentration of the thickest ice.

4. Forms of Ice (F_a, F_b, F_c) are used to report special forms of ice such as pancake ice and floe size using the following table:

0	Pancake Ice
1	Small Ice Cake/Brash
2	Ice Cake
3	Small Ice Floe
4	Medium Ice Floe
5	Big Ice Floe
6	Vast Ice Floe
7	Giant Ice Floe
8	Fast Ice/Growler/Floeberg
9	Icebergs
x	Unknown
/	Unknown

Also found in the Forms of Ice Section is the symbol for strips and patches of ice with higher concentrations.

~ 8

This indicates strips and patches of ice of 8 tenths concentration.

ICEBERGS

FORMATION AND MOVEMENT- Icebergs (Figure 4-10) are pieces of glaciers from Greenland, Northeastern Canada, Svalbard and the Soviet Arctic. The primary sources of icebergs are Greenland, Northeastern Canada and Svalbard. They are most common in Baffin Bay, the Davis Strait and the Grand Banks. Iceberg location information can be obtained from the International Ice Patrol. Icebergs do not always travel in the direction of the wind. They have a small sail area relative to their total size and travel in the direction of the current, which may be against the wind. Figure 4-11 shows the general drift pattern of Atlantic icebergs. Figure 4-12 shows typical areas where icebergs can be anticipated in the Pacific region.

HAZARDS TO SHIPPING - Large icebergs can be a major threat to modern shipping.

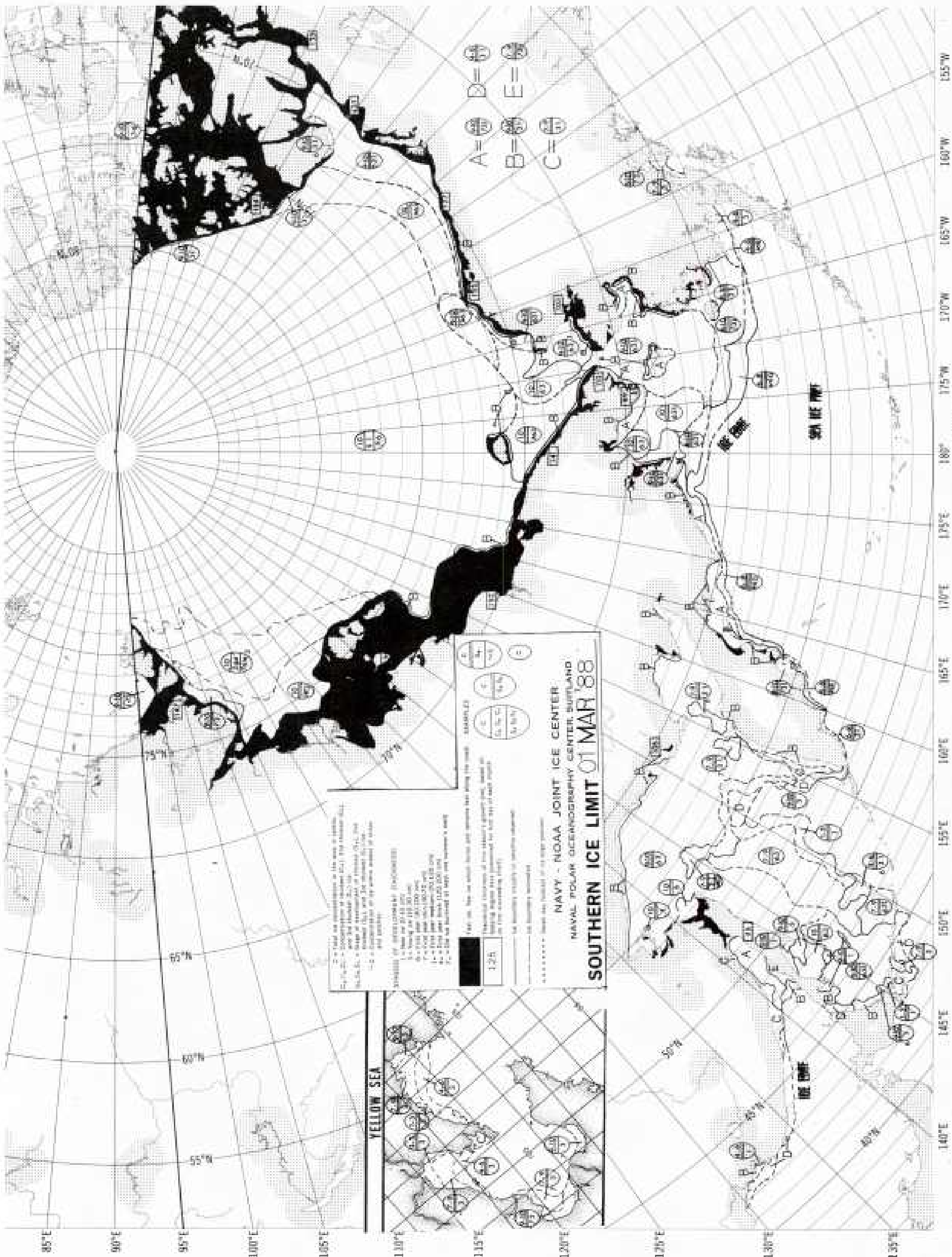


Figure 4-8 Southern ice limit, 1 March 1988, North Pacific.

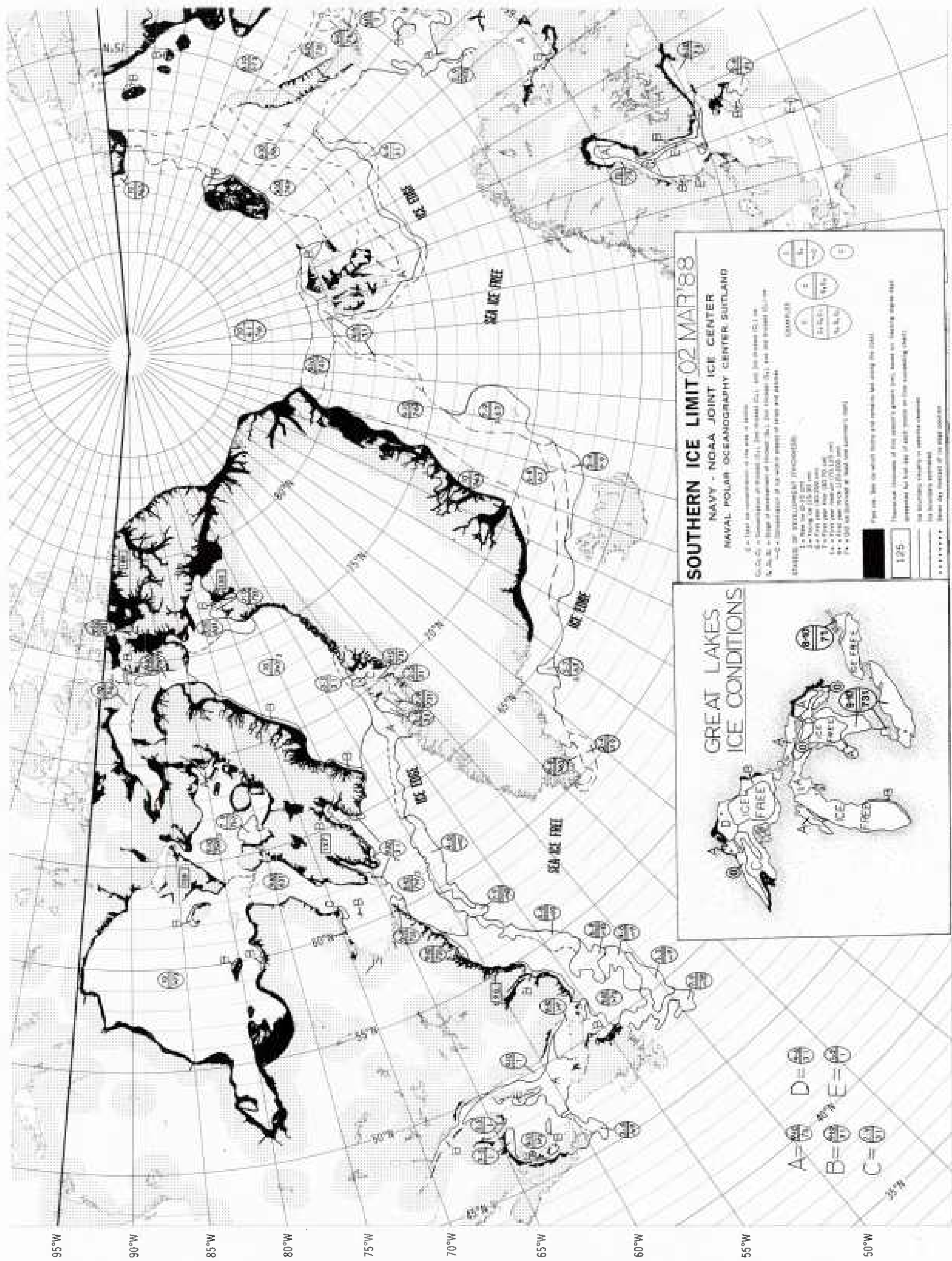


Figure 4-9 Southern ice limit, 2 March 1988, North Atlantic.

Figure 4-10 Icebergs, bergy bits.

Smaller pieces of ice which often float near icebergs such as bergy bits (about the size of a small house) and growlers (about the size of a piano) can also pose a threat to shipping since they are not always visible on radar. In particular, growlers are often lost in the sea return due to the waves during high seas. These relatively small objects can puncture a hull, damage screws, rudders and other appendages creating mission-threatening and possibly ship-threatening situations.

FORECASTING ICEBERGS

The NPOC weather forecasting products will be a primary source of weather forecasting information. Embarked NPOC forecaster(s) will be of great assistance if obtained as recommended in Chapter 3. Since weather data is scarce in the Arctic, all available sources of information should be explored, including Soviet broadcasts of weather data. Figures 4-13 through 4-20 are photographs taken during recent cold weather exercises.

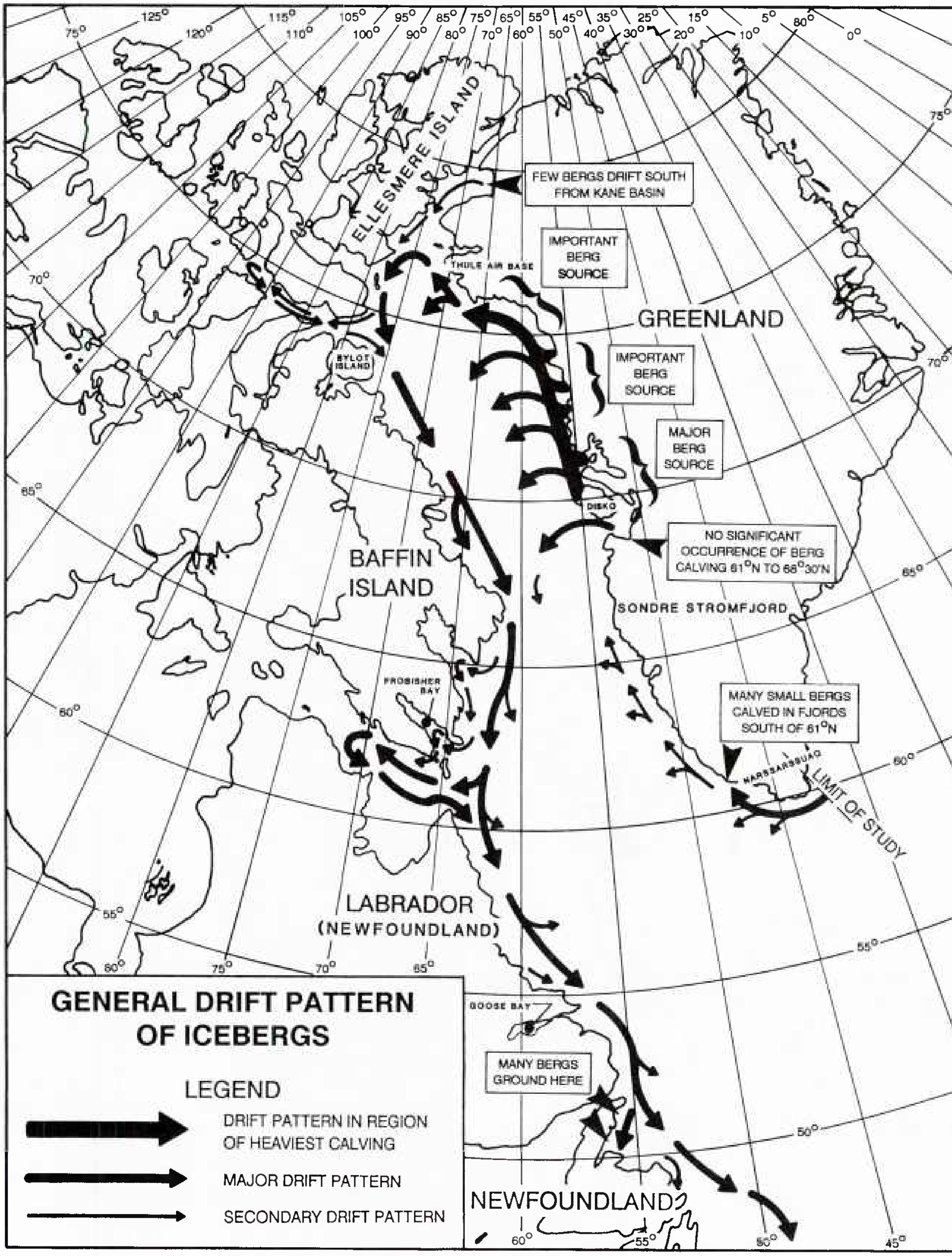


Figure 4-11 General drift pattern of Atlantic Ocean icebergs.

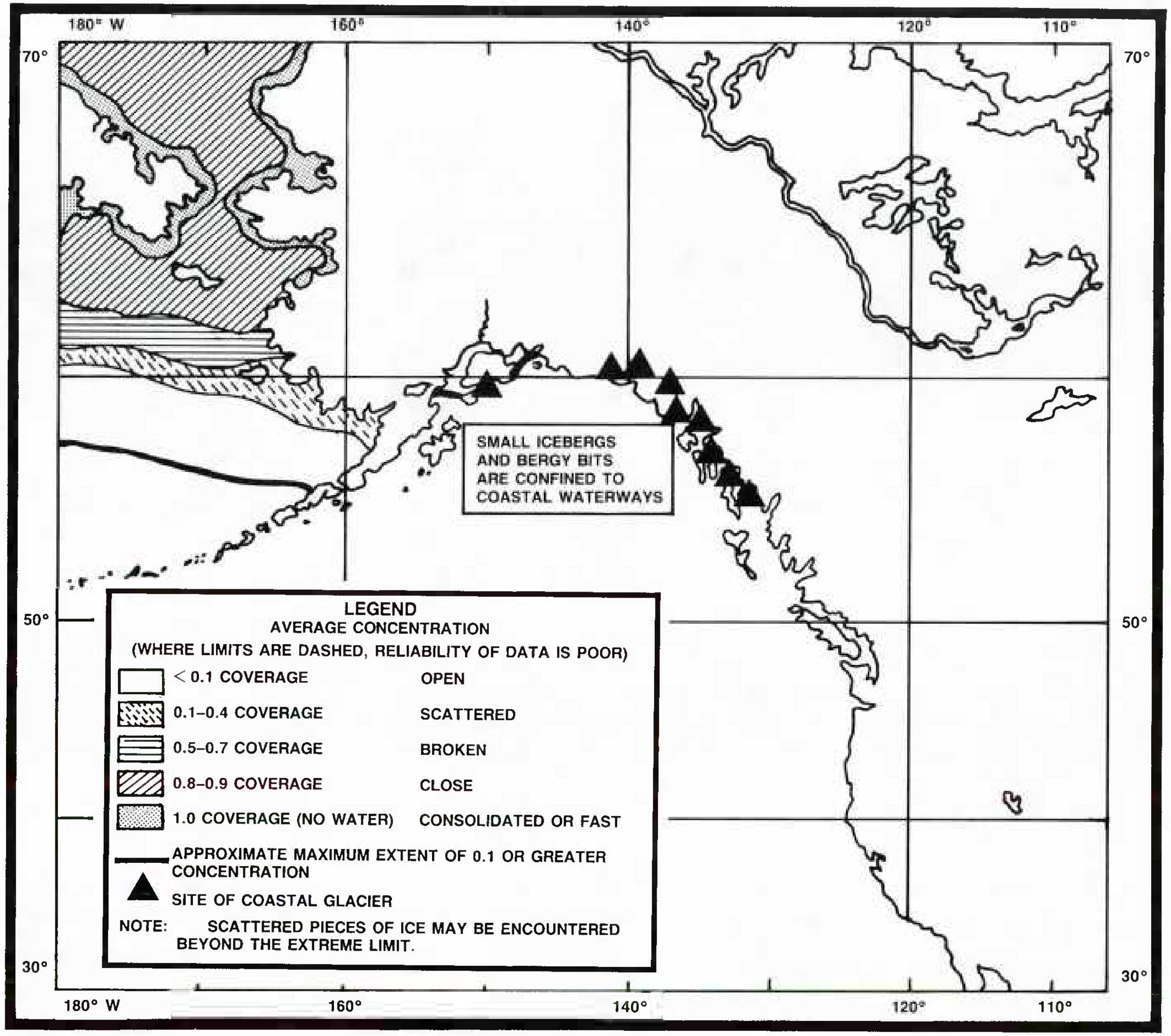


Figure 4-12 Pacific Ocean icebergs.

Figure 4-13 Diffuse ice edge.

Figure 4-14 Eddy, MIZ.

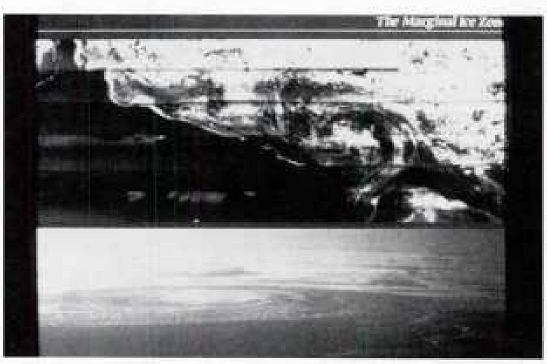


Figure 4-15 Satellite photo of MIZ, top, shows Eddy, also shown at bottom.

Figure 4-16 Downwind side of band of sea ice, Bering Sea.

Figure 4-17 Ice bands, Bering Sea, upwind.

Figure 4-18 Ice edge with on-ice wind and sea, Greenland Sea.

Figure 4-19 The MIZ.

Figure 4-20 Ice floes in the MIZ.

1 PLACE	2 PERCENT CLOUD COVER JAN	JUL	3 MEAN AIR TEMPERATURE °C JAN	JUL	4 MEAN PRECIPITATION (INCHES) JAN	JUL	5 MEAN MONTHLY PRECIPITATION % FREQUENCY JAN	JUL	6 MEAN VISIBILITY %<2NM//%<5NM JAN	JUL	7 MEAN NUMBER OF DAYS VISIBILITY <1/2 MI JAN	JUL	8 SEA AND SWELL %>5'//%>12' JAN	JUL	9 MEAN VECTOR WINDS DIR/SPEED(KT) JAN	JUL	10 PERCENT OCCURRENCE FOR PARTICULAR WIND SPEEDS ≤10/>17/>28/>34(KTS) JAN	≤10/>17/>28/>34(KTS) JUL
					RAIN/SNOW	RAIN/SNOW	RAIN/SNOW	RAIN/SNOW										
CANADA																		
ARCTIC BAY	40	65	−28	2			20/20	15/10	10/75	10/85			ICE	<10	NW/10	NE/5	45/ / /<5	50/ / /0
BAFFIN ISLAND	45	70	−26	4			15/15	15/10	15/80	10/85			ICE	<10	NW/10	NW/<2.5	40/ / /<5	45/ / /0
BANKS ISLAND	43	70	−32	4			20/20	10/10	<10/70	10/70			ICE	–	N/10	NW/<2.5	40/ / /<5	50/ / /0
CAMBRIDGE BAY	42	65	−32	8			20/20	15/05	10/70	10/80					W/10	NE/05	40/ / /<5	50/ / /0
DAWSON	50	70	−28	16			25/15	20/0	10/80	10/70					NE/10	SE/05	30/ / /<10	50/ / /0
ELLESMERE ISLAND	40	70	−32	6			0/75	02/17	30/50	30/40					N/10	SW/10	–	50/ / /0
FROBISHER BAY	45	75	−24	4			15/15	20/05	15/70	10/85					NW/10	VAR/05	35/ / /05	50/ / /0
INUVIK	45	70	−28	8			20/20	20/05	10/70	20/70					SW/2.5	NW/05	45/ / /<10	50/ / /0
NUGVIK	45	70	−26	8			10/10	20/<5	20/70	10/80					SW/5	S/<2.5	30/ / /05	50/ / /0
QUEEN ELIZABETH ISLAND	40	75	−32	4			0/11	04/07	15/20	30/45					W/10	N/10	–	50/ / /0
RESOLUT	40	65	−32	4			0/11	04/07	15/20	30/45					W/10	N/05	45/ / /0	50/ / /0
REPULSE BAY	38	60	−28	8			20/15	20	20/70	10/90					NW/10	NW/05	40/ / /<5	50/ / /0
VICTORIA ISLAND	48	65	−32	8			20/20	15/05	10/70	10/80					NW/10	NE/05	40/ / /<5	50/ / /0
WHITEHORSE	55	70	−20	12			30/15	20/0	10/80	10/70					NE/10	SE/05	20/ / /<10	50/ / /0
DENMARK																		
FAROE ISLANDS	75	80	−12	4	8.0/2.7	5.1/0.0	30/10	20/0	10/75	10/70			50/15	3/1	SW/10	SW/<2.5	20/30/25/15	40/18/3/0
FINLAND																		
HELSINKI	80	55	−8	16	1.70/–	2.20/0.0		2/0			2.9	0.8		0/0		W/11	/3.5/0.1/	46/1.6/0.1/0
OULU	80	55	−8	16	2.90/–	2.36/0.0		2/0			3.2	0.5		1/0		S/10	/3.3/0.1/	45/1.4/0.0/0
KIRUNA	80	55	−8	16														
GREENLAND																		
AMMASSALIK	50	60	−4	4	2.90/–	1.50/–	5/13	5/3			N/A	N/A	6/0	0/0	NE/30		23/20/28/0	40/28/1.1/0
GOTHAB	60	60	−12	4	1.40/–	2.20/–					N/A	N/A					N/A	N/A
ITSEQQORTOOMIIT	60	60	−12	4	1.80/–	1.50/–					N/A	N/A					N/A	N/A
NORD	45	60	−28	4	0.84/–	1.00/–					N/A	N/A					/9.8/2.4/	/6.5/0.6/
QAQORTOQ	65	60	−6	4	2.78/–	1.20/–					N/A	N/A					N/A	N/A
QEQERTARSUAQ	60	60	−16	4	0.61/–	2.13/–					N/A	N/A					N/A	N/A
THULE	40	60	−28	4	0.36/3.3	0.67/0.0					5.0	7.4					/8.1/2.3/	/6.7/1.0/
JAPAN																		
KUSHIRO	60	88			1.80/–	4.40/0.0	3/9	9/0			6.8	12.7	7/.5	1/0	NW/15	E/8	/8.8/0.4/	/1.5/0.0/
MORIOKA					2.33/–	6.64/0.0					N/A	N/A					N/A	N/A
GIFU AB					2.76/–	9.48/0.0					N/A	N/A					/1.7/0.0/	/0.4/0.0/
NIIGATA	88	94			7.50/42.6	6.40/0.0	6/25	10/0			6.5	1.3	7/4	8/0	NW/18	SW/8	/19.9/2.0/	/0.2/0.0/
ICELAND																		
AKUREYRI	70	75	0	9	1.70/–	1.30/–					2.8	0.4	3/10	7/0	NE/22	NE/8	32/9.3/0.9/0	42/1.7/0.1/0
REYKJAVIK	75	75	0	9	4.00/–	2.00/–					2.8	0.3	1/0	4/0	SW/23	N/13	22/35.9/10.5/0	39/9.4/0.6/0
IRELAND																		
MALIN HEAD	80	78			2.60/–	2.84/0.0	12/2	8/0			0.1	0.8	4/0	2/0	SW/17	NW/12	31/33.2/4.4/0	43/10.2/0.1/0
NORWAY																		
BERGEN	75	69	−2	12	7.90/–	5.20/0.0	10/25	15/0	05/20	25/40	N/A	N/A	30/15	10/10	S/10	SW/<2.5	20/N/A/N/A/<10	40/N/A/N/A/0
BJORNOYA ISLAND	75	69	−4	4	SEE CLIMATIC ATLAS		20/35	10/<5	25/70	25/40	SEE CLIMATIC ATLAS		30/<10	10/<10	N/10	NE/10	20/ / /<10	20/ / /<5
JAN MAYEN ISLAND	75	69	−4	6	SEE CLIMATIC ATLAS		05/30	25/<5	25/35	20/30	SEE CLIMATIC ATLAS		10/10	10/<10	N/15	CALM	20/ / /20	30/ / /<5
HAMMERFEST	75	69	−4	12	SEE CLIMATIC ATLAS		20/35	10/<5	25/70	25/40	SEE CLIMATIC ATLAS		30/15	10/<10	N/10	NW/<2.5	30/ / /10	40/ / /<5
NARVIK	75	69	−2	12	2.80/–	2.32/0.0					5.3	0.5					/14.0/2.4/	/2.1/0.1/
SVALBARD	75	69	−12	4	SEE CLIMATIC ATLAS		25/25	20/<5	10/15	05/10	SEE CLIMATIC ATLAS		–	10/<10	NE/15	S/15	05/ / /10	20/ / /<5
TRONDHEIM	75	69	−2	12	2.14/–	3.00/0.0					1.2	0.2					/7.2/1.2/	/6.8/0.1/

Table 4-1 Arctic Region Weather Trends

1 PLACE	2 PERCENT CLOUD COVER		3 MEAN AIR TEMPERATURE °C		4 MEAN PRECIPITATION (INCHES)		5 MEAN MONTHLY PRECIPITATION % FREQUENCY		6 MEAN VISIBILITY %<2NM//%<5NM		7 MEAN NUMBER OF DAYS VISIBILITY <1/2 MI		8 SEA AND SWELL %>5'//%>12'		9 MEAN VECTOR WINDS DIR/SPEED(KT)		10 PERCENT OCCURRENCE FOR PARTICULAR WIND SPEEDS ≤10/>17/>28/>34(KTS)	
	JAN	JUL	JAN	JUL	JAN	JUL	JAN	JUL	JAN	JUL	JAN	JUL	JAN	JUL	JAN	JUL	JAN	JUL
SCOTLAND					RAIN/SNOW	RAIN/SNOW	RAIN/SNOW	RAIN/SNOW										
PRESTWICK					3.48/–	3.02/0.0					1.2	0.4					/20.1/1.5/	/6.5/0.0/
SHETLAND ISLANDS	70	75	4	12			30/10	20/0	10/80	10/75			30/10	10/<10	SW/10	WSW/05	20/ / /15	40/ / /0
WICK					2.93/–	2/57/0.0					0.3	3.5					/32.2/11.8/	/6.2/11.6/
SOUTH KOREA																		
SEOUL					1.20/4.9	14.80/0.0					1.9	1.5					/1.2/0.0/	/0.7/0.0/
SACHON	74	70			0.78/1.1	10.34/0.0	3/4	6/0			0.2	0.9	14/3	2/0	NW/15	E/10	28/1.9/0.0/0	49/1.7/0.0/0
SWEDEN																		
GAVLE	70	67	−8	16	1.10/–	2.60/0.0					N/A	N/A				N/12	/N/A/N/A/	50/12.4/1/7/0
KIRUNA	70	67	−8	16	0.70/–	2.70/0.0					N/A	N/A					/N/A/N/A/	/N/A/N/A/
UMEA	70	67	−8	16	1.40/–	1.90/0.0					N/A	N/A					/N/A/N/A/	/N/A/N/A/
USA (ALASKA)																		
ALASKA PENINSULA	80	85	−4	12														
A. COLD BAY	80	90			2.37/8.0	2.20/0.0	7/6	6/0	/18	/38	5.1	5.3	1/1	4/1	E/20	W/13	23/43.0/9.0/0	36/31.4/2.7/0
B. KING COVE	80	90			1.08/6.10	2.13/0.0	7/6	6/0	/18	/38	2.6	4.8	1/1	4/1	E/20	W/13	23/19.1/2.4/0	36/5.6/0.3/0
ANCHORAGE	80	80	−16	13	1.08/11.8	2.37/0.0			/14	/2	7.7	0.6					/2.4/0.2/	/0.6/0.0/
BARROW	50	75	−24	6	0.19/2.4	0.89/0.7			/17	/39	N/A	N/A		0/2		E/13	/N/A/N/A/	42/N/A/N/A/0
BETHEL	70	85	−16	13	1.12/10.5	2.17/0.0			/16	/22	4.7	2.7					/17.9/0.8/	/0.8/0.2/
FAIRBANKS	55	75	−24	14	0.90/12.0	1.90/0.0			/20	/4	7.1	1.3					/0.5/0.0/	/0.4/0.0/
NOME	60	80	−16	12	1.10/10.5	2.70/0.0			/18	/27	5.4	3.0		1/0		SSE/16	/22.0/2.6/	39/5.7/0.1/0
PRUDHOE BAY	45	75	−28	10	N/A	N/A	25/25	20/05	<10/70	20/70	SEE CLIMATIC ATLAS				W/<2.5	NW/05	50/ / /0	50/ / /0
VALDEZ	70	80	−16	13	5.21/60.5	4.22/0.0					N/A	N/A					/N/A/N/A/	/N/A/N/A/
USA (ALEUTIANS)	80	85	0	8														
ADAK	89	95			6.74/15.7	2.99/0.0	7/17	10/0			3.3	3.3	2/.5	3/.5	SE/20	W/12	28/36.7/8.2/0	38/20.1/2.0/0
UMNAK	90	96			2.70/–	3.70/0.0	7/14	7/0			N/A	N/A	2/1	3/0	W/20	W/14	23/N/A/N/A/0	35/N/A/N/A/0
USSR																		
ANADYR	55	80	−16	8	2.45/–	1.35/0.0					3.0	1.2					/40.4/16.4/	/26.9/2.9/
EVENSK	70	80	−28	12	1.26/–	2.09/0.0		7/0			1.1	2.5		3/0		SW/12	/48.9/16.6/	43/2.7/0.0/0
FRANZ JOSEF LAND	70	90	−16	2														
A. NAGURSKOYE					1.27/–	1.09/–					1.9	3.8					/19.5/4.7/	/13.8/1.3/
B. OSTROV HEYSA					1.74/–	1.52/–					1.3	3.0					/27.5/6.5/	/13.2/0.9/
LENINGRAD	80	55	−8	16	1.12/–	2.90/0.0					0.3	0.2					/4.8/0.1/	/0.9/0.0/
TIKSI	50	75	−36	10	1.45/–	1.78/–					2.9	2.3					/26.0/8.7/	/8.6/0.3/
MURMANSK	75	70	−12	12	1.49/–	2.19/0.0	1/17	7/0			2.5	0.3	1/0	0/0	SW/21	E/10	18/27.6/3.8/0	49/5.0/0.0/0
NEW SIBERIAN ISLANDS	35	85	−32	2														
A. OSTROV KOTELNYY					0.41/–	1.32/–					0.3	3.0					/20.6/2.0/	/22.4/2.1/
B. MYS SHALAVROVA					0.59/–	1.5/–					1.3	3.9					/19.8/3.7/	/22.6/1.1/
NOVAYA ZEMLYA	60	80	−16	8														
A. MYS ZHELANIYA					1.98/–	1.11/–					3.2	5.1					/43.4/17.1/	/33.5/8.5/
B. MALYYE KARMAKULY					1.67/–	2.40/–					1.5	2.0					/48.3/21.3/	/23.6/8.0/
PROVIDENIYA	70	60	−16	6	3.77/–	2.93/0.0	0/21	4/0			1.5	2.7	0/0	2/0	NE/23	SW/14	20/25.7/4.4/0	28/1.0/0.0/0
SEVERNAYA ZEMLYA	55	85	−28	4	0.67/–	1.99/–					1.0	5.9					/18.9/2.4/	/11.1/0.5/
WRANGLE ISLAND	59	81	−24	4	1.14/–	1.39/–					1.5	6.0					/27.4/8.2/	/9.1/0.9/

Table 4-1 Arctic Region Weather Trends (Continued)

1 PLACE	2 PERCENT CLOUD COVER JAN	JUL	3 MEAN AIR TEMPERATURE °C JAN	JUL	4 MEAN PRECIPITATION (INCHES) JAN	JUL	5 MEAN MONTHLY PRECIPITATION x FREQUENCY JAN	JUL	6 MEAN VISIBILITY x<2NM//x<5NM JAN	JUL	7 MEAN NUMBER OF DAYS VISIBILITY <1/2 MI JAN	JUL	8 SEA AND SWELL ≥5'//≥12' JAN	JUL	9 MEAN VECTOR WINDS DIR/SPEED(KT) JAN	JUL	10 PERCENT OCCURRENCE FOR PARTICULAR WIND SPEEDS ≤10/>17/>28/>34(KTS) JAN	≤10/>17/>28/>34(KTS) JUL
					RAIN/SNOW	RAIN/SNOW	RAIN/SNOW	RAIN/SNOW										
BAFFIN BAY									20/20	30/20			10/			E/10	80/ / /	70/ / /
NORTH	45	70	-28	8				06/07										
SOUTH	55	75	-16	8				11/0										
BARENTS SEA									20/50	10/25					SE/15	NE/15	40/ / /	60/ / /
NORTH	70	85	-16	2			18/51	07/03					30/	10/10				
SOUTH	80	75	-8	6			10/23	14/0					40/	>10/>10				
BERING SEA									20/30	20/40				10/	N/10	S/20	30/ / /	50/ / /
NORTH	65	90	-16	4			30/30	25/0					10/0	0/0	NE/12	SE/12	24/31/17/	46/16.3/1.7/
SOUTH	80	90	0	6			30/30	30/0					4/0	5/1	SE/12	W/12	28/30/15/	38/21/3.7/
BERING STRAIT									20/30	20/35				>10/	N/10	SW/10	40/ / /	60/16.3/1.7/
NORTH	55	80	-20	6			25/20	20/<5										
SOUTH	65	85	-16	6			30/30	20/0										
BEAUFORT SEA															SW/05	E/05	60/ / /	60/ / /
NORTH	40	80	-30	2			0/55	04/33	13/25	35/40								
SOUTH	45	70	-28	5			0/33	11/4	13/20	15/35								
CHUKCHI SEA									20/30	30/35				10/	NE/15	CALM	65/ / /	65/ / /
NORTH	45	85	-28	0			01/28	18/02										
SOUTH	50	80	-16	4			01/28	18/02										
DENMARK STRAIT									05/30	20/30			50/20	20/	SW/05	N/10	40/ / /	75/ / /
NORTH	65	60	-8	8			-	13/02										
SOUTH	70	75	0	8			-	13/02										
DAVIS STRAIT									15/25	25/30			35/15	15/10		CALM	55/ / /	70/ / /
NORTH	55	75	-12	8			-	11/0										
SOUTH	60	75	-8	8			-	11/0										
EAST SIBERIAN SEA									20/35	30/40					NE/15	NE/10	65/ / /	60/ / /
NORTH	35	85	-32	4			0/27	17/06										
SOUTH	45	75	-28	12			0/27	17/06										
GREENLAND SEA									/30	30/35			10/10	10/		S/10	60/ / /	80/ / /
NORTH	50	75	-20	4			-/-	03/0										
SOUTH	70	70	-8	8			-/-	16/0										
KARA SEA									30/50	20/30				15/>10	SE/15	NE/05	40/ / /	50/ / /
NORTH	65	85	-24	2			02/31	15/03										
SOUTH	75	80	-16	6			02/31	15/03										
LAPTEV SEA									20/40	20/35				15/	S/15	W/10	65/ / /	60/ / /
NORTH	40	75	-28	4			01/23	15/05										
SOUTH	47	75	-28	8			01/23	15/05										
NORWEGIAN SEA									05/25	25/30					S/10	NE/10	30/ / /	60/ / /
NORTH	80	85	-4	8	12/10	8/0	10/23	14/0					35/10	10/10	S/10	NE/10	/37.5/2.6/	/28/2.4/
SOUTH	75	70	0	8			01/24	22/01					45/20	20/<10				
SEA OF JAPAN																		
NORTH	70	80	-2	16			40/20	20/0	05/20	0/10			30/0	10/0	NNW/15	SE/05	30/ / /05	40/ / /0
SOUTH	83	68													NW/19	SW/11	23/37.8/10.1/0	55/12.3/1.4/0
SEA OF OKHOTSK													50/0	30/10				
NORTH	61	76					40/40	20/<5	30/50	25/45						SW/<2.5	20/41/5.8/10	40/17.4/1.5/0
SOUTH	76	91					55/55	20/0	20/50	10/40					NW/15	WSW/05	25/37.8/8.5/10	35/15.5/1.0/0

COLUMN	DEFINITION
1.	IDENTIFICATION OF AREA
2.	PERCENT OF TIME TOTAL CLOUD COVER EXISTS DURING THE MONTH
3.	AVERAGE AIR TEMPERATURE IN °C DURING THE MONTH
4.	AVERAGE NUMBER OF INCHES OF PRECIPITATION (RAIN/SNOW) DURING THE MONTH
5.	PERCENT OF TIME PRECIPITATION (RAIN/SNOW) OCCURS DURING THE MONTH
6.	PERCENT OF TIME THE VISIBILITY IS LESS THAN (2 NM/5 NM) DURING THE MONTH
7.	AVERAGE NUMBER OF DAYS WHEN VISIBILITY IS LESS THAN 1/2 NM DURING THE MONTH
8.	PERCENT OF TIME WHEN SEA AND SWELL IS GREATER THAN (5'/12') DURING THE MONTH
9.	MEAN VECTOR WINDS DURING THE MONTH ARE FROM DIRECTION/AT AN AVERAGE SPEED
10.	PERCENTAGE OF TIME A PARTICULAR WIND SPEED (≤10,>17,>28,>34 KTS) OCCURS DURING THE MONTH

Table 4-1 Arctic Region Weather Trends (Continued)

CHAPTER 5

PROTECTIVE CLOTHING

One of the most challenging yet seemingly simple tasks encountered in a cold weather environment is trying to keep people properly dressed and warm. Having both the proper clothing and the necessary amount of clothing to carry out the mission is imperative in cold weather. It is essential that the crew be able to function in the cold, i.e., maintain sufficient mobility, warmth and dryness to safely perform their duties. The best way to avoid cold weather casualties starts with wearing the right clothes, and wearing them properly.

The following sections provide general descriptions of available clothing and give some specific advice based on previous cold weather experiences. For detailed descriptions, illustrations and ordering information, refer to Appendix D.

TYPES OF COLD WEATHER CLOTHING

Navy cold weather clothing is divided into two general categories. One category includes clothing which has been designed and tested for use in temperatures of 20°F and above. This clothing is usually referred to as Cold Weather Clothing, and consists of a variety of protective garments called A-2 Intermediate Clothing. Although it is designated for 20°F and above, the clothing can be worn at colder temperatures with the addition of extreme cold weather underwear and sweaters. The second category is for use at 0°F and above. Again, this designation is only used based on testing criteria and is useful more for comparison purposes rather than defining the minimum usable temperature. These items are often referred to as A-1 Extreme Cold Weather Clothing, and have usually been tested to temperatures below zero.

One particular problem encountered in the Navy with the use of protective clothing is the wet environment in which it is used. The clothing selected must therefore be suitable for use in what is called a wet/dry cold condition. It is important to keep this in mind when selecting clothing, particularly if it is nonstandard or commercially procured. A goose down jacket, for example, is excellent in dry cold but provides little insulation when wet. In some situations it is impractical to wear completely waterproof items so extras will be necessary to replace items which get wet and lose their insulating properties. Intelligent selection of cold weather clothing includes knowing and considering the job to be done, as well as the temperature and precipitation conditions to be encountered.

GARMENT DESCRIPTIONS AND OUTFITTING

BOOTS

Two types of cold weather boots are available. The Navy Standard boot is a rubber, insulated boot often referred to as a vapor barrier boot or "Mickey Mouse" boot. This boot is very effective at keeping the feet dry and warm. Despite its large and somewhat cumbersome nature, the boot has been effectively used in harsh, wet, cold weather aboard ships. The boot consists of a rubber exterior and interior with a layer of insulation in between.

Another type of boot is the extreme cold weather mukluk. This boot is made for use under dry, cold conditions and it is not well-suited for a wet environment. It has a rubber sole and a cotton upper portion with laces at the ankle and a zipper above the instep. There are other boots available commercially, made from a fabric called "Gore-tex" which is lighter-weight and may be preferred by some sailors.

Many factors are involved in keeping feet warm and protected: boot construction, boot care, personal hygiene and proper boot wear. When extended exposure to extreme cold weather is anticipated, footwear such as the vapor barrier boot should be used.

GLOVES AND MITTENS

Several different protective covers are available for the hands, which can be broken into the broad categories of mittens and gloves. Each has its own particular advantages. The gloves generally provide more dexterity and are well suited for handling and grasping tasks. Mittens, on the other hand, provide additional warmth and protection by grouping the fingers into one area, thereby reducing heat loss.

Most gloves come in a set consisting of an insulating liner and a durable exterior shell. The liner is worn next to the skin to maintain the warmth while the shell is worn over the liner to provide a wear-resistant covering. Several sets of liners will be needed for each pair of gloves because the liners will tend to get wet if the outer shell gets wet. Most liners are typically a wool blend knit and the shell is typically leather.

Mittens are extreme cold weather items and come in a variety of types. The most basic is a one-piece construction with a coated cloth or leather shell that is lined and insulated. The mitten has one pocket for the four fingers and a thumb pocket which provides maximum warmth but limits the ability to grasp.

The Navy Standard extreme cold weather mitten is actually a cross between a glove and a mitten. It has individual places for the thumb, index finger and middle finger, while the ring and little fingers are grouped together. Sometimes the middle finger is also grouped with the latter two. The purpose is to maximize dexterity while ensuring the fingers not required for manipulations are kept as warm as possible. One particular version of these, the extreme cold weather mitten set, consists of a synthetic insulating liner and a chloroprene-coated outer shell. Some mittens like these also may have long cuffs which can be tucked up under the sleeve of a jacket for added protection.

SUITS

One-piece anti-exposure suits are designed to increase the chances of survival for someone who falls overboard and to keep a person warm and dry aboard ship. The Navy's submarine deck exposure coverall, shown in Figure 5-1, is constructed with a durable external shell, a closed cell foam insulating layer and an inside liner. Rather than trying to keep the person dry in the water, the suit is designed with snug closures at all openings which prevent water from flushing in and out of the suit. The foam layer provides insulation and positive buoyancy. A life jacket is still required with the suit for self-righting flotation capabilities.

The suit provides excellent protection out of the water, too. It was originally used on sub-

Figure 5-1 Anti-exposure suit.

marine decks because the topside personnel worked very close to the water where the risk of falling overboard was high. It is now being adapted for all ships as an extreme cold weather outfit, with the added benefit of increased water survival. The one-piece design has proven to be more comfortable than comparable two-piece suits. Examples of on-deck use are shown in Figures 5-2 and 5-3. Commercial suits are available, such as the Mustang and the Stern suits, which offer the same features as mentioned above and which provide similar protection.

JACKETS AND TROUSERS

Jackets and trousers are often used in combination to create a suit to cover the major portions of the body. The use of separate articles for the top and bottom (rather than a one-piece suit) allows them to be used individually or together to create the level of protection desired. Normally, these items are well-insulated and can be considered water-resistant. The trousers can be worn over normal work clothes and usually have a high waist which provides a good insulating seal. The cuffs may also have a device to seal around the ankle which minimizes cold air entry. Likewise, the mid-length jacket overlaps the trousers and will draw up tightly to form a seal at the bottom. The neck can be closed tightly and the cuffs are designed to limit cold air leakage. Some jackets are provided with hoods, which may be permanently attached or detachable, and even interchangeable with different styles of hoods. These jackets and trousers require the addition of a life jacket, which can be cumbersome.

Individual jackets (with no trousers) are also available. These are usually short waisted jackets which fit snugly at the waist for warmth, such as the cold weather flyer's jacket. When selecting jackets and trousers, remember to size them large enough to allow layering of clothing underneath.

HEADGEAR

Protective clothing for one's head is perhaps one of the single most important items in cold weather. The extremities in general (i.e., head, hands, feet) are the most difficult parts of the body to keep warm. The head, in particular, may account for up to 80% of the body's heat loss. A variety of items is available to keep this critical body area warm.

Hats and ski masks are the most familiar headgear. Wool watch caps and fire retardant face masks are readily available in the Navy supply system and ski masks usually can be purchased commercially. All provide good insulation and are comfortable to wear. Loose-knit varieties provide only marginal protection in the wind. Fleece-lined caps, like those which are part of the ensemble, with ear flaps and visors, provide better wind-resistance and protect the entire ears and neck areas.

Hoods provide excellent protection and can be used in conjunction with some hats. The hood creates a warm cavity around the head. Some hoods designed to be used with sound powered phone headsets have ear pockets built-in. There is also a hood designed for use ashore with a fur piece around the face which forms a snorkel to keep cold air out. Hoods are usually supplied as accessories to extreme cold weather jackets, either permanently attached or as detachable, interchangeable items.

A face mask is available through the Navy supply system for use in extreme cold weather which attaches to the head with elastic webbing. It has a nose piece which opens and closes to adjust nose protection. The mask provides good wind protection and is fire-retardant.

Scarves also provide good insulation for the face and neck, and can be easily adjusted for individual comfort. A drawback of the scarf is that when loose, it can quickly become a hazard to performance and to equipment. Therefore, if a scarf is worn, ensure it is well-wrapped and secured. An alternative face protector which has been favorably used underneath cranials while on the flight deck is a commercially-procured tube, referred to as a "Necker Upper."

Goggles, available commercially and from the supply system, have proven to be very effective at protecting the area around the eyes, particularly in high winds, sleet and snow conditions. Commercial ski goggles which fit over eyeglasses are particularly good for protecting those who must wear glasses.

Figure 5-2 Anti-exposure suits and life vests.

Figure 5-3 Anti-exposure suits and life vests.

UNDERWEAR, SOCKS AND SWEATERS

Thermal underwear and heavy wool socks are essential items for protection from the cold. Both wool and polypropylene undergarments are available and perform essentially the same function. The most important things to remember when using these items are to keep them dry and to change them frequently.

Even if effective water-repellant clothes are worn, the body will still get wet from perspiration. It is important to note that cotton undergarments readily absorb perspiration, become saturated and thereafter conduct heat away from the body. Many synthetics cannot absorb moisture and will remain dry and warm.

Sweaters also provide an effective means of added insulation. Wear them over work clothes and beneath a jacket or anti-exposure suit. Sweaters can be easily donned or doffed to maintain a comfortable body temperature.

PROPER CLOTHING USAGE

Any piece of equipment works best when the operator knows how to use it properly. The more knowledgeable the operator is, the better the equipment will function. Clothing is no exception. When properly worn, clothing can be very effective at keeping the body warm and dry. If clothing is worn improperly, without considering the environment and type of activity to be performed, it can be a constant source of frustration. It will make jobs harder and cause premature fatigue. The importance of dressing properly for the task at hand cannot be overemphasized. The difference between a successful evolution and tragedy can depend on the right clothing being worn properly.

The tendency to overdress by personnel not acclimated to a cold environment could cause overheating, and the likelihood of heat exhaustion is increased when strenuous labor is required.

METHODS OF DONNING

Determine ahead of time how many items of each type clothing are required, based on the task to be performed. This step may seem simple, but as the number of people involved grows it can become surprisingly difficult. Make sure that the clothing will be there when it is needed.

Consider in detail what clothing will be required and what level of protection is sufficient:

- How long will each person stay out in the cold?
- How active will they be on the job? (Does the clothing provide enough ventilation?)
- Will they be directly exposed to wind or partially protected?
- Who will likely get wet and to what extent?
- How much dexterity (particularly use of hands) will be required?
- Who will be wearing special gear, such as headphones?
- What field of vision is required?

These questions should be answered, along with any others pertinent to the particular task. Many of the answers will depend on the severity of the weather and the condition of the operating station.

Allow sufficient time for donning clothes prior to an evolution. The time will depend upon the number of people involved, how much they need to wear, and the type of clothing required. It is equally important to ensure that people are not loitering fully dressed for long periods of time prior to entering the cold. Their underclothes and socks will become damp with perspiration in a very short time, reducing the insulating effectiveness. Feet will also sweat after a short time, particularly in all-rubber boots, and can lead to problems such as trench foot.

With most cold weather clothing, the order of donning each piece and the way to wear it is obvious. Some general points which may not be so obvious to everyone, however, bear mentioning. First of all, boots, headgear and gloves should be the last items donned. Some headgear may need to be tucked under the collar of the jacket, so make adjustments accordingly. Pant legs should be worn outside of boot legs to keep water which runs down the outsides of the pantlegs out of the boots. Some pants have zippers or straps to help secure the area around the boot. If practical, glove openings should be tucked under the cuff of jacket sleeves for the same reason. Some jackets also have devices at the cuff for this purpose. If wearing gloves with liners, carry at least one extra pair of dry liners in case the hands get wet. And, it's a good idea to tie a string to the liners and gloves when they are being worn so they are not lost when removed. Run the string through the sleeves and across the back of jacket, with each end tied to a glove or mitten.

CLOTHING COMBINATIONS

Many of the items available in the supply system are interchangeable. For example, wearing only the jacket and not the matching trousers of a set is acceptable, as long as one's legs are properly protected.

When choosing clothing combinations, the best advice is to layer clothing. As the work rate changes the number of layers can be adjusted for comfort. Cotton long underwear and wool clothing are most comfortable and provide a good insulation base. Wool socks are an absolute necessity. In extreme cold, it may be necessary to wear two pairs at the same time. A word of caution, however: more layers reduce maneuverability.

WET CLOTHING PRECAUTIONS

The biggest single threat to maintaining body warmth is wet clothing. Wetness robs the body of heat by breaking down the thermal protection of insulating clothes. It is extremely important that wet clothing be replaced as soon as possible to prevent injuries from the cold, particularly if the person is idle after a period of profuse perspiring. Many cold weather medical problems involve wet hands and wet feet, so these extremities should receive extra special care.

The two key methods of combating wetness are to prevent getting wet in the first place and to replace items in a timely manner if they do get wet. The first method is the most desirable but may not always be practical. Proper selection of waterproof or water-resistant clothing is a good place to start, particularly if it is known that the people will be exposed to sea spray or rain.

Sometimes it will be impossible not to get wet. For example, using a wool liner and leather glove combination may be ideal for handling lines, but the gloves are not water-resistant enough to keep the hands dry.

If it is not possible to keep from getting wet, at least anticipate the problem with adequate quantities of dry wool socks and glove liners. The same philosophy applies to long underwear. Keep extras on hand.

Here are some suggestions to help ship's personnel stay warm and dry:

- Wear two pairs of socks with a plastic bag between them to keep water out. These socks should be 100% wool or 75% wool/25% cotton to maintain insulation even when feet perspire.
- Use silicone water displacing compound (NSN 8030-01-041-1596) to help waterproof leather boots. However, if boots are silicone-treated, no other waterproof compound should be used.
- If hands will be wet severely or continuously, try a pair of wet suit diver's gloves.
- Inspect all cold weather outfits to ensure they are clean and undamaged before encountering cold weather.
- Have all personnel verify sizes of clothing they will need prior to a cold weather deployment.
- Anti-exposure suits have proven very successful for deck and boat crews during extended cold weather operations.
- Standard rain gear worn over cold weather clothing aids in protection from wind and water.
- Commercially-procured, wool full face ski masks and goggles provide good face protection, but limited visibility.

SHIP WASHER/DRYER AVAILABILITY

Arrangements must be made to accommodate the increase in clothing being worn and to ensure it is properly cleaned. Socks and underwear, especially, will need to be washed and dried frequently. Since they are essential to people while working in the cold, special consideration should be given to timely drying and/or laundering of socks and underwear.

Additionally, heavier items such as trousers and jackets may require drying after use. Anticipate many wet, heavy clothes and make arrangements to provide drying for them. Instructions for care of the garments are included on the labels. Be extremely careful not to exceed the drying temperature recommended for each item. Heavy items, such as anti-exposure suits and jackets, may require cleaning on an individual basis. Provisions should be made, if possible, to provide space for laundering and drying.

STOWAGE FACILITIES

Cold weather clothing should be stowed in a dry, secure place to reduce the possibility of mildew and prevent pilferage. Ensure all items, particularly leather ones, are completely dry prior to stowage. Temporary stowage locations and drying rooms should be established when the clothing is frequently used. Proper care of the clothing is important, so ensure it is carefully hung and aired between usage. Arctic marine regions have typically 28°-32°F dewpoint, so drying time may be slightly less than in warmer regions.

CHAPTER 6

ROUTINE OPERATIONS IN COLD WEATHER

NAVIGATION

Cold weather and extreme latitude operations present several unusual challenges to the navigator. Loss of effectiveness of magnetic and gyro compasses at extreme latitudes, unfamiliar chart projections in the polar regions, frequent cloud cover and periods of constant daylight or darkness are a few of the factors which require special attention on the part of the navigator. More detailed information is contained in Chapter 4 and in Chapter XXV, "Polar Navigation," NVPUB9VI, *American Practical Navigator*.

MAGNETIC COMPASS

As the poles are approached, the horizontal component of the earth's magnetic field (used by magnetic compasses to find North) reduces to the point where a magnetic compass becomes erratic or totally ineffective. At the same time the earth's vertical magnetic component (influenced by the ship's structure so as to cause deviation) remains constant and deviation exerts an increasingly large influence on magnetic compass behavior. In an effort to minimize these effects upon magnetic compass performance, the ship should be swung in high latitudes, prior to entering areas of sea ice. The flinders bar and the horizontal and heeling magnets should be set to minimize deviation.

Azimuths should be taken frequently to monitor magnetic compass performance. Large deviations are still likely to be a problem as are significant local magnetic variations. Swinging the ship when large magnetic compass errors are evident may be necessary to distinguish between the effects of variation and deviation. While these factors might lead one to decide that the magnetic compass should not be utilized in extreme latitudes, it must be carefully monitored for variation and deviation at all times since it may have to be relied upon should power be lost to other navigating systems.

GYRO COMPASSES

Gyro compasses also become less effective and reliable as the poles are approached. Azimuths should be taken frequently (every watch) between latitudes of 70° and 85° to monitor gyro error. The gyro compass should not be relied upon at latitudes greater than 85°.

SATELLITE NAVIGATION

In the extreme northern and southern latitudes, Navigational Satellite (NAVSAT) coverage is the best in the world as NAVSATs circle the earth in polar orbits. In fact, the frequency of satellite overpasses can cause difficulty in correctly identifying and tracking a given satellite. This is a problem primarily with the older model NAVSAT receivers, those requiring hand tracking of satellites. Newer NAVSAT receivers which automatically track satellites do not have this difficulty. In general, experience has been that both coverage and accuracy are excellent in northern latitudes.

SHIPS INERTIAL NAVIGATION SYSTEM (SINS)

The AN/WSN-5 unit common to those surface ships carrying SINS is unaffected by proximity to the poles. No special operating procedures or corrections are required to utilize the AN/WSN-5 near the poles or under other cold weather conditions.

ELECTRONIC NAVIGATION AIDS

Omega, Loran C and DECCA are all available in northern latitudes with variations in coverage depending upon system and location. Although Omega is a worldwide navigational system, some difficulties can be experienced in extreme latitudes. Omega signals suffer attenuation when passing over large bodies of ice, such as Greenland, the Polar ice cap or Antarctica. This can affect the ability to receive certain Omega stations depending upon ship's position. Another problem with Omega unique to the Polar Regions is polar cap absorption. This is the result of the atmosphere in the Polar Region being ionized due to occasional solar activity. This phenomena affects signal strength and phase deviation. The accuracy of Omega fixes is affected more than the ability to obtain an Omega fix.

CHARTS

Mercator projection charts become increasingly difficult to use as one's latitude increases beyond 70°. The projections more frequently used for Arctic Region charts are:

Transverse Mercator Projection
Modified Lambert Conformal Projection
Polar Stereographic Projection
Polyconic Projection

The increasing convergence of the meridians as the pole is approached causes the true directions of an oblique course line to continually change as the line is traveled. The polar grid provides the navigator with the changing true courses needed to follow a given oblique line near the pole. A polar projection chart is superimposed with vertical lines which are parallel to the Greenwich meridian and tangent to each latitude circle. After the line for the desired track is drawn on the chart, the angle between each meridian and the desired track gives the course to be steered as that meridian is crossed to follow the desired track. This provides a close approximation to a great circle route between two points when passing near a pole. Figure 6-1 is an example of a polar grid. A complete description of the polar grid and its use is provided in H.O. Publication No. 9, Chapter XXV - Polar Navigation, *American Practical Navigator*.

Due to the unique nature of navigating near the pole where the longitude meridians converge, it is particularly important for the navigator to recognize which projection is being used, as well as any unique requirements for the use of that projection.

RADAR NAVIGATION

Radar has some limitations as a means of accurately and reliably fixing position. Obtaining fixes using radar ranges from points of land is often less than accurate for several reasons. Due to relatively little survey information, the charts for the Arctic and Antarctic regions are not as accurate as those for most regions. It is also frequently difficult to distinguish between points of land and ice on radar. For these reasons, fixes obtained by radar range navigation tend to be less accurate than those obtained by similar means in other areas of the world. Ranges should be plotted to as many points of land as possible when forced to rely upon radar range navigation. In the event that all ranges fail to intersect within a reasonable area to constitute a fix, continued plotting and study of the ranges may be required to determine which, if any, of the charted points of land plot accurately for navigational purposes. The major benefit to radar range navigation is that fixes obtained from radar ranges are not affected by gyro error which can be erratic, significant and unpredictable in extreme latitudes.

VISUAL NAVIGATION

Bearing takers need to be properly clothed and protected so they can perform effectively when conducting visual navigation under cold weather conditions. Depending upon the conditions (temperature, wind, spray, rain, etc.), it may become necessary to rotate bearing takers more frequently.

In many cases visual navigation will not be possible during cold weather operations. Visibility due to rain, snow or fog may render the taking of visual bearings impossible. Of greater concern is the general lack of visual navigational aids (landmarks) in most cold weather regions. The Arctic and Antarctic both lack the visual navigational aids such as ranges, buoys, buildings and radio towers that are available in most coastal and harbor navigational situations. In the event that visual navigational aids are available

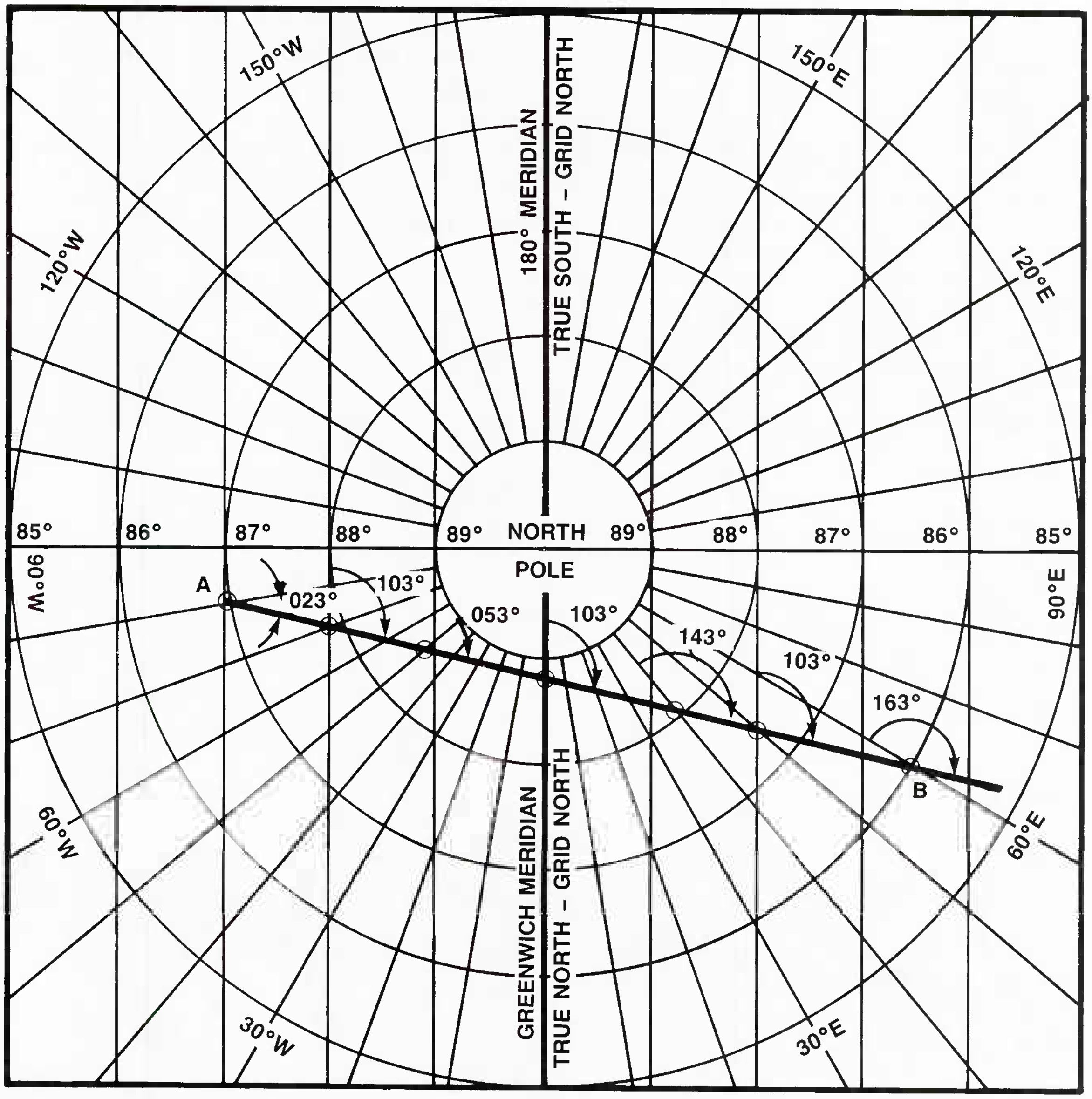


Figure 6-1 Polar grid navigation.

while operating in extreme latitudes, it should be remembered that visual navigation is profoundly affected by gyro error, a major concern in these latitudes. For these reasons visual navigation is essentially nonexistent in both the Arctic and the Antarctic.

CELESTIAL NAVIGATION

When operating in lower latitudes under cold weather conditions, celestial navigation may be essentially unaffected. However, in higher latitudes, high seas and cloud cover may make sighting elevations to the heavenly bodies difficult or obscure the horizon and heavenly bodies from view. Cloud cover can be a major problem for celestial navigation in the northern latitudes. For example, cloud cover is present in the Arctic between 40% and 80% of the time in January and between 70% and 90% of the time in July.

Constant sunlight during the Arctic or Antarctic summer eliminates the possibility for routine celestial navigation by means of sighting the elevation to identified heavenly bodies above the horizon at twilight. The primary means of celestial navigation when operating during Arctic/Antarctic summer is the taking of frequent azimuths to the sun to monitor gyro and magnetic compass errors. Several sun lines taken over the course of the day can also be utilized to obtain a running fix. This becomes less effective if frequent course changes are required. Constant course changes at low speeds render a dead reckoning track, necessary for a running fix, inaccurate.

Constant darkness during Arctic/Antarctic winter will affect the availability of a visible horizon. The aurora borealis will also frequently obscure portions of the sky. Familiarity with a number of stars will minimize this effect.

Times of continuous daylight/darkness are illustrated in Figure 6-2.

SUMMARY

A combination of Loran C, DECCA and NAVSAT, augmented by radar and celestial navigation when available, is the recommended means of maintaining a reliable navigational track when operating in the Arctic. A comparison of position information is more important than usual in the Arctic where atmospheric conditions can affect electronic navigation information and magnetic anomalies characteristic to Polar Regions can affect magnetic and gyro compasses.

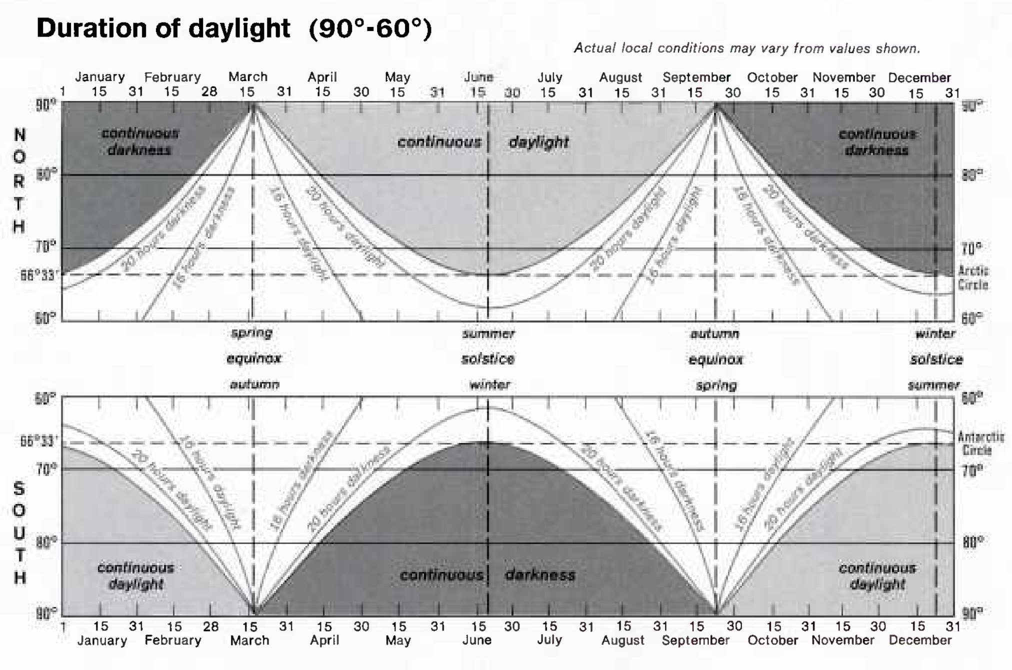


Figure 6-2 Duration of daylight.

MANEUVERING IN SEA ICE

SEA ICE

Fast-moving cold fronts can drop air temperatures more than 20°F in only a few hours. If the sea surface is near freezing and air temperatures drop, the surface of the ocean can become covered in a slushy ice within hours. The ship will have to force its way through the slush which may accumulate in a mass ahead of the ship. When the mass becomes too great to move, the ship must back away from it and start on a new path. This may become a tedious, time and fuel consuming operation.

Detection

Sea ice does not always appear on radar due to its low profile. Also it may become lost in radar sea return. Visual searching by the bridge team and lookouts is the most reliable means of detecting the proximity of sea ice. There are several things lookouts can observe which indicate that sea ice is near. An abrupt smoothing of the seas suggests that pack ice is near to windward. A sudden wall of fog may be located over the edge of pack ice. The sighting of birds and seals far from land is a clue that pack ice is not far away. A white glare on the horizon to about 15° elevation above the horizon indicates that pack ice is in that direction. This is known as *ice blink* and is the result of the sun reflecting off the surface of pack ice. Ice blink is particularly visible with the presence of uniform cloud cover as shown in Figure 6-3. A sudden drop in air temperature and/or humidity is often a sign that the edge of an ice pack is nearby. Ships carrying or in company with helicopters can use them as advanced scouts to fly ahead and report the location of the ice edge. Individual floes can be encountered 40 or 50 miles before reaching the ice edge. Qualified ice observers and forecasters are available from the NPOC as ship riders for any ships anticipating operating in the MIZ.

Sea Ice Drift

Sea ice moves on a local scale in response primarily to the local winds. For a given wind speed, it will move further when winds are off-pack than on-pack. Floes colliding reduce the total ice drift. A good rule of thumb is that sea ice drifts at 1/100 the wind speed at an angle of 15° to 30° to the right of the wind (in the Northern Hemisphere).

Figure 6-3 Ice blink.

Entering Sea Ice

Decisions regarding whether or not a ship should enter sea ice depend a great deal on the mission and design of the ship and whether it is in company with other ships that are designed for ice operations (ice breakers). Ships that are not ice-strengthened have to be extremely careful when operating in and around ice due to the risk of suffering damage to the hull, screws, rudders and appendages. If the edges of the ice pack lying in the ship's path can be seen, it is generally wise to skirt the ice edge.

A non ice-strengthened ship should always enter an ice field at a very slow speed and gradually increase speed to maximize steerage way and maneuverability while minimizing the potential for damage from the ice (generally 2-5 knots, depending on ice concentration).

When operating in sea ice, screws and rudder are exposed to damage from ice being drawn under the stern of the ship. The possibility of damage increases with increased forward speeds and always exists when backing.

Satellite images from polar orbiting satellites normally used for weather forecasting may be used to detect gross ice features such as the ice edge and the largest leads and polynyas if the skies are clear. Radar should be used to track features identified by helicopter reconnaissance.

When following an ice breaker into an ice floe, the goal is to remain close enough to the ice breaker to pass through the channel it creates before the ice closes back in. Leave sufficient distance for unexpected stops which occur frequently in ice breaking operations. Generally, 200 to 300 yards astern is appropriate, but will vary with conditions. The ice breaker should be relied upon for guidance in this matter. Effective communications must be established with the ice breaker.

ICEBERGS

Icebergs are large pieces of freshwater ice that calve off glaciers and fall into the sea.

Detection

The primary means of detecting the presence of icebergs is from iceberg tracking reports provided upon request to ships operating in areas where icebergs might be encountered. Navy and Coast Guard units can obtain iceberg tracking reports from:

Commanding Office
Naval Polar Oceanography Center
4301 Suitland Road
Washington, D.C. 20390

Requests may also be addressed by AUTODIN message to:

NAVPOLAROCEANCEN
SUITLAND MD

In addition to monitoring iceberg tracking messages, ship's force must also be vigilant for the possible presence of icebergs. Radar is the primary shipboard means of detecting large icebergs. Large icebergs generally show up well on radar and are therefore not difficult to detect and avoid. Growlers, however, are not always visible on radar, particularly in rough seas where they tend to get lost in the sea return of the waves. While growlers do not usually pose the same kind of threat to ships as contact with an iceberg, they can cause hull damage and significant screw, rudder and appendage damage.

Active sonar can be used as an additional source of information when on the lookout for icebergs. Again, icebergs can usually be detected on active sonar due to their size. In some cases, growlers not visible on radar will be detected by active sonar.

Lookouts are another means of remaining alert for the presence of icebergs. In reduced visibility lookouts should be stationed in the eyes of the ship and protected, to the maximum extent possible, from the wind. In fog a lookout stationed high in the ship may be able to see approaching icebergs better by looking down through the fog than lookouts situated nearer the surface.

Maneuvering in the Vicinity of Icebergs

Icebergs should be given a wide berth. An iceberg is far larger under the surface than it is above the surface; in fact, about 90% is under water. The underwater portion of an iceberg will be irregular in shape and often will include underwater protrusions known as rams which could pierce the hull of a ship venturing too near. There is also the possibility that an iceberg could suddenly topple over due to a change in its center of gravity, the result of constant melting and erosion of the underwater portion of the iceberg. In addition to maintaining a safe separation, ships should pass to windward of icebergs. Icebergs are typically accompanied by bergy bits and growlers recently separated from the main iceberg and these smaller pieces tend to stream downwind from the iceberg.

COMMUNICATIONS

ANTENNAS

Ice formation can be a hazard to all types of external antennas, causing breakage or changing the antenna characteristics and reducing the operating range. Ice and snow should be removed from antenna strain insulators to prevent excessive transmission losses.

All antenna connectors should be checked daily, if possible, since high winds can unravel the protective tape.

When icy conditions exist, personnel should wear two safety belts when working aloft, one of which must be firmly secured at all times. Maintenance aloft should not be attempted unless an emergency condition exists. Rigging of appropriate protective cover against windchill and installation of portable heaters will reduce the effects of extreme cold weather conditions and allow for greater hands-on maintenance.

In the event electronics repairs become necessary, they can be difficult since solder will not flow below -4°F using conventional irons.

Communications and navigation antennas need to be monitored frequently for icing. Movable/rotatable communication antennas must be frequently rotated to assure they are not frozen in place. All deck edge antennas should be raised whenever possible to reduce spray/ice build-up.

Fan antenna insulators must be deiced and cleaned, as necessary.

TELEPHONES/MICROPHONES/TRANSCEIVERS

When using telephones or microphones in exposed locations, care should be taken to prevent the speaker's breath from freezing in the microphone.

Small power communications transceivers should be kept inside the clothing to allow body heat to extend battery life. This includes spare battery packs as well.

COMBAT SYSTEMS READINESS MAINTENANCE

Ice formation on rotating antennas will only coincidentally be symmetric. With sea spray icing, the ice will create a geometric rearrangement of dipoles and reflectors.

In addition to electromagnetic effects, the weight, center of gravity, wind resistance and center of wind force will all be shifted by ice encrustation. These mechanical effects will increase the loading on the antenna drive and support systems. As mentioned above under "Antennas," no maintenance aloft should be attempted unless an emergency condition exists and all necessary precautions have been taken. During cold weather operations, all antennas should be left rotating with their pedestal heaters on.

Directors/illuminators should be rotated at least once daily. Equipment that is not in regular use needs to be heated periodically to drive out moisture. Waveguides and other nonpressurized lines that are fitted with drain cocks should be drained at regular intervals to eliminate accumulated condensation. Wave guide dryers, if provided, must be used as directed.

Equipment which is used in exposed positions, and which is returned to warm spaces for stowage after use, must be thoroughly dried to remove all traces of moisture formed by condensation due to temperature change. After drying, the equipment should be left open in the warm space for some time prior to stowage.

The AN/SPY-1 antenna faces must be cleaned when weather and sea conditions permit. Monitor the SPY antenna using SWR or other means, so that icing and possible deterioration of performance can be recognized early.

BOAT HANDLING

All small boat handling operations are more difficult and hazardous during very cold weather. This section contains recommendations which pertain to various aspects of small boat handling including boat preparation and stowage, boat crew training, boat equipment, launching, operations afloat and retrieval. Recommendations concerning life rafts are also included in this section.

BOAT PREPARATION AND STOWAGE

- Provide a cover for every boat which covers the entire top of the boat down to the waterline. Secure the cover with multiple lines so the crews can uncover parts of the boat to conduct routine maintenance without removing the entire cover. Do not use straps made of velcro, since it does not perform well in heavy weather.

- Install electric auxiliary heaters on boat engines (engine block, oil system or cooling system) for easier starting. Equipment available from auto parts stores such as dipstick heaters are effective. Other means which can be used to keep boat engines warm are heat lamps, floodlights, drop lights and insulation blankets.

- Install heaters on boat batteries to prevent the loss of capacity which occurs at low battery temperatures. Install jump start connections to the boat batteries. Connect a constant trickle charger to keep the boat batteries fully charged at all times. Ensure that plenty of spare batteries are in stock.

- Install antifreeze (ethylene glycol) in the engine cooling systems to prevent freezing. A minimum 60/40 mixture of ethylene glycol and water should be added to the boat's saltwater pumps and bilge pumps to prevent freeze damage and to the bilges to prevent ice build-up.

When starting a cold boat engine, the air intake should be covered to stop (choke) the engine in case of a runaway caused by high viscosity oil on the injector rack.

- Special low viscosity cold weather lubricants (motor oil, gear oil and greases) should be used to replace the lubricants used normally.

- A complete inspection and required routine maintenance of the lifeboats and the launching equipment should be made daily to ensure their readiness.

- Remove portable J-bar davits and secure them below decks.

- Debarkation nets and cargo nets used in man-overboard recovery may become heavily iced in their normal position on the lifelines and will be useless for rescue purposes. They should be removed and stowed below.

- Heavy seas may prohibit the use of ordinary small boats. If possible, a zodiac type boat which has excellent seakeeping capability should be included in the ship's cold weather kit.

BOAT EQUIPMENT

- Radio direction finders and radar reflector devices should be included in the boat gear. Because of whiteout conditions which frequently occur in Arctic regions, this equipment is often the only means of controlling and communicating with small boats. One radio plus a spare is the minimum that should be carried on each boat. Radio batteries should be routinely changed after a full day's use and spares should be carried in the boat.

- Anti-exposure suits should be provided for the crew of every small boat. These suits provide the best protection from cold weather and also provide flotation and protection in cold water.

LAUNCHING

- Check fuel, lubricating oil and boat equipment each time before launching. To ensure quick response of ready lifeboats during special operations, the boat engines should be run for five minutes prior to beginning the operation. Ether should be used for quick starts of sluggish boat engines. Fuel tanks should be kept full to prevent condensation and freezing.

- Engines should be warmed-up very slowly prior to launching boat. If the engine is cooled by an external water intake, the water flow rate should be reduced to a minimum (just enough to prevent overheating of the engine).

- Ensure the davits, sheaves, hook and bail assembly and other equipment are operational before launching.

- Boat falls may birdcage on the winch when cold. The heating of winch machinery by running it for one hour will improve performance. The best prevention of birdcaging is to keep falls free of ice.

- Prior to launching, all drain plugs should be in place.

OPERATIONS AFLOAT

- When operating in sea ice, a bow lookout should be stationed in a position to warn of nearby ice.

- Use caution when approaching ice. Proceed at slow speed, avoiding as much as possible any contact with the ice. If contact is unavoidable, push against the ice at a slow speed so that the piece of ice will be moved to one side.

- After a landing is made, the engines should not shut down. Coxswains should never leave their tillers unattended. When there is drifting ice about, the boat should always be ready to move quickly.

RETRIEVAL

- When a boat is hoisted out of the water, the drain plugs should be removed from the drain holes or they may become frozen in place. If the engine is cooled by an external water intake, the engine block should be drained to prevent freezing.

- When the boat is lifted from the water, the struts, propeller and sea suctions should be checked for damage.

LIFE RAFTS

The potential for life raft launching system malfunction is significantly increased in cold weather environments because of ice accumulation. To safeguard against unplanned launching of life rafts, all life raft hydrostatic releases should be wrapped in clear plastic bags and sealed. Rafts will still release automatically in this condition. The life rafts and launch equipment should be inspected daily and deiced as necessary. Both low-pressure steam lances and hot seawater systems are recommended for deicing.

Tests during previous Arctic operations indicate that a light ice accumulation leads to only minor difficulties in deploying inflatable life rafts. However, a heavy ice build-up makes the rafts useless in an emergency.

AIRCRAFT HANDLING

Weather will influence all aspects of flight operations, from engine/aircraft performance to personnel. In the upper latitudes storms can appear suddenly without warning and last for days. Tanker planes should be on alert status to provide in-flight refueling of planes that cannot be recovered until after the weather subsides.

The effects of icy weather may render the ship's elevators unusable. Anything necessary on the deck, including the aircraft, should be positioned on deck to ensure availability.

Extra care will need to be taken due to the high winds. During one recent expedition, wind over the deck consistently ranged from 50 to 80 knots.

FLIGHT DECK

Tie-downs

High winds combined with the slippery decks can move both planes and equipment, which necessitate use of extra tie-downs as shown in Figure 6-4. (12-point tie-downs were used successfully on a recent exercise.) Extra tie-downs

Figure 6-4 Cold weather tie-downs.

will also be needed for deck machinery and equipment.

Tie-down padeyes, since they extend below the deck, will accumulate any liquid, slush or snow and subsequently will become packed and frozen, rendering them unusable. One solution is to apply ethylene glycol or methanol to the padeyes, which will melt the frozen liquid. (Ethylene glycol, however, will cause a slippery condition.) Avoiding any spills and sparing use will help reduce the total volume put on deck. The preferred preventive action is continuous clearing of the deck, which helps keep the padeyes clear.

Clearing The Deck

Keeping the deck clear of ice and snow should be a primary consideration. This section will discuss some methods of keeping the deck clear.

Jet aircraft equipped with exhaust deflectors may be taxied or tethered/towed along the flight deck and used as snowblowers. A-6s are known to work because of the downward deflection of their exhaust.

Plows can be fabricated for use with tractors for snow removal. Caution should be used to take the extra width into consideration. Damage to and/or removal of the nonskid resulting from this method should be anticipated. And, as always, a slow but sure back-up is an old-fashioned shovel brigade.

Keeping the deck clear is important in avoiding FOD. It is difficult to see objects on the deck when they are covered or mixed with snow and slush. Chunks of ice, especially from frozen padeyes, are FOD items common in cold temperatures.

MANEUVERING

Maneuvering and handling aircraft with slippery decks and high winds can be very difficult. When aircraft with wings in the folded upright position are taxied, they can be susceptible to damage from a crosswind. (In general, this should not be done with winds greater than 25 knots.) In some cases, turning aircraft around may not be possible because of high winds. Aircraft with large sail areas (particularly the E-2C) can be caught on their side by high wind. On one recent expedition, it was necessary to position E-2s on the cat for starts during downwind headings. Plane captains accustomed to walking along with the aircraft while taxiing/towing must be ready to toss chains or chocks in front of tires because of higher tendency for the aircraft to slide.

While aircraft are taxiing, any crew members exposed to rotor down-wash could be exposed to the increased risk of frostbite from the high winds and propwash. Reduced deck traction will reduce personnel's ability to withstand winds encountered at normal distances. Wider berth for both aircraft and personnel movement will be required.

There is higher residual thrust at ground idle which makes turning and stopping more difficult on cold and slick decks. Sliding sideways is not uncommon. Differential braking, as well as differential thrust, may be needed in some cases.

COLD WEATHER AIR OPERATIONS CONSIDERATIONS

Unrestricted use of elevators cannot be counted on in cold weather; therefore, planes and equipment will need to be kept on deck.

Increased room is needed between aircraft for safe operations in icy conditions. Therefore, nonessential aircraft will need to be left in the hangar to accommodate additional area requirements.

To alleviate damage to wing fold actuators in high wind conditions, wings should be spread prior to turning crosswind. Close coordination among the OOD, the air boss, the flight deck officer and the flight deck crew will be required. Wing locks should be left in place whenever possible.

Time delays occur in turnarounds during cold weather. Aircraft movement, starts, checks and loading require more time and personal attention to detail.

AIRCRAFT CARE AND MAINTENANCE

Icing

Even with all precautions taken, icing can occur and deicing will be required. Deicing can take several hours if the ice build-up is heavy. Safety harnesses are a must for personnel working/deicing on top of the aircraft. Deicing generally works well at removing the ice and keeping it from forming, but it should be noted that the deicing solution has a tendency to wash off and is very slippery. Deck washing is not easy in cold temperatures and the detergents do not emulsify well. One section of the deck should be designated solely for deicing and care must be taken to keep glycol off the rest of the deck.

Helicopter icing can be a serious problem, especially on the SH-3, which ices up under snow squall conditions. Visible moisture in the air, in the form of steam or fog, should be avoided. Indications of icing include:

- Ice on the windshield and wiper blades
- Rise in compressor speed
- Rotor vibrations

Fuel

The tendency of entrained moisture to separate out of fuel is increased at lower temperatures, resulting in more water accumulation (up to several gallons of water per 1,000 gallons of fuel). The water will settle to the bottom of the tank since it is heavier than the fuel. If this occurs at below freezing temperature, the water will crystallize and freeze fuel drains and internal valves. Condensation in service and storage tanks can also create large amounts of water and cause a loss of fuel system icing inhibitor.

CAUTION

Fuel spilled on personnel's skin can cause severe frostbite of the affected area. Protective gloves should be worn at all times.

Mechanical Concerns

Aircraft become cold-soaked in about two hours. Brake failures are common with severe hydraulic problems. (This occurred from 3 to 5 times per day on a recent exercise.) Fluid leakage is common. Seals, unions and O-rings tend to shrink and leak, or shrink at different rates in extremely cold temperatures. Frequent replacement of oils and seals may be required to operate aircraft, especially aileron/spoiler extension unit seals. Hydraulics should be heated 10 to 15 minutes before moving the controls, then moved slowly to assure proper lubrication. Fluid levels should be checked more frequently during the cold.

High winds can necessitate the folding of rotors on alert helicopters. Helicopters would then have to be downgraded to Alert 15 due to the time required to spread rotors.

Other Notes:

- Moisture freezing on pitot static ports/probes can be reduced by using covers. Snow accumulation in alert F-14 ramp bleed duct areas may need to be swept out by hand periodically. As a general rule, if ice is detected, the plane should be downed.
- Sum/difference and IFF wave guides may need to be repacked on all E-2s because of cold shrinkage at couplings and subsequent loss of wave guide pressure.
- Wingbutts should be frequently deiced and cleaned. Wingbutt cannon plugs need to be cleaned and dried 30 minutes prior to man-up for each launch.
- Ice in pigtails may cause frequent external fuel tank quantity errors.
- Engine inlet anti-ice element failures may require several element changes.
- Ramps/bleed exit doors collect snow and ice and must be cleaned continuously in alert aircraft. Bleeding exit covers helps

reduce the amount of snow and ice accumulation.

- Due to high winds and high sea states, cold effects on personnel and slippery decks, aircraft handling times may be increased by a factor of at least two. Earlier than normal preparation and increased exposure time must be anticipated. Crew rotation and warming will be a priority.

UNREP/VERTREP/HELO OPERATIONS

The following sections present observations, suggestions, recommendations and precautions based on lessons learned by personnel experienced in cold weather operations. These suggestions should be followed to ensure maximum safety and efficiency of UNREP operations in a cold weather environment.

COLD WEATHER CONSIDERATIONS

Under high sea state conditions, downwind, quartering or sea astern courses may make ship handling difficult. Even if ship handling appears to be no problem, replenishment distances near the maximum should be used to guard against rogue seas which may cause an unusual roll, surge or yaw. Two of the best helmsmen available should be used during UNREP to spell each other.

When the sea states are high, separation distance between the ships should be increased and the size of the loads transferred should be reduced. Under these conditions, the handling of heavy cargo on deck is more dangerous and UNREP crews will need to work slower and more deliberately. Extra supervision should be provided during operations in severe weather. There should be one safety observer watching the UNREP rig crew and another watching the line handlers.

Most combatants can take the phone/distance line from midships instead of the forecastle, if necessary, to reduce the line handlers' exposure to the elements.

Careful planning and coordination between the delivery and receiving ships are necessary to ensure that the staging, transfer, receipt staging and strikedown are done quickly enough to prevent freeze damage. Some cargo such as food, weapons and medical supplies may be damaged by freezing or long-term exposure to low temperatures.

PRE-UNREP OPERATIONS

Before beginning UNREP operations, lifelines and cargo nets should be rigged to help protect personnel from falling overboard.

All deck surfaces and equipment should be cleared of snow and ice prior to beginning UNREP. Safe footing for personnel is essential for a safe UNREP operation and clear decks are required for materials handling by pallet trucks and fork lift trucks. Additionally:

- Use rock salt to melt thin layers of ice at temperatures above 15°F.

- Use calcium chloride to melt through thicker ice layers to reach the deck. Calcium chloride produces heat when mixed with water so it acts faster than rock salt. A mixture of one part calcium chloride to three parts rock salt will be effective to temperatures of 0°F and below.

CAUTION

Calcium chloride will burn skin and eyes so rubber gloves and goggles must be worn when handling. Avoid breathing dust. Use with adequate ventilation.

Urea should be used for melting thin layers of ice above 15°F and for preventing ice accumulation in freezing rain. Urea is less corrosive than rock salt or calcium chloride.

Removing winch covers will accomplish much of the deicing. Because ice is weak in bending, a blow struck in the middle of a cover should shatter all ice in the vicinity.

Ice should be removed manually from the kingpost and sliding padeye mechanism prior to use. Self-deicing by means of system operation may cause damage to the sliding padeye and should be avoided.

Winch transmissions should be warmed up before full power operation.

MINIMIZE CREW EXPOSURE

In cold weather, line handlers and rig personnel should be rotated into a heated waiting area inside the ship. Two complete crews per station may be needed so that personnel are not overly exposed. In extreme cold weather, the number of rigs may have to be limited to allow for more frequent personnel rotation.

- To reduce prolonged exposure to the elements, UNREP details should not be called out too early.
- Crew members should not allow themselves to get warm and sweaty when wearing foul weather gear in heated areas. Outer gear should be put on shortly before UNREP or personnel should step outside to cool off if they get too warm inside.
- In high winds canvas wind screens should be rigged to protect crew members.

UNREP EQUIPMENT

The following are some general comments concerning UNREP equipment:

- Lines may not be able to be faked out early on deck due to freezing.
- Chemlites lose intensity after one or two hours in cold weather. For this reason they should be activated just before coming alongside and spares should be kept nearby.
- Because ram tensioners may be sluggish in cold weather, antislack devices may have to be turned up to pull wire rope through the ram tensioner.
- Wands and marker lights should be kept in a heated compartment (rather than stored in unheated FAS lockers) until needed for use.
- Electric megaphones should be kept in the pilot house until needed for use.
- The phone distance line should be stowed in a heated space until needed. This will keep the battery voltages high on the distance lights and also keep the phone line more pliable and easy to handle.
- Life jackets for UNREP personnel should be stowed in a heated space until needed on deck.
- To minimize problems due to icing, all small UNREP equipment should be stowed below decks when not in use and replaced below when operations are finished.

VERTREP/HELO OPERATIONS

Crews working on vertical replenishment operations or other helicopter operations should pay special attention to protecting themselves from the high windchill factor caused by helicopter rotor down-wash.

All ice should be cleared from decks, RAST and other equipment in the VERTREP area because the ice can break loose and cause foreign object damage (FOD) to the helicopter engines.

MAINTENANCE

Most routine maintenance of topside equipment will be impractical under cold weather and high sea conditions. Wherever possible, routine maintenance of all exposed equipment should be performed in advance of the cold weather operations.

Some maintenance of the seawater service system and firemain system may become necessary during cold weather operations which is not necessary during normal operations:

- Small ice particles may be drawn into the seawater service or firemain systems and cause clogged strainers. More frequent strainer cleaning may be necessary.

- Larger ice particles or chunks in the seawater may be drawn into sea chests and clog them. Connections are provided on the sea chests to permit them to be blown out with steam or compressed air.

- Sea chests can become clogged with sea ice causing loss of suction to main condensers, firemain and other auxiliary systems. Systems taking suction from the sea must be closely monitored when operating in sea ice. Operators must be prepared to shift suction and/or blow out sea chests with L.P. air in the event of loss of suction due to sea ice ingestion.

PERIODIC EXERCISE OF EQUIPMENT

All major equipment exposed to the cold weather environment should be checked and operated periodically to maintain a high state of readiness. Specific recommendations for the periodic checkout and exercise of boat engines and boat handling equipment, UNREP and other deck equipment, aircraft handling, communications and combat systems equipment are presented in the corresponding sections of this chapter.

The CRP propeller hydraulic oil will be cooled as it passes through the cold shaft and propeller hub components. If the oil gets too cold and viscous, pump damage due to cavitation may occur. When in port, keep the oil circulating and the pitch control operating to warm the oil.

EMERGENCY RESPONSE GEAR

Emergency equipment stored topside will in some cases require alternative stowage to protect it from ice accumulation and cold temperatures. It is imperative that the appropriate personnel are thoroughly aware of the new stowage location.

Emergency systems, such as firefighting and washdown systems, which have been partially drained and isolated to prevent freezing, must be capable of functioning completely without undue delay in activation. Overboard discharges used for dewatering compartments must be free from ice. Anchors must be functional when maneuvering in shallow water. Lifeboats and launches used in emergency rescue must be ready for action. Systems which are assumed to be functioning normally, and particularly those seldom used, that affect emergency response must be considered.

In addition to training personnel on the status of emergency response gear, it is important to frequently monitor the systems and equipment to ensure operability.

WATER ENTRY

Probably the last thing anybody in their right mind would want to do is enter freezing water. However, there are times when, either voluntarily or not, people may end up in the water. What is the best way to handle water entry? Here are some important aspects of cold water entry.

Of all the hazards associated with water entry (drowning, sharks, etc.), hypothermia is possibly the greatest danger in cold weather areas. Two factors contribute to this:

- Water conducts heat about 25 times faster than air.

- The water temperature is very low, often near the freezing point.

Even for properly protected personnel the combination of these factors makes survival in the water difficult.

The anti-exposure suit provides protection while dry (out of water) and acts as emergency protection in cold water. It traps water next to the body and minimizes the flow of cold water into the suit. When properly worn it can significantly enhance survivability. Likewise, any other clothing that traps water and provides insulation can aid in limiting heat loss. Regardless of the type of clothing, it is imperative that it be properly worn with all seals and closures fastened for maximum protection.

In addition to wearing proper clothing, there are some actions that can be taken by man-overboard victims to minimize heat loss. When a capsized boat is available or an ice floe is nearby, it is extremely important to get as much of the body out of the water as is possible. It is prudent even if heavy seas will repeatedly wet the victim and if the windchill factor is significant. Water will rob the body of more heat than the effect of windchill because of water's high thermal conductivity. Even in a wet or dry suit, it is better to be out of the water.

If abandoning ship is necessary in cold water, the best advice is to keep as dry as possible. The most waterproof outer layer available should be worn, even if it's only a plastic garbage bag with holes cut in it. Do not jump in the water before entering a life raft if at all possible! Huddling together with other survivors to conserve heat and provide emotional support is prudent. (This applies to multiple man-overboard situations too.) And most important of all, one can survive the effects of cold water entry and live to tell about it if properly prepared.

AT SEA

After taking to the life rafts and/or lifeboats:

- Stay clear of the ship (out of oil-saturated waters) but in the vicinity until it sinks.

- Search for missing personnel.

- Salvage floating equipment. Stow and secure all items and check rafts for proper inflation, leaks and points of possible chafing. Bail out the raft; be careful not to snag it with shoes or sharp objects.

- If not already done, don exposure suit, if available, and begin combating exposure, hypothermia or other physical debilitations. For example, rig a wind break, spray shield or canopy. Huddle together and exercise regularly. Check the physical condition of all onboard; give first aid if necessary. Take sea sick pills if available; wash off oil and fuels from the body and clothes.

- If there is more than one raft, connect rafts or boats with at least 8 meters of line.

- Get the emergency radio into operation if available. Prepare other signaling devices for instant use.

- Items such as compass, matches, watches and lighters should be stowed in waterproof containers such as plastic bags. Make a calm, careful review of the situation and plan a course of action.

- Securely stow water and rations; assign duties to the crew.

- KEEP:

  — a log
  — an inventory of all equipment
  — a supply of water and food
  — a ration schedule
  — calm; and above all
  — a sense of humor and use it often!

- Remember that rescue is a cooperative project. Increase visibility by using all possible devices for attracting attention.

CHAPTER 7

ICE ACCUMULATION, PREVENTION AND REMOVAL

ACCRETION MONITORING AND CONTROL

The regions historically known for producing significant icing conditions lie in the North Atlantic and North Pacific Oceans, as outlined in Figure 7-1. However, icing can occur in other cold weather areas.

ICE ACCRETION INFLUENCING FACTORS

Icing is caused by atmospheric and sea conditions. In subfreezing temperatures precipitation such as snow, freezing rain or mist can result in the formation of ice layers on exposed areas of the ship. However, high winds cause particularly heavy icing due to the amount of dense seawater spray produced by bow slamming. While many factors affect shipboard icing the major influences are, as follows, listed in descending order:

Air Temperature
Wind Velocity
Water Temperature
Geometry of Accreting Surface

Subfreezing air temperature and high wind velocity producing freezing spray from bow slamming are the overriding factors influencing the amount of ice accretion the ship can expect.

PREDICTING POTENTIAL SHIP ICING

There are no exact methods of predicting ice accretion for ships at sea. However, over the past two decades research and observations by scientists and mariners have led to some fairly reliable indicators that can be plotted graphically. The most noted of these are Mertins icing diagrams developed in 1968. Since the publication of the Mertins tables, a much improved data base and improved analysis have resulted in more accurate icing diagrams.

The results of the most recent studies are summarized in the nomograms (Overland, et al., 1986) of Figure 7-2, and are endorsed by the National Oceanic and Atmospheric Administration (NOAA). NOAA recommends that previous nomograms and the Mertins tables be disregarded.

The nomograms of Figure 7-2 are based on small ships studies and are provided as baseline data. As the size of the ship increases, a proportional decrease in the amount of accretion can be expected. These nomograms show potential icing on the ship's superstructure for four water temperature ranges and a ship heading into or abeam of the wind. Ships running downwind will not likely incur accretion rates as high.

THICKNESS

Under heavy icing conditions accumulations of greater than 0.8 inches per hour can be expected. In a 24-hour period this can amount to ice almost 2 feet thick or greater in some areas. Since most of this accumulation will occur about the superstructure and the forward one-third of the ship, stability can be severely affected.

In addition to general ice build-up, some fittings and equipment may pose special problems:

Liferails, Stanchions and Antennas

Icing is very dependent on shape and will occur first on smaller items, especially railings, lifelines and rigging. Antennas above the house can have heavy ice from sea spray before any is noted at deck level.

Accumulations of 12 inches in a 24-hour period have occurred, turning liferails into large

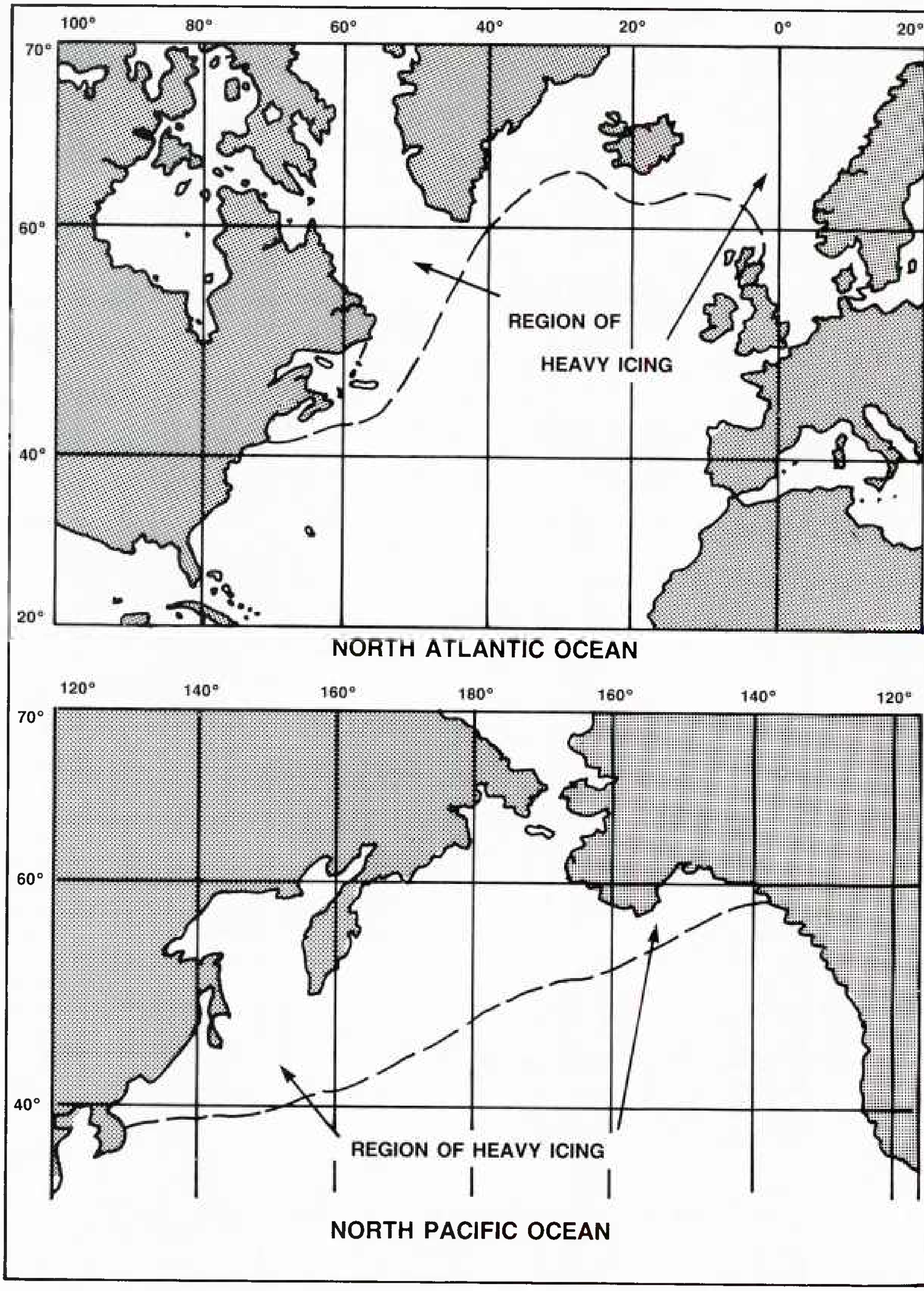
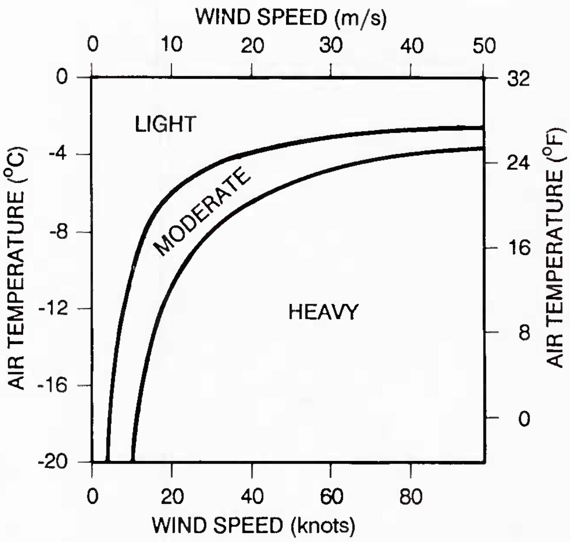
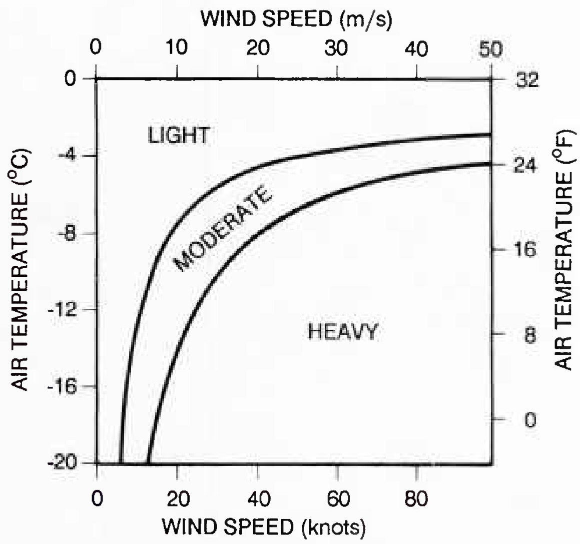


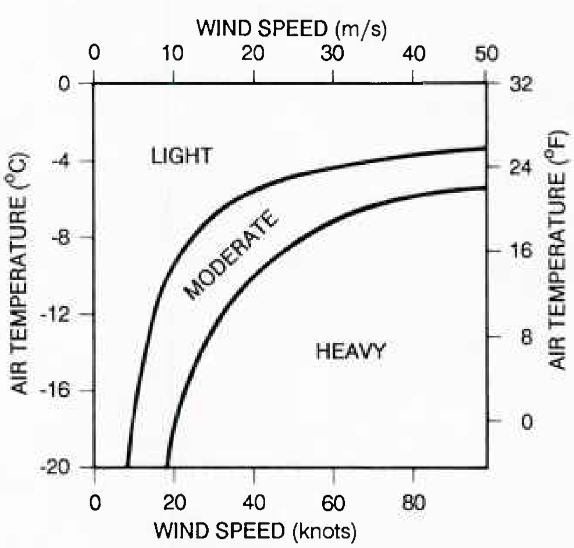
Figure 7-1 Regions historically known for producing significant icing conditions.



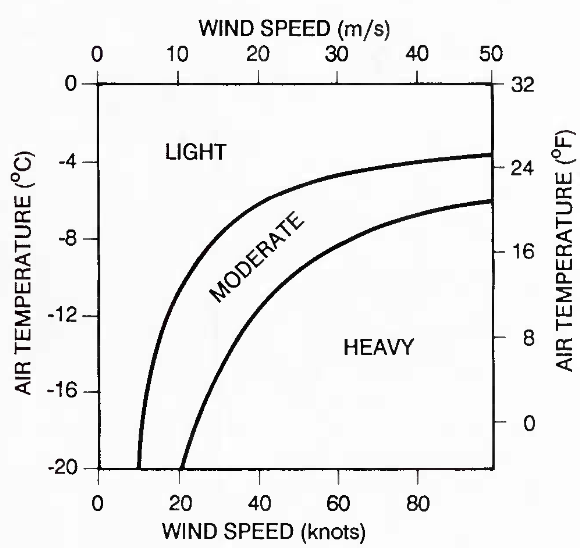
Icing conditions for vessels heading into or abeam of the wind for water temperatures of +1°C (34°F)



Icing conditions for vessels heading into or abeam of the wind for water temperatures of +3°C (37°F)



Icing conditions for vessels heading into or abeam of the wind for water temperatures of +5°C (41°F)



Icing conditions for vessels heading into or abeam of the wind for water temperatures of +7°C (45°F)

Light Icing - Less than 0.7 cm/hr (0.3 in/hr)
Moderate Icing - 0.7 cm/hr (0.3 in/hr) to 2.0 cm/hr (0.8 in/hr)
Heavy Icing - Greater than 2.0 cm/hr (0.8 in/hr)

Figure 7-2 The most recent nomograms (Overland et al. 1986)

bars of ice. This increases the weight of such fittings by several times their original weight.

Chocks, Fairleads and Scuppers

Accumulation around these fittings will block drainage and trap green water on the weather deck.

WEIGHT AND STABILITY IMPACT CONSIDERATIONS

The primary effects of topside icing in addition to ship systems and combat systems inoperability are increases in the ship's displacement and vertical center of gravity. Ice accretion to one side of the ship, caused by wind-blown spray on ships abeam of the wind will cause a shift in the ship's transverse center of gravity resulting in a list. The degree of severity these conditions may pose is dependent on several factors:

The Type of Ship

FFs, FFGs, CGs, CGNs, DDs and DDGs, as well as other ships with relatively large superstructures and low freeboard, are especially vulnerable. Larger aviation type ships, i.e., CVs, CVNs, LHAs and LHDs, are less vulnerable.

Ship's Stability Status

Intact stability critical ships in either stability status 2 or 3 are of particular concern. Status 2 ships cannot accept an increase in weight or rise in KG, while status 3 cannot accept a rise in KG. KG rise is a major concern due to high winds accompanying icing conditions.

Ship's Ballasting Capability

The ship's damage control book should be reviewed for the ballasting plan for topside icing. Note that extended cold weather operations may result in ice loading and wind velocities exceeding those considered in the damage control book. Ships with ballasting capability can account for changes in stability due to icing by changing their ballast.

POTENTIAL ICING LOADS

The nomograms of Figure 7-2 offer the best prediction method for icing available to the fleet. Laboratory experiments conducted at the Naval Applied Science Laboratory provide some further indication as to the potential weight increase that the ship may experience. Figure 7-3, presented to give an approximation of ice buildup, shows ice accretion versus wind velocity for six air temperatures. It's important to note, however, that icing rates vary with geometry of structure and orientation, whether horizontal or vertical.

Figure 7-3 shows, for example, that with wind speeds of 10 mph or approximately 8.7 knots, and an air temperature of 0°F, an ice accretion rate of 8 pounds per square foot can be possible. An FFG 7 class ship has over 7,000 square feet of exposed area on the forward one-third of the ship. Therefore, ice accretion could amount to 25 long tons per hour of high weight.

SHIP HANDLING CONSIDERATIONS

In many cases the rate of ice accretion can be reduced by course alterations. When possible, setting a course to minimize apparent wind velocity and bow slamming will reduce the amount of spray generated. In addition, ship's heading will affect the nature of ice accretion. Ships abeam of the wind will accumulate ice on one side, resulting in asymmetrical ice loading and a shift in the ship's transverse center of gravity. This is a major concern because the ship will heel to the leeward side from the effects of the wind and the resulting heel to windward, due to the weight of the accumulated ice, will not be noticed immediately. When the ship changes course across the wind, the wind heel will compound the heel due to the accreted ice.

When ice removal and ballasting measures are no longer effective and maintaining stability is doubtful, it will be necessary to relocate the ship to an area of less severe conditions, preferably on wind heading of between 120° and 240° relative.

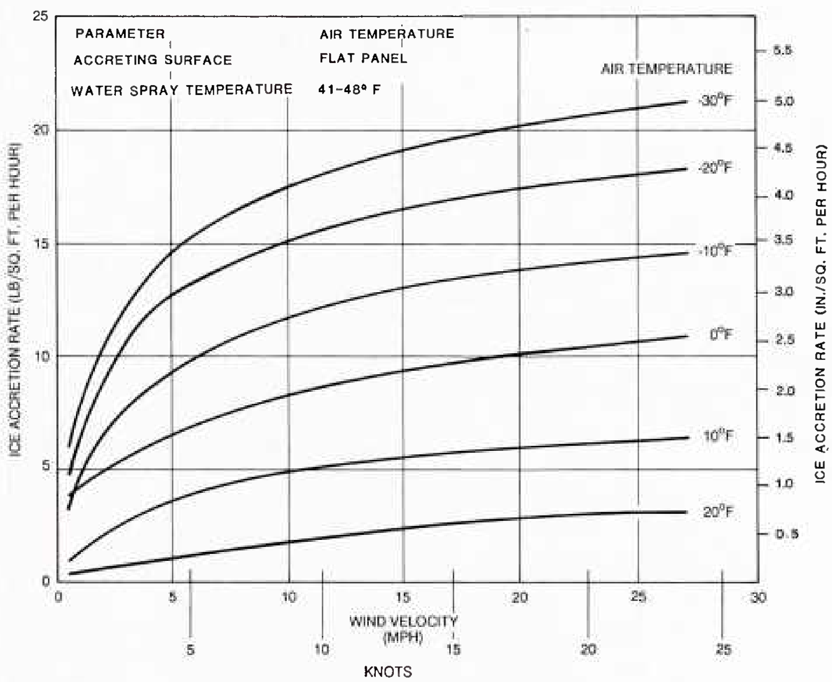


Figure 7-3 Ice accretion versus wind velocity for six air temperatures.

COATINGS

Coatings applied to topside weather surfaces to reduce ice accretion are referred to as ice-phobic coatings, meaning they have an aversion to ice. Ice-phobic coatings work by providing a very slick, nonporous surface which will shed water readily and will not form a good bond with the ice. Therefore, built-up ice is much easier to remove.

TYPES

There are two ice-phobic coatings that have proved effective in research and testing laboratories:

- FPC (Fluorocarbon penetrating coating). This coating is a hydrophobic coating for hulls to reduce drag. It has been found to be a good ice-phobic coating as well.

- Vellox 140.

Other ice-phobic coatings that have shown some success in nonshipboard applications have not shown much promise for shipboard application due to their incompatibility with other corrosion prevention coatings. Some are listed in Appendix C, with applicability and procurement information.

APPLICATION

Application Procedure

Ice-phobic coatings should be applied in accordance with the technical manuals for the ice-phobic coatings contained in Appendix C and applicable manufacturers' instructions.

Areas of Application

It is generally impractical and unnecessary to apply ice-phobic coatings to every above-waterline and topside area.

As noted in the first section of this chapter, "Accretion Monitoring and Control," certain topside locations are subjected to greater icing than other areas, depending on weather and ship's course. Also, certain topside equipment and fittings benefit greater from coating than others.

The following is a list of priority areas to be considered for coating application.

NOTE

Ice-phobic coatings, due to their inherent slickness, should not be used on walking areas of weather decks.

SUPERSTRUCTURE - Concentrate on the forward and side bulkheads, and apply coating beginning at approximately 2 feet above the weather deck. Ice below this point will tend to be more brittle and easier to remove, due to the settlement of brine in seawater.

Concentrate on the upper portions of superstructure that can be readily reached by ice removal crews in inclement weather. This will help to minimize ice accretion high in the superstructure, which has a more adverse effect on the ship's stability.

Treatment of the superstructure is less critical on CVs and amphibious ships of the LHD, LHA and LPH classes, due to relatively small superstructures and the attendant reduction on weight and moment impact.

MASTS, YARDARMS AND PLATFORM - Concentrate on areas that can be reached by ice removal crews. Also cover the sides and bottoms of yardarms and other spars, standing rigging, etc., where gravity and ship motion and vibrations will help dislodge built-up ice.

ANTENNAS, DIRECTORS, ILLUMINATORS, ETC. - Coat these equipments to avoid loss or degradation of navigation or communication facilities. Equipment manuals and manufacturers' recommendations should be consulted. Some coatings other than those cited as approved in this Handbook may be recommended.

HAWSE PIPE OPENINGS, CHOCKS, FAIRLEADS AND SCUPPERS - Coat these fittings to the extent practical to facilitate ice removal. This is important in order to maintain good drainage of green water from the weather deck. Concentrate on the weather deck area forward of the superstructure, although all fittings of this type should be treated, especially in-way VERTREP and helicopter landing areas. Note, however, that the life of the coating will be short, due to abrasion effects.

HATCH COVERS, DOORS AND SCUTTLES - Concentrate on raised hatch covers and scuttles to facilitate ice removal. This is important in order to avoid significant weight build-up on hatches and scuttles.

STANCHIONS AND LIFERAILS - Coat to the extent practical, especially forward of the superstructure.

TOPSIDE WEAPONS SYSTEMS - Consult weapons manuals for any ice-phobic coating recommendations and procedures for application.

MAINTENANCE

Ice-phobic coatings tend to lack abrasion resistance and some (Polysiloxane, for example) are sensitive to ultra violet sunlight. Ice-phobic coatings will generally have a short useful life and therefore should be applied just prior to anticipated cold weather operations. Some ice-phobic coatings are not compatible with the Navy's topcoat paint system. Some require controlled application conditions, some are difficult to maintain and some affect low visual recognition due to glossiness. Refer to Appendix C for more information and manufacturers' instructions for further information on each coating.

REMOVAL EQUIPMENT AND TECHNIQUES

When operating in cold weather conditions, snow and ice should not be allowed to accumulate to the point that the ship's stability or its operating capability is lost. Snow and ice removal operations should begin early and continue as needed to maintain the safety and readiness of the ship. Some equipment and techniques for ice and snow removal which have been successfully used during Arctic operations are described below.

SNOW REMOVAL

Snow, slush and soft ice should be removed from all topside surfaces as soon as possible. If fresh accumulations are not removed promptly, they may melt under the daylight sun and then freeze at night to form hard ice. Snow shovels and stiff push brooms are the most effective tools for removing snow from decks.

Snow can be removed quickly and easily by spraying it with firehoses, when the air and seawater temperatures are sufficiently high to prevent the freezing of seawater on deck.

On aircraft carriers, snow can be blown off the flight deck using the exhaust from a jet aircraft which has been secured to the deck.

ICE REMOVAL

Ice may be removed by physically breaking it up with deicing tools or by melting it with chemicals or heat. Tools which have been found to be effective for breaking or chipping ice off decks or equipment are: steel bladed ice scrapers, nylon mallets, baseball bats and garden tools such as spades, digging hoes and picks. The long handled ice scrapers are most useful for removing thin ice from decks. The mallets and bats are effective for heavier ice accumulations on equipment, ladders, lifelines, etc. The steel bladed garden tools are best for heavy accumulations of hard ice. All of these ice removal tools should be used with discretion on topside equipment, especially electronics and electrical gear which may be susceptible to impact damage from any heavy hammering action. Procurement information for these tools and the chemicals described below will be found in Chapter 3.

Thin ice can be removed most effectively from decks and other flat surfaces by the use of dry chemicals such as sodium chloride (rock salt), calcium chloride and urea. These materials are simply spread over the frozen surfaces in a thin layer as required. Rock salt is the most economical material and is effective above 15°F. Calcium chloride produces heat when mixed with water so it acts faster than rock salt. Use calcium chloride to melt through thicker ice layers to reach the deck. A mixture of one part calcium chloride to three parts rock salt will be effective to temperatures of 0°F and below.

Urea (granular or pellets) is effective for melting thin layers of ice above 15°F and for preventing ice accumulation in freezing rain. Urea is less corrosive than rock salt or calcium chloride. Sand can be used alone or in combination with any of the deicing chemicals to improve traction on ice-covered decks. More information about the specific properties and usages of calcium chloride and urea can be found in Chapter 9.

Ethylene glycol, methanol or approved liquid deicer are effective deicers and may be sprayed on equipment and decks from a garden sprayer. This method is recommended for equipment which might be damaged by mallets or bats.

If a source of steam is available, steam lances may be used for melting ice accumulations on structures and equipment. Thick ice formations can be removed by first cutting through them with the steam lance and then breaking them up with deicing tools. Compressed air can be used following the steam to blow the residual water off the deck or equipment before it refreezes.

Ice removal details should be formed to remove ice from flight decks or other decks where good traction is required for special operations such as UNREP. The ice removal sequence should be as follows:

1. Shovel snow and loose ice off of deck. Use brooms where possible to reduce damage to deck nonskid.

2. Use steam lance to melt residual ice.

3. Use brooms and compressed air to remove water.

4. Apply ethylene glycol, methanol or other deicing chemicals to equipment and deck areas to melt any remaining ice and to prevent immediate refreezing.

Portable hot air guns and hair dryers may be used for melting small deposits of ice and for spot thawing of pipes and mechanisms.

NOTE

Do not use hair dryers to defrost glass because the uneven thermal expansion caused by localized heating may cause the glass to break.

CHAPTER 8

HEAVY WEATHER SHIP HANDLING

Heavy weather ship handling in cold weather is largely the same as in warmer conditions. The frequency and magnitude of heavy weather encountered in extreme latitudes and the possibility of topside icing, however, make it of particular concern when anticipating cold weather operations. Figure 8-1 illustrates a heavy weather environment in the North Atlantic.

Heavy weather is encountered more frequently and with higher sea states in northern latitudes in both the Atlantic and Pacific Oceans. This is largely due to long fetches, expanses of open water along the direction of prevailing winds allowing the winds to build high wave systems. Heavy weather is more difficult to predict and lasts longer in northern or southern latitudes, increasing the possibility of encountering heavy weather with little or no notice. Confused seas are another characteristic of northern latitude heavy weather since more than one wave system frequently converge. These conditions can exist in northern latitudes in warm or cold conditions.

GENERAL HEAVY WEATHER CONSIDERATIONS

The main concerns in any heavy weather situation are to maintain stability, buoyancy, power and structural integrity.

Figure 8-1 Heavy weather encounter.

STABILITY

The chief engineer, assisted by the damage control assistant (DCA), is responsible for the maintenance of ship's stability. The three axes of motion and their corresponding elements of stability are: thwartships (pitch and sway), longitudinal (roll and surge) and vertical (yaw and heave). Transverse stability (roll) is by far the most significant for ship survival in heavy weather because capsizing is the most likely result of insufficient stability. Longitudinal stability affects deck wetness and the amount of hull stress induced as a result of slamming. Directional stability affects the ship's ability to maintain course in heavy weather. The monitoring and maintenance of transverse stability in heavy weather will be emphasized in the following paragraphs.

Major Effects To Transverse Stability

The height of the ship's center of gravity above the keel (referred to as KG) is the one variable in the stability relationship that can be controlled by shipboard personnel. A high center of gravity (large KG) reduces transverse stability. A low center of gravity (small KG) increases transverse stability. Every effort should be made while in heavy weather to maintain the lowest possible center of gravity.

Loading

Liquid load management is the primary means available to shipboard personnel for controlling KG while underway. Fuel loads should be maintained at the maximum possible level during heavy weather to prevent fuel shortages in the event UNREP is not possible for a period of time. It is important that consumed fuel be replaced in the tanks by salt water ballast between replenishments. This practice improves KG two ways. It prevents the loss of low weight through the consumption of fuel. It also prevents a situation where fuel in partially filled tanks sloshes from side to side as the ship rolls. This occurrence is known as free surface effect and has the same effect on ship stability as an actual rise in the center of gravity.

Other tanks, such as potable water tanks and propulsion plant feedwater tanks should also be maintained as full as possible. Again, this keeps weight low in the ship and prevents free surface effect. While water tanks are not generally ballasted (except perhaps in an absolutely critical stability situation) the liquid load should be actively managed to minimize the number of partially filled tanks. It is better to have one tank empty and another full than to have both tanks half-full with free surfaces on each.

Heavy deck loads should be moved below decks to get the weight as low as possible and also to prevent the loads from being damaged or lost during heavy weather.

One loading condition unique to cold weather operations is the accumulation of ice on the topside. Every effort should be taken to prevent, minimize and remove topside ice to maintain the lowest possible center of gravity in heavy weather.

BUOYANCY

Material condition Yoke must be properly set to maintain buoyancy during heavy weather. The setting of material condition Yoke secures all topside accesses through which seawater might enter the ship and secures closures in main watertight subdivisions to minimize the spread of damage and the loss of buoyancy. The setting of material condition Yoke, combined with prudent seamanship, preventing the ship from being exposed to avoidable hazards, constitute the primary means of safeguarding the ship's buoyancy during heavy weather.

POWER

The maintenance of continuous propulsion and electrical power during heavy weather is critical to the ship's safety. The loss of propulsive power in a high sea state will put the ship at the mercy of the seas. In short order the ship will orient itself broadside to the seas (in the trough) and experience maximum roll amplitudes. Depending upon the sea state and the degree of ship's stability this situation will be, at the very least, highly uncomfortable and hazardous to ship's personnel and equipage. It could result in the loss of the ship.

There are a number of precautionary measures which can be taken to maximize the chances of maintaining continuous power during heavy weather. Multiple, split plant operation of the propulsion and electrical systems should be employed to the extent permitted by ship design so that a problem in one propulsion plant or generator will not result in a total loss of propulsive or electrical power.

Ships operating in northern or southern latitudes should UNREP frequently to keep their fuel supplies as high as possible so they are in the best possible fuel status should heavy weather hit. Extra care should be taken to ensure that fuel service tanks (and in the case of steam powered ships, feedwater tanks) are fully topped-off before being put into service and that another tank is always ready on short notice.

Ventilation openings which might permit the entrance of seawater should be secured during heavy weather. In addition to the harmful effects seawater can have on heating and ventilation systems, seawater in ventilation systems can find its way into electrical distribution system components. This could result in the shorting out of switchboards or load centers which could in turn result in electrical fires and/or the loss of electrical power.

PREPARATIONS FOR HEAVY WEATHER

All divisions will have some responsibilities for preparing for heavy weather. These responsibilities are outlined in the Ship's Organization and Regulations Manual (SORM, OPNAVINST 3120.3). Each ship should also have an up-to-date Heavy Weather Bill assigning detailed responsibility for all tasks.

Securing for sea amounts to securing weather openings such as vents to prevent the entry of seawater, the fastening down or relocation of deck gear to prevent its loss overboard and the securing of all items in the ship which might come adrift. When heavy weather is anticipated the ship should be rechecked with an exaggerated level of attention to detail. The Heavy Weather Bill should require the following:

- Eliminate free surface effects by consolidating liquids and taking on ballast as necessary.
- Ballast the ship to maintain minimum possible KG.
- Secure vent ducts and other weather openings which might permit the entry of seawater.
- Relocate heavy, movable topside loads as low in the ship as possible and ensure that they are secure.
- Check all deck lashings. Double up if necessary.
- Tighten up all boat gripes. Rig boats in if davits allow.
- Rig extra lifelines where topside evolutions such as UNREP or man-overboard recovery will be conducted.
- Fix dead lights (metal covers) over port lights.
- Check cargo and apply extra shoring where necessary to keep it stationary during high seas.
- Light off sufficient propulsion and auxiliary machinery to allow for split plant operations so that the loss of one plant does not result in a total loss of propulsion or electricity.

SHIP HANDLING IN HEAVY WEATHER

The course and speed chosen relative to the seas will determine the way the ship will ride. Maximum roll will be experienced when on a course approaching parallel to the seas. The roll period of a typical destroyer is approximately 9-10 seconds. Extreme roll will be experienced if the ship is on a course parallel to seas which approximate the ship's roll period. Steering a course parallel to the seas (riding in the trough) is usually undesirable from crew comfort and effectiveness standpoints in anything beyond moderate seas.

The course to minimize roll is directly into the seas. While this minimizes roll it maximizes pitch. Extreme pitch can also be very uncomfortable for the crew, especially over long periods of time. If pitch becomes severe enough for the bow of the ship to leave the water it will slam down into the next wave. Slamming is both uncomfortable for the crew and imposes significant stresses on the hull. The extreme deck wetness experienced while running into high seas will maximize the accumulation of topside ice when cold weather conditions exist.

Generally, a course running with the seas will minimize pitch and result in moderate roll. Course keeping can be a problem when running with the seas. Ship speed should not be matched with the speed of the swells. The ship will experience little rudder effect as it rides the crest of each wave. A differential between ship speed and swell speed will minimize the time the ship is riding the crest of the swell and will also minimize the loss of steering control experienced while on the crest of the swell. Yaw will be most noticeable on course headings with the swells approaching from an aft quarter.

Following are a few tips on heavy weather ship handling which apply in cold weather operations as well as other operations:

- Reduce speeds to minimize shipboard damage and topside icing.
- Adjust speed when running into the seas to permit no more than one heavy slam into the seas every 15 minutes.
- Take collision avoidance action sooner than under normal circumstances.
- Secure everything for sea.

TACTICAL DECISION AIDS

In the near future surface ships will be able to utilize shipboard computer programs called Tactical Decision Aids (TDA) to help select the best course for seakeeping in heavy weather. The TDA uses data inputs on environmental conditions such as wave and swell direction, period and height. With this data the TDA produces a set of polar graphs that predict the magnitude of ship pitch, heave and roll for any combination of course and speed. With known operational limits such as roll, pitch and heave limits for the conduct of flight operations or the use of weapons systems, a course and speed combination can be identified on the polar graphs which will meet the limits for the intended operation, if such a course and speed combination exists under the present conditions.

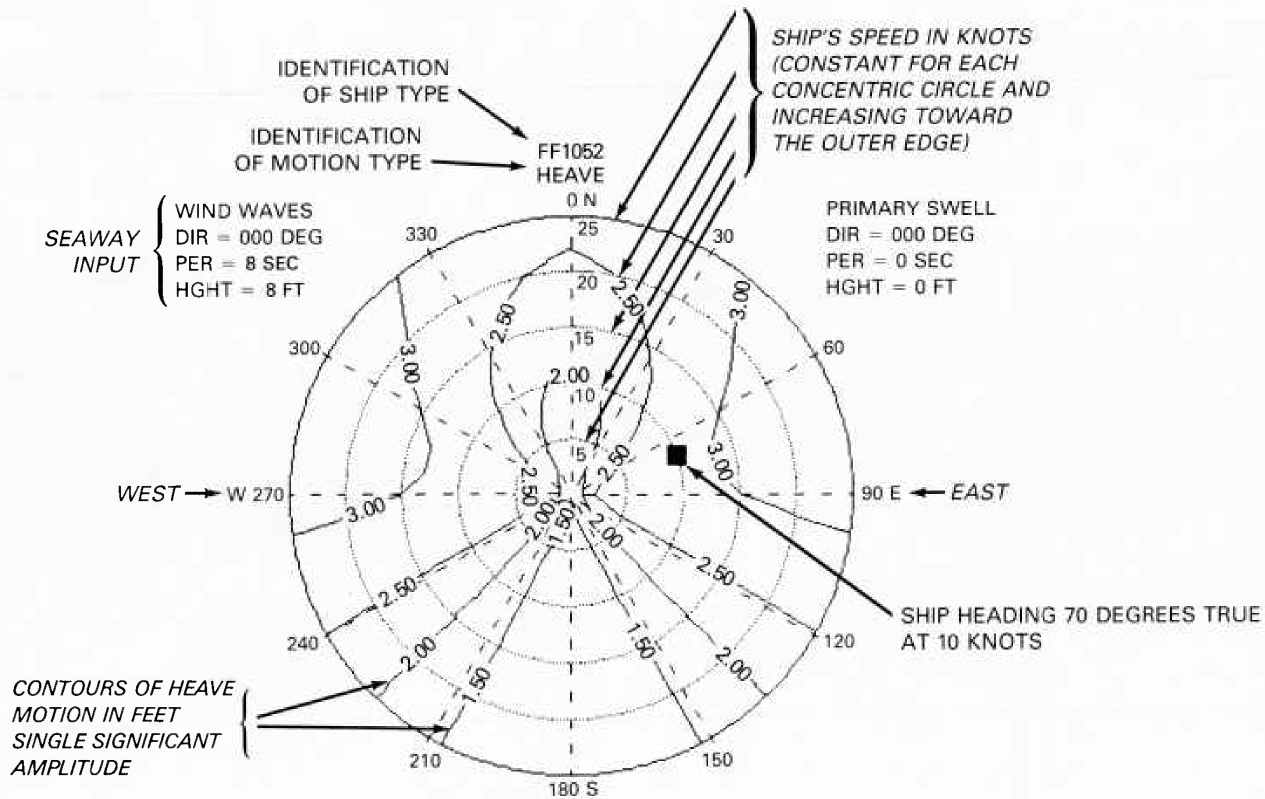
Figure 8-2 is a plot of the vertical motion (heave) an FF 1052 class ship would expect to experience on any course and speed combination with no swell and with waves coming from the north, with a period of 8 seconds and height estimated to be 8 feet. The TDA is being introduced on surface ships as part of the Tactical Environmental Support System (TESS).

HEAVY WEATHER IN A COLD WEATHER ENVIRONMENT

The primary factor setting heavy weather operations in cold weather apart from other heavy weather operations is topside icing. In its earliest stages topside icing affects evolutions requiring topside personnel, such as UNREP, due to slippery conditions. As ice continues to accumulate it begins to affect the operation of deck machinery, weapons systems and communications systems. The most serious potential effect of ice accretion, however, is the significant impact it can have on ship's stability due to the continuing addition of very high weight. The degree of ice accretion required to constitute a serious hazard to the safety of the ship depends upon the size of the ship, the amount of reserve stability available to the ship and the wind and sea state conditions.

Several conditions must exist in order for ice accretion to take place. The air temperature must be below freezing and there must be a source of moisture whose temperature is close enough to freezing to permit freezing on contact with ship structure. Rain, snow, fog and sea spray are all moisture sources which can contribute to ice accretion. For sea spray to promote topside icing the temperature of the sea has to be close to freezing, about 40°F or lower and sufficient wind and waves to cause the spray to repeatedly impact the ship. Sea spray is the cause of most significant topside icing episodes.

For sea spray-induced icing, the most significant variables are wind, sea state and sea temperatures. High sea states and high winds can



Explanation of the speed polar chart in the Ship Response Program on the HP 9020.

Figure 8-2 Tactical decision aids.

cause significant sea spray to hit the ship which will, in turn, cause significant topside icing.

Although air temperature and seawater temperature are variables that cannot be controlled, relative wind and course relative to the seas can be. When in a serious ice accretion situation, the best measure available to the commanding officer is to select a course and speed which will stop or minimize the incidence of spray hitting the ship. Experience indicates that a course with the seas 20° to 60° off the bow will cause the highest rate of ice. Generally, a course running with the seas will minimize sea spray over the ship thereby minimizing topside ice accretion. If topside icing becomes serious enough, minimizing continued build-up will have to become the primary consideration and the best navigationally safe course for this purpose will have to be selected.

Monitoring reserve stability during a severe topside icing episode is difficult since it is not possible to accurately estimate the weight of the accumulated ice or the height of the center of gravity of the ice. Therefore, an accurate weight and moment calculation cannot be applied to the ship's normal stability to calculate stability under icing conditions. The best means of monitoring stability under icing conditions is to monitor roll period. If stability becomes critical the roll period will become slow and erratic and the ship will have a tendency to hang at the end of a roll and lurch from side to side.

Under these circumstances, any actions to lower the ship's center of gravity should be taken immediately. The ship should accomplish any additional ballasting that can be done, in accordance with the ship's damage control book, to reduce free surface of partially filled tanks and to increase low weight in the ship. The removal of topside weights should also be undertaken to the extent that weather conditions permit. The first topside weight to be removed, if possible, should be the accumulated ice itself. If the situation becomes critical, consideration should also be given to removing any other topside weights that could be jettisoned or moved down in the ship.

HEAVY WEATHER IN PORT

Preparations for heavy weather in port under cold weather conditions are essentially the same as under any other conditions except for the additional task of ice and snow removal from the ship's decks and the pier area adjacent to the ship. Other in-port heavy weather precautions should include:

- Double up mooring lines and inspect them frequently.
- Remove camels to prevent hull, rudder and screw damage.
- Establish special boat watch (if boats are in the water).
- Establish special anchor watch (if the ship is riding at anchor).
- Have propulsion plant ready to answer bells. This may be needed to prevent anchor dragging or to get underway whether at anchor or dockside.
- Be prepared to disconnect shore power lines on short notice and shift to ship's power.
- Be prepared to put over storm wires, spring lays or anchor chain, as necessary, to augment mooring lines.
- Be prepared to get underway on short notice.

SUMMARY

Heavy weather operations in cold weather are essentially the same as operations under similar sea state and wind conditions under warmer circumstances. The frequency of heavy weather in regions such as the North Atlantic and North Pacific in winter time and extreme southern latitudes and the added concerns of topside icing and exposure for personnel involved in topside evolutions make being prepared to deal with heavy weather particularly important during cold weather operations.

CHAPTER 9

COLD WEATHER SAFETY

Safety is of great concern no matter what the environment. The hazards of underway replenishment and moving ammunition, even in a calm sea, are well understood. The abundance of experience and lessons learned in these evolutions adds to overall safety awareness. The purpose of this section is to briefly describe the safety precautions which should be observed during cold weather operations. Bitter cold temperatures with high winds and icy seas complicate even the simplest evolutions, such as ascending or descending an ice-covered ladder, or traversing an icy deck.

Blinding snow and ice storms with extremely high winds can develop with very little warning. Visibility reduces rapidly. High winds and rough seas will cover the ship with spray. This very unpleasant weather may last for hours. It is imperative to be safely prepared *before* encountering such weather.

The following sections present some particular safety precautions. The purpose is to emphasize the need for special safety concerns and to stimulate safety consciousness when operating in the cold weather environment.

PERSONNEL SAFETY

A cold shipboard environment can pose many threats to the safety of the crew. To adequately deal with these threats and to not become a casualty to the cold, it is important to understand the effects of cold weather on personnel safety. In addition to the direct effects of cold, several indirect effects are also discussed in this chapter. Prior to cold weather operations, the senior medical department representative should provide briefings on the necessity of safety in the cold.

MEDICAL CONSIDERATIONS

It is essential to recognize cold weather hazards in order to survive in the cold. Prevention of injuries is, of course, the objective of being safety conscious. When injuries do occur, accurate, early diagnosis will greatly reduce the dangers and aid in a speedy recovery. The four most common cold weather medical hazards are briefly discussed in this chapter, including information on detection and proper emergency treatment for each. More complete information on cold weather medical concerns will be found in Chapter 10.

Hypothermia or "Exposure"

Simply stated, hypothermia is a lowering of the core body temperature to 94°F or below. One of the most serious cold weather injuries, hypothermia is often the most difficult to recognize. Initially most hypothermic symptoms are related to the nervous system. A hypothermic person may exhibit a variety of symptoms, including one or more of the following:

- Lack of coordination, stumbling or difficulty with simple manual tasks
- Drowsiness or confusion
- Change in personality
- Dilated pupils
- Faster than normal breathing

Anyone suspected of being hypothermic should be brought immediately to sick bay for medical attention.

It is very important that the buddy system be used for shipmates to check each other. Frequently, a hypothermic person will not realize the problem until it may be too late for help.

A person who falls overboard into extremely cold water may die of hypothermia in a matter of minutes. The anti-exposure suit will help improve the chances of survival, but only if it is worn properly. The key to survival in cold water is to conserve body heat. This means maintaining a warm envelope of water next to the body and minimizing activity to save energy. An envelope of warm water can best be established by sealing off the clothing as much as possible to prevent additional cold water from flushing in and out. Anti-exposure suits are designed with closures for this purpose. To conserve energy, body motion should be minimal, moving only enough to keep the head above water.

Frostbite

Frostbite is a tissue injury which results from the freezing of tissue fluid. Frostbite can be *superficial*, where only skin and tissue just under the skin are involved, or *deep*, where layers of tissue as deep as bone are involved. It may be difficult to distinguish between superficial and deep frostbite prior to rewarming, but in general the following characteristics apply:

- Superficial: skin appears waxy or white, feels resilient and may be numb.
- Deep: skin appears waxy or almost clear, feels solid and is definitely numb.

Both superficial and deep frostbite occur mainly on the hands, feet, ears and nose. Anyone suspected of having frostbite should be taken to sick bay at once. Improperly treated or untreated frostbite may refreeze, which can lead to gangrene and possible amputation. *Do not rub the areas in question*. This only extends the injury.

Immersion Foot or "Trench Foot"

Immersion foot is injury to the skin of the feet caused by prolonged exposure to cold moisture at *above-freezing* temperatures. Trench foot can occur during repeated episodes of standing on deck in sweat-soaked socks and boots.

Initially, the symptoms of trench foot appear in the form of a cold, waxy, swollen foot with purple splotches. The foot will be relatively numb. Upon rewarming, the foot may become quite painful, turn red, swell and possibly form blisters.

Permanent disability can occur as a result of trench foot. Keeping the feet dry and wearing clean socks will prevent the occurrence of trench-foot.

Dehydration

Everyone has experienced dehydration on a warm summer day, but in the cold it is a different matter. Not only is it less easily recognized, but the effects of dehydration can be devastating.

Normally, the body controls its fluid balance by sweating off excess water and by becoming thirsty, which triggers the response to drink to replace lost water. In the cold, both of these mechanisms can become fouled up: in extreme cold, we often do not become thirsty when dehydration sets in; also, in extreme cold we urinate more than normal. These factors, coupled with excessive coffee, cola or other caffeine drinking (which usually causes increased urination), can lead to a dangerous dehydration. A dehydrated individual is at even greater risk from the cold weather injuries described here, because body fluids play a major role in regulating bodily functions, including circulating blood to the extremities and maintaining body temperature.

It is important to know the warning signs which indicate that dehydration is occurring. Early signs include:

- Increased pulse rate
- Constipation
- Dark urine in small quantities

Be sure to drink at least one to two quarts extra of water per day.

FOOTING

Extreme caution must be used when going topside to avoid slipping on ice which accumulates on deck. Even when wearing boots with excellent traction, injury can occur from a fall on ice. The following precautions must be followed to prevent injury:

- Large, bulky boots, such as the blucher type, may be very warm but can present difficulty when walking. Particular care must be taken on ladders, passing through hatches and in confined spaces where obstacles can cause tripping. Since the boots are larger than normal footwear, they will be cumbersome. Some practice will be required to grow accustomed to wearing them.

- Do not allow feet to become numb. Without feeling in the feet it is easy to stumble over objects. Footing on icy decks will be particularly unstable with the ship rolling and pitching and numb feet will only make the situation worse.

- Wear hardened-toe boots whenever working where objects could be dropped on the toes. Effective hard-toe cold weather boots are commercially available. Future approval is expected for a Navy hard-toe boot, although stock numbers are not yet available.

- Make every effort to remove the ice prior to traversing decks and ladders. It is difficult to walk on an ice-covered platform when it is stable. The effects of ship motion will complicate the feat considerably. Avoid walking on ice whenever possible.

FATIGUE

Many accidents occur when fatigue sets in because the mind loses attentiveness and physical coordination diminishes. Fatigue will occur more quickly in the cold. Proper diet and rest will combat the onset of fatigue.

It will be necessary to rotate work crews much more often than normal. Four to eight hour rotation periods may be reduced to 30 minutes due to fatigue from the cold. Experience on air-capable ships in particular has proven this to be true. The constant struggle to maintain balance, footing and to perform a task will bring on fatigue. Being fatigued increases the danger of accidents occurring, so it is very important for personnel to be properly rested and rotated.

The symptoms of fatigue must be monitored closely to avoid fatigue-related accidents. Busy sailors are poor judges of their own level of fatigue and therefore must be closely supervised. Some of the symptoms to look for are:

- Loss of coordination
- Dizziness
- Shortness of breath
- Chills

The increased level of safety achieved by ensuring proper rest and rotation of the work crews is well worth the effort and will certainly pay off in the long run.

WINDCHILL

We know from our own experiences that when a high wind is blowing it feels much colder than when it is calm. Temperature alone does not, therefore, give a true indication of the relative impact of the outdoor environment. Some scale has to be used, based on temperature and wind, and the most common one is the windchill scale. Windchill is a measure of the combined effects of wind and temperature. Figure 9-1 shows equivalent temperatures in relation to the windchill factor.

The table should be entered with the measured temperature (to the closest 5°F) at the top and the relative wind speed along the left side. The number at the intersection is the *equivalent temperature,* that is, the temperature that will cause the same rate of cooling under calm conditions. Note that this only applies to bare skin. Therefore, even the slightest bit of protection will greatly reduce heat loss. This should be kept in mind if it is necessary to remove clothing to perform a task. The windchill effect aggrevates already-cold temperatures and personnel will get colder more quickly.

INTERIOR TEMPERATURE

To aid in keeping the living spaces warm during cold weather, all weather accesses should be kept secured while not in use. It may also be necessary to rig temporary ducting covers in some spaces to prevent high winds from forcing cold air into the ship. Main space temperatures

WIND SPEED (KNOTS)	TEMPERATRURE																
CALM	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40
	EQUIVALENT CHILL TEMPERATURE																
5	34	29	24	19	14	9	3	-2	-7	-12	-18	-23	-28	-33	-39	-44	-49
10	29	19	14	7	2	-3	-13	-18	-23	-29	-38	-43	-49	-54	-63	-69	-73
15	23	13	8	0	-7	-12	-22	-27	-32	-42	-47	-54	-62	-69	-74	-82	-89
20	17	10	2	-3	-13	-18	-28	-33	-41	-48	-56	-63	-71	-78	-86	-91	-101
25	11.5	7	0	-9	-19	-24	-30	-39	-49	-54	-64	-69	-79	-84	-94	-99	-109
30	10	5	-4	-10	-20	-29	-34	-40	-50	-59	-65	-74	-80	-89	-99	-104	-114
35	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115
40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115
	LITTLE DANGER					INCREASING DANGER (Flesh may freeze within 1 minute)						GREAT DANGER (Flesh may freeze within 30 seconds)					
	DANGER OF FREEZING EXPOSED FLESH FOR PROPERLY CLOTHED PERSONS																

Figure 9-1 Windchill chart.

in the low fifties have been experienced during periods of extreme cold and high winds.

Additional emphasis should be placed on properly maintaining heating systems to ensure their effectiveness in the extreme cold. It is imperative that the heating systems be restored to top condition prior to entering cold weather.

If auxiliary portable heaters are used to help keep the ship warm, the equipment should be electrically safety-checked prior to use to ensure that no one will get burned by contact with the units.

LIFELINES

A person who falls overboard in icy water without special protection can survive for only a few minutes. To prevent this, nylon lifelines should be rigged in strategic locations in the event access to topside equipment is required. In addition to lifelines, cargo nets can be set up at underway replenishment stations to prevent line handlers from falling overboard.

GENERAL PRECAUTIONS FOR PERSONNEL WORKING ON DECK

Sending crews out to work on open weather decks can be a hazardous evolution in rough weather. The danger presented in this situation greatly intensifies if the decks are covered with ice because it is easier for one to slip and fall overboard. Furthermore, the chances of survival in cold water in view of current rescue capabilities is limited by the victim's ability to survive in the cold water. The survival time of a person in 29°F (-1.67°C) seawater is estimated between 2 and 5 minutes.

Standard procedures should exist to describe precautions for personnel performing work outside on unprotected, ice-covered weather decks. This form of guidance should be listed in the "Commanding Officer's Standing Orders for the Officer of the Deck." Guidance should require permission from the commanding officer via the officer of the deck prior to sending personnel out on ice-covered decks. Personnel should never be sent out on an ice-covered deck alone. Working parties should consist of a minimum of two people with the work performed at a location which can be directly observed by the bridge, or at least observed by a sound powered telephone communications station which is in direct contact with the bridge. Additional safety precautions such as the use of lifelines and harnesses should be taken as the situation dictates. Man-overboard rescue equipment should be readily available to facilitate a fast rescue in cold waters. In the event that an individual falls overboard in a cold weather region, it is recommended that the usual man-overboard rescue procedures be carried out in the most expeditious manner with special emphasis on quickly removing the victim from the water and providing immediate medical attention. Appendix G provides guidance for the treatment of immersion hypothermia which should be used in the absence of other medical guidance. Personnel working on exposed weatherdecks should follow the guidelines listed below:

- Avoid excessive perspiration which can freeze in clothing and the portion of the body exposed to the ice will become cold very quickly. This situation often occurs when too much clothing is worn for the present level of physical activity. Sweating can be avoided by removing excessive clothing before increasing physical activity. It is very important that both the body and clothing should be dry prior to exposure to severe cold.

- Ensure that cold weather clothing fits properly. Clothing that is too tight will restrict or cut off blood circulation and invite frostbite. Excessively loose clothing allows heat to escape from the body.

- Do not touch metal objects with bare hands. Dry hands as well as wet hands will freeze to cold metal and cause painful tearing of the skin. Dry gloves should always be worn when handling cold metal objects.

BRIDGE AND LOOKOUT WATCHSTATIONS

Locations for watchstanders should be heated whenever possible and provide adequate protection from wind and blowing spray. In situations where it is not possible to provide heat or shelter to an exposed watchstation (for example, a lookout's station on an open bridge wing) supervisors must frequently rotate the watch and carefully monitor exposed watchstanders for signs of frostbite, hypothermia or fatigue, ensuring that watch reliefs are called before performance is degraded. Supervisors must also ensure that watch reliefs are properly clothed.

EQUIPMENT SAFETY

Safe handling of equipment cannot be overemphasized, particularly in a cold weather environment. The dangers associated with operating much equipment during routine evolutions in a moderate climate are sometimes formidable. In a cold, harsh climate there is no such thing as a routine evolution. Evolutions typically take 2-3 times the normal period to perform. Every operation requires effective planning and extra attention to safety for successful completion.

This section addresses some particular safety concerns when operating equipment in cold weather. The purpose is to encourage a thoughtful, safety-conscious approach to hazards involved.

CHEMICALS

Certain chemicals will be used aboard ships operating in cold weather conditions that are not used under normal conditions. These chemicals will be used for such purposes as:

- Preventing ice build-up or melting ice which has accumulated on decks and equipment

- Removing or preventing fog or frost from forming on windows and optical equipment

- Preventing freezing of cooling water systems

- Starting cold engines

Table 9-1 Commonly Used Chemicals in Cold Weather

Application	Chemical/Material	Form
Deice & Anti-Ice	Rock Salt (Sodium Chloride) Calcium Chloride Urea (Carbamide) Propylene Glycol Ethylene Glycol Methanol	Crystals Flakes, Pellets Pellets Liquid Liquid (Spray can) Liquid
Antifog	Alcohols Plus Glyceride	Liquid
Antifreeze	Propylene Glycol Ethylene Glycol	Liquid Liquid
Starting Fluids	Diethyl Ether	Pressurized Cartidges or Aerosol Cans

Table 9-2 Safety Precautions for Handling of Cold Weather Chemicals

Chemical/Material	Form	Precautions
Rock Salt (Sodium Chloride)	Crystals	May irritate cuts and scratches on skin; use of gloves is recommended.
Calcium Chloride	Flakes, Pellets	Will burn skin and eyes so rubber gloves and goggles must be worn. In case of contact, flush affected areas with plenty of water. If in eyes, hold eyelids open and flush with plenty of water for 15 minutes minimum. Avoid breathing dust. Use only with adequate ventilation.
Urea (Carbamide)	Pellets	Treated surface may be slippery. Avoid breathing fumes or dust. Use of safety goggles and gloves is recommended. In case of contact, flush with fresh water. Store in cool dry location (exposure to high heat will produce mildly toxic acid).
Alcohol Plus Glycols	Liquid	Use only in well-ventilated area. Avoid breathing fumes and contact with eyes. Minimum flash point is about 80°F so material must not be sprayed in the presence of an open flame or spark. The spray cans are under pressure - do not puncture. Store cans only in cool, dry area. Before discarding empty container, relieve all pressure by depressing valve and dispersing all gas and liquid. Do not incinerate empty containers.
Alcohol Plus Glyceride	Liquid	Store containers in cool area; do not allow to freeze.
Propylene and Ethylene Glycol	Liquid	Harmful or fatal if swallowed. Propylene glycol is less toxic than ethylene glycol, but the same precautions apply to both materials. If swallowed, induce vomiting immediately and call for medical personnel.
Diethyl Ether	Pressurized Liquid	These materials are highly flammable. Store in cool, dry, ventilated area away from heat and electrical arc. Do not expose to fire, flame or spark. Ether is an anesthetic; concentrated fumes will cause unconsciousness. Spray only in well-ventilated area. Avoid contact with eyes. Containers are under pressure; do not puncture. Before discarding empty container, relieve all pressure by depressing valve and dispersing all gas and liquid. Do not incinerate empty containers.

The intended application and form of the most common chemicals which will be used during cold weather operations are shown in Table 9-1.

The recommended safety precautions which should be observed during the use of these chemicals are presented in Table 9-2. Because calcium chloride is so widely used to melt ice on decks, almost everyone aboard ship will come into contact with it at some time. For this reason, and because its potential hazards are not generally known, the precautions for handling this chemical are presented in more detail.

Calcium chloride is an effective deicer at temperatures below 0°F because it gives off heat when mixed with water. A concentrated solution may get hot enough to boil. This same property may cause irritation or burns to the eyes, mucous membranes (nose and mouth) and skin. In case of contact with the eyes, promptly flush with plenty of water for at least 15 minutes and call medical personnel. For skin contact, flush with water and wash thoroughly. Remove and wash contaminated clothing.

Because regular and anhydrous flake calcium chloride can absorb moisture from the surroundings, it can dry out leather and damage fabrics. Calcium chloride should always be stored in a cool *dry* place. Protective clothing which should be worn by personnel handling bulk calcium chloride includes:

- Rubber boots or well oiled leather shoes
- Rubber or latex coated canvas gloves with gauntlets
- Rubberized raincoat, goggles
- Dust respirator or face mask

BATTERIES AND ELECTROLYTES

Because the performance of batteries is severely degraded at cold temperatures, ship's personnel who use battery-powered equipment are more likely to become involved with the handling of batteries during a cold weather cruise than under normal conditions. This handling may include recharging batteries, warming up batteries which have become too cold or replacing batteries which are no longer serviceable. In recognition of the potential serious safety hazards involved in handling batteries and electrolytes, this section describes some of the safety precautions which should be enforced at all times. Emphasis is given to considerations which are especially important under cold weather operating conditions. These and other precautions are described in greater detail in NSTM, Chapter 313.

Rechargeable Batteries

The most common storage battery used aboard ship is the lead-acid type which contains an electrolyte solution of sulfuric acid and distilled water. Sulfuric acid is very dangerous to personnel and highly corrosive to equipment or materials.

Another type of storage battery which will be encountered aboard ship is the alkaline type battery containing nickel-cadmium and an electrolyte solution of potassium hydroxide. This electrolyte is also dangerous to personnel and is corrosive to many materials including aluminum and glass.

Hydrogen Hazards

SPARKS AND FLAMES - Both hydrogen and oxygen gas are given off from a storage battery, especially during recharging. Because hydrogen mixed with oxygen or air is very explosive, sparks, smoking or flames of any kind must never be allowed in the vicinity of any rechargeable battery.

BATTERY COMPARTMENT VENTILATION - Extra care is necessary after opening a battery compartment which has been sealed. Because hydrogen is colorless, odorless and tasteless, such compartments should always be thoroughly ventilated before they are entered. To avoid the possibility of an explosion, no light switches should be turned on and no electrical connections should be made or broken in the compartment until it has been well ventilated. When preparing to recharge a battery located in a battery compartment, verify that the ventilating system is operating properly before starting the charge. Stop the charge if the ventilation is interrupted.

CHARGING RATE - Charge a battery only at the rates given on its nameplate. Reduce the charging rate if the battery electrolyte begins to evolve bubbles of hydrogen and oxygen or if the battery temperature reaches 96°F. Stop charging if the battery temperature approaches the upper limit of 125°F.

SPARKS - To prevent dangerous sparks, ensure that no current is flowing into or out of the battery before disconnecting or connecting battery terminals. When batteries are used with one terminal grounded, the grounded terminal should be disconnected first when removing the battery and connected last when replacing the battery. Verify that all terminal connections are tight to preclude sparks due to loose connections. Use only tools with insulated handles to prevent short-circuiting the battery terminals.

Handling Electrolytes

PROTECTIVE EQUIPMENT - Personnel engaged in handling any electrolyte (or cleaning up a spill) should wear rubber aprons, rubber boots, rubber gloves and goggles or a full face shield so that the electrolyte cannot come in contact with clothing or skin.

TREATMENT OF ELECTROLYTE BURNS - Should acid or electrolyte come in contact with the skin, immediately wash the affected area freely with a large quantity of freshwater for about 15 minutes.

Should acid or electrolyte come in contact with the eyes, flush with freshwater for a minimum of 15 minutes ensuring that both upper and lower lids are pulled sufficiently to allow water to flush under them.

In either case, the medical department must be notified of the accident as soon as possible and must be requested to come to the site. If the medical department cannot be notified, wash or flush with water for 15 minutes before transporting victim to sick bay.

In an extreme emergency, where freshwater is not available, seawater may be used, but *ONLY AS A LAST RESORT.*

Clothing that may have been splattered with electrolyte should be promptly removed. Skin areas touched by electrolyte beneath contaminated clothing should be promptly treated by flushing with water as described above.

REPLACING ELECTROLYTE - Nothing but distilled water should be added to a battery except when it is necessary to replace spilled electrolyte. When replacing spilled electrolyte, use only premixed electrolyte. Sulfuric acid of specific gravity greater than 1.350 should not be added to a battery.

CONCENTRATED SULFURIC ACID - Only premixed electrolyte is to be used or stored aboard ship. The use and storage of concentrated acid for the purpose of preparing electrolyte or for adjustment of specific gravity are authorized only for shore activities or ships designated as IMAs. Two of the most important precautions to be followed in handling concentrated sulfuric acid, especially in cold weather, are:

- In making electrolyte, always pour acid slowly *into water* and never water into acid. The addition of even a small quantity of water to a container of strong sulfuric acid may cause an explosion due to the sudden evolution of heat.

- Containers of concentrated sulfuric acid must be stored in a place where freezing cannot occur. Under certain conditions, concentrated acid can freeze at temperatures as high as 42°F. Freezing can cause the container to break with consequent grave danger of serious acid burns to personnel.

PREVENTION OF BATTERY DAMAGE - Precautions to prevent battery damage also serve to protect the personnel handling the batteries. The following are precautions which should be followed to protect batteries from damage caused by cold weather and related conditions:

- Discharged Batteries: The sulfuric acid electrolyte in a discharged battery can freeze at +5°F whereas, in a fully charged battery, it will remain liquid down to -60°F or below. Freezing may damage the battery internally and/or crack the case causing a hazardous spillage of electrolyte. All batteries exposed to cold weather conditions should be kept fully charged.

- Adding Water: When distilled water is added to a battery to replace that lost during normal operation, the water should be added just before the battery is placed on charge. The water remains on top of the electrolyte until mixed with it by charging. In cold weather, the unmixed water may freeze, causing the battery case to crack and leak electrolyte.

- Battery Heaters: Equipment which may be installed to warm batteries which are exposed to cold weather should be controlled to keep the battery compartment temperature below 96°F and the battery below 125°F or damage to the battery may occur.

Other Battery Hazards

GASOLINE FUMES - Batteries used for engine starting are frequently located near the engine itself. Care should be taken to avoid sparks when removing or replacing batteries located in compartments which may contain gasoline fumes.

SALTWATER - Care should be taken not to allow saltwater to splash or leak onto an acid battery because saltwater entering a battery cell will produce chlorine gas which is extremely toxic.

DRY BATTERIES - The following safety precautions should be observed for dry-cell type batteries:

- Hydrogen Hazards: Never continue to use a multicell dry battery after its closed circuit voltage has dropped below a value equal to 0.9 volt per cell. Discharging a battery beyond this point will force current through some cells which may be completely disharged. This will result in the generation of hydrogen and oxygen gases caused by the electrolysis of electrolyte. When this happens, there is danger of a hydrogen explosion and possible injury to personnel and damage to equipment.

- Shock Hazards: Some ships have high voltage dry batteries, like the 300 volt B section of the Navy type 19026 pack battery. They are capable of imparting a very serious, if not fatal, shock to anyone coming in contact with their terminals. When disconnecting them, the current flow should be stopped before disconnecting the plug. It is possible for sufficient gaseous hydrogen to accumulate in this battery to produce a serious explosion if ignited (by the spark caused by pulling the plug while the current is flowing).

- Short-Circuits: In order to prevent a short-circuit, wire leads should be kept insulated when the battery is not connected to apparatus. Short-circuits may result in sufficient heat to cause a fire. In addition, a discharge caused by a short-circuit generally causes the cells to burst, spilling corrosive electrolyte which can damage equipment and cause injury.

- Mercury Cell Batteries: These batteries may explode if improperly used. Never discharge a mercury cell battery after the battery fails to operate the equipment or the voltage falls below 0.9 volt per cell. Do not leave the battery switch on when the equipment is not in use or after the battery fails to operate the equipment. Never impose a dead short-circuit on a mercury cell or allow it to become overheated. A temperature of about 400°F will cause such a cell to explode. Discard exhausted mercury cell batteries as soon as possible. Dead single and multicell batteries with steel jackets should have holes punched in the jackets before being discarded to release any gas which might have formed. Follow proper disposal procedures.

EQUIPMENT HANDLING WITH COLD WEATHER CLOTHING

Equipment handling may be difficult while wearing cold weather clothing because maneuverability and dexterity will be reduced as the thickness of clothing increases. Mittens and gloves make it more difficult to grasp some objects, such as wrenches and screwdrivers. It will be nearly impossible, for example, to fine-tune electronic equipment with small potentiometer knobs while wearing large gloves. The following safety precautions should be observed while wearing cold weather clothing:

- Be extremely careful while handling heavy equipment. Ensure properly-fitted gloves of suitable warmth are worn. Leather gloves with liners are good for handling equipment and lines. It is also important to keep hands dry to prevent numbness. Carry extra liners to replace wet ones.

- It is permissible to remove hand protection for short periods of time if necessary to perform particular tasks. Precautions should be taken not to touch any cold metal surfaces or to get hands wet. Put gloves back on between evolutions to maintain warmth. Alternatives to removing gloves include modifying gloves or mittens to suit a particular task, such as cutting a trigger finger hole, and wearing light glove liners to improve dexterity without exposing bare hands.

- Hoods are very effective for keeping the head warm but they can also hinder vision and head movement. Consider wearing wool caps and scarves in place of hoods when unobstructed view and movement are needed.

- After donning cold weather clothing, check to ensure no straps, flaps or other parts of clothing are loose which could catch on appendages or get stuck in moving machinery. A buddy system should be used to conduct cold weather clothing checks.

MOVABLE/SLIDING EQUIPMENT

Equipment which is normally movable or slides may easily become frozen in place by ice. Before attempting to free the equipment, it should be secured so that it will not go adrift when it breaks free.

When moving large equipment on an icy deck, ensure it is securely held to prevent losing control of it. Without normal traction, objects will be more difficult to stop and may require the use of restraining lines. Experience has shown that missile rearming is very difficult and may be ill-advised in heavy weather. In particular, transferring missiles from one magazine to another using the Mk 6 dolly may not work at all, even in a moderate sea state.

CHAPTER 10

COLD WEATHER MEDICAL CONSIDERATIONS

The purpose of this chapter is to provide general information about the cause, recognition, treatment and prevention of cold injuries, as well as other medical effects of the cold. Although the treatment of the injuries is presented here, it is not intended to take the place of thorough training by medical personnel. The corpsman will provide instruction on how to handle victims of cold injuries. The information here is intended to make everyone aware of the dangers of too much exposure to the cold.

Perhaps the most frightening aspect of cold weather injuries such as frostbite or trench foot is the extreme pain associated with recovering from the injuries. Anyone who has gone out in the cold until their toes or fingers were numb knows that rewarming them hurts. In addition to the pain, the damage caused by such cold exposure can be permanent. In times of war, many feet and limbs have been lost in the cold. Even the partial loss of use of a hand or foot can be frightening.

The most important point to be learned is how to prevent such casualties from occurring. Those medical effects which cannot be completely avoided must be given adequate attention to minimize the impact on personnel. The Cold Injuries section of this chapter describes injuries specifically caused by the cold. The Medical Effects section discusses side effects of the cold and how to deal with them.

COLD INJURIES

FROSTBITE

The term frostbite refers to the freezing of any part of the body. The tissue affected actually freezes. Frostbite is caused by exposure to temperatures or windchill below 32°F. The water in the tissue cells turns to ice and disrupts the normal functions and even the cellular structure of the tissue. Normally the body's metabolism (burning of calories) produces enough heat to keep all parts of the body warm. When exposed to severe cold, however, heat loss becomes very rapid and the blood supply to the area reduces to conserve body heat. If the affected area is not reheated, the blood there may get very thick and plug up the arteries. Without any source of heat, the area will begin to freeze. The extent of damage depends on how much freezing occurs.

To put the danger of frostbite into perspective, just look at its effects in past wars. In 1942 the Germans had 100,000 casualties in Russia due to frostbite alone. Over 15,000 amputations were required! In World War II, the Americans had 90,000 frostbite casualties, when the mean temperature was about 30°F. In Korea at 10°F, there were 9,000 casualties. In some northern areas of concern the mean temperature may be as low as -40°F. It is important to understand frostbite, how to prevent it and how to treat it.

Identifying frostbite can be relatively easy. Usually there is an uncomfortable sensation of coldness, followed by numbness. There may be tingling, stinging, aching or even a cramping pain. Visible indications, which are used primarily to detect a buddy with frostbite, include the skin first turning red, then later becoming pale or waxy white. The parts affected, in order of most common occurrence, are:

- Nose
- Ears
- Cheeks
- Forehead

- Exposed wrists
- Feet, especially toes
- Fingers

Frostbite can be classified into two types based on the severity of tissue damage:

Superficial Frostbite involves only the skin or the tissue immediately beneath it. Mild cases are sometimes referred to as frostnip, and can be easily rewarmed with little or no tissue damage. There is a certain amount of whiteness or waxy appearance. After rewarming, the frostbitten area will first become numb, mottled blue or purple and then swell, sting and burn for some time. In more severe cases, blisters will occur beneath the outer layer of skin in 24-36 hours. These slowly dry up and become hard and black in about two weeks. Generally, swelling of the injured area will subside if the casualty stays in bed or at complete rest. Throbbing, aching and burning of the injured part may persist for several weeks, depending on the severity of the exposure. After the swelling finally disappears, the skin will peel and remain red, tender and extremely sensitive to even mild cold and it may perspire abnormally. Figure 10-1 is an example of superficial frostbite.

Figure 10-1 Superficial frostbite.

Deep Frostbite is a much more serious injury and it damages not only the skin and subcutaneous tissue but also goes deep into the tissue beneath and can even include the bone. It is usually accompanied by the formation of large blisters as shown in Figure 10-2. In marked contrast to superficial frostbite, these blisters take from three days to a week to develop. Swelling of the entire hand or foot will also take place, and may last for a month or more. During this period of swelling, there may be marked limitation of mobility of the injured fingers or toes, and blue, violet or grey (the worst) discoloration takes place. After the first two days, aching, throbbing and shooting pains may be experienced for as long as 2-8 weeks. The blisters finally dry up, blacken and slough off, sometimes in the form of a complete cast of the finger or toe, nail and all, leaving beneath an exceptionally sensitive, red, thin layer of new skin, which will take many months to return to anywhere near normal. Sometimes, itching and abnormal perspiration persists for more than six months after the initial injury, and the part will suffer lengthy or permanent sensitivity to cold. In extreme cases of severe frostbite that have not been rewarmed

Figure 10-2 Large blisters.

Figure 10-3 Severe frostbite.

rapidly, permanent loss of some tissue almost invariably occurs. Figure 10-3 is a graphic depiction of severe frostbite. In such cases the skin does not become red and blistered after it has thawed, but turns a lifeless grey color and continues to remain cold. If blisters occur they will probably appear along the line of demarcation between the acutely frostbitten area and the healthy remainder of the limb. In cases of acute deep frostbite of the foot, adjacent swelling can extend as high as the knee. In a week or two after the injury, the tip of the injured area begins to become black, dry and shriveled, but the rest of the damaged area may progress in one of two entirely different ways: the tissue may shrivel to almost half the normal size and become mummified right up to the beginning of the healthy flesh, as shown in Figure 10-4, or the tissue may become wet, soft and inflamed if it becomes infected.

Figure 10-4 Severe frostbite; flesh partially mummified.

In the dry type, the uninjured remainder of the limb usually does not become intensely swollen or painful, and there is a clear line of demarcation between damaged and undamaged tissue. In the wet type, the whole limb tends to become painful and swollen, and originally undamaged tissue may suffer serious damage unless the infection is promptly checked. Surgical intervention is rarely needed in less than two months. Even minor surgery on frostbitten tissue should rarely be performed. In an extreme case in which the loss of some tissue is inevitable despite careful treatment, the dead material will simply slough off at the proper point and at the proper time, with maximum saving of the sound underlying tissue. Occasionally, hospitalization and professional surgical intervention may be needed. However, if even this type of case is kept scrupulously clean and sterile, the proper use is made of antibiotics and the patient stays constantly in bed at rest throughout the illness, the chances are high that auto-amputation will eventually occur.

Chances of getting frostbite are increased by several factors in addition to duration of exposure and freezing temperatures. These should be kept in mind, particularly when it comes to choosing people for duties where they are susceptible to frostbite. Some at risk people include:

- Older people
- Smokers
- Those unaccustomed to cold weather
- Injured people
- Fatigued or sick people
- Those with previous cold injuries
- Those with poor nutrition habits

Treatment Of Frostbite

The degree and difficulty of treating frostbite are related to the severity of frostbite. It may be as simple as rewarming a nose with body heat or as painful and complicated as thawing a frozen foot.

The following is a summary of ways to treat frostbite. Always consult the corpsman before performing more than basic treatment.

Superficial Frostbite

- A minor case of superficial frostbite is fairly common and serves as a warning. It should not interfere with job performance except for the time it takes to get the affected area thawed out.

- A frozen nose is the most common type of minor frostbite. Holding the pile on the back of the mitt over the lower face and breathing into it will warm the nose quickly. A scarf or mask worn over the face will usually prevent frostbite.

- Minor frostbite can usually be thawed with body heat. Place a bare warm palm against a frostbitten cheek or ear or place frostbitten hands against the chest, between thighs or under armpits.

Deep Frostbite

- Move the victim to a heated area to avoid danger of further frostbite. Do not allow the frostbitten area to thaw and refreeze.

- Remove all constricting items of clothing such as boots, gloves and socks from the area of injury if this can be done without causing further damage to the frostbitten part.

- Rapid rewarming is the specific treatment which minimizes tissue loss. The extremity should be thawed in a carefully controlled water bath at a temperature between 104° and 106°F until affected tips turn pink or burgundy red (approximately 20 minutes to 1 hour). This is best accomplished in a whirlpool bath or tub bath. If a bath is not available, thaw with warm wet packs at temperatures ranging between 100° and 112°F.

- Avoid infection by cleaning and dressing with dry sterile gauze loosely wrapped.

- Early treatment by a medical officer is vital.

The following precautions should be observed when treating frostbite:

- Don't rub or massage the injury. It will cause more damage.

- Don't use any creams or ointments.

- Don't rupture any blisters.

- Don't allow the victim to smoke or consume alcoholic beverages, even though the pain may be severe.

- Don't allow an injury to thaw and refreeze.

- Don't rub ice or snow on the injury.

- Avoid excess heat when rewarming the injury.

Prevention Of Frostbite

To avoid the pain and agony of frostbite and the associated casualties, some basic principles should be followed:

- Dress properly.

- Keep clothing clean and dry.

- Don't overextend either yourself or the people around you.

- Be aware of the signs of frostbite.

- Don't touch cold bare metal with bare skin.

- Always use a buddy system to look for early signs of frostnip.

HYPOTHERMIA

Hypothermia is a condition that occurs when the body is unable to maintain adequate warmth and the body core temperature drops below normal. Although the body can tolerate changes of a few degrees for short periods, variations from normal body temperature for long periods will endanger the person. Hypothermia is a formidable threat to those who must operate in a cold environment.

Hypothermia is caused by a loss of body heat at a rate greater than the body is able to produce. The heat is lost through four mechanisms:

- Radiation: Emission of infrared energy from the body

- Conduction: Direct contact between the body and a colder object

- Convection: Heat transference from the body to a moving fluid, such as water or air

- Evaporation: Loss of energy (in the form of body heat) in the conversion of internal liquids to vapor (such as sweat)

The greatest losses of body heat occur when a person is improperly clothed or when skin becomes wet. Convection of heat to cold, outside air that gets under clothing, conduction through wet clothing (which conducts heat faster than dry clothing) and evaporation of moisture on the skin are some of the ways body heat will be lost.

The body adjusts to the loss of heat by producing more heat. Energy, in the form of calories, is converted to heat within the body. This heat is transferred to the blood which circulates to the rest of the body, attempting to maintain normal body temperature. If this system is unable to keep up with the heat loss, the body temperature will drop and symptoms of hypothermia will appear.

The first visible sign may be uncontrollable shivering, which is the muscle mechanism attempting to generate heat. The person affected will often feel very tired and fatigued (more than normal) because the body is working harder to produce the necessary heat. Other indicators of the onset of hypothermia include muscle weakness, a loss of coordination, untypical behavior, poor decision making and even the cessation (stopping) of shivering. Hypothermia generally progresses as outlined in Table 10-1.

Treatment of Hypothermia

In most cases, (particularly aboard ship) early signs of the onset of hypothermia will be enough to prompt people to go inside and get warm. Warm drinks, quick energy food and muscular movement will aid in recovery. However, there may be cases - such as a man-overboard situation - that result in severe hypothermia. The key to first aid treatment is to stop any further loss of body heat.

For victims who are wet, it is imperative to get them into dry clothing. Get them to a warm area immediately and provide plenty of warm, loose insulation. (Don't wrap insulation too tightly or it will restrict circulation.) Also do not try to rewarm victims too rapidly. Obtain medical help as soon as possible.

Table 10-1 Hypothermia Progression Chart

Bodytemperature	Symptoms
99° - 96°F	Intense uncontrollable shivering; impared ability to perform complex tasks.
95° - 91°F	Violent shivering, difficulty speaking, sluggishness; amnesia begins.
90° - 86°F	Shivering decreases; muscles become rigid; muscle coordination impaired; erratic movements.
85° - 81°F	Irrational; stupor; lost contact with environment; pulse and respiration slow.
80° - 78°F	No response to words; reflexes stop working; heartbeat is erratic; unconsciousness begins.
Below78°F	Failure of heart and lungs; internal bleeding; death.

Prevention Of Hypothermia

Hypothermia is best prevented by properly dressing for the climate to be encountered. Remember, it doesn't have to be near freezing to cause hypothermia.

The biggest threat aboard ship is exposure to cold water, which can cause a rapid cooling of the body and lead to death in a matter of minutes. Proper safety precautions are a must when topside or in a small boat. Personnel should dress based on water temperatures. At a minimum an anti-exposure suit may often be required to increase the chances of survival in water.

IMMERSION FOOT

Immersion foot, also commonly called trench foot, is a cold injury to the feet (and possibly the hands) resulting from prolonged exposure to dampness and temperatures below 50°F. Note that the temperature does not have to be below freezing to cause this injury. In the early stages of immersion foot, the feet and toes are pale and feel cold, numb and stiff. Walking becomes difficult. If no action is taken at this point, the feet will swell and become painful. In extreme cases the flesh dies and may fall off, and amputation of the foot or the leg may be necessary. Other signs of trenchfoot include pain and tingling insensitivity; blotchy, red and white, waxy skin; poor blood circulation.

Treatment of Immersion Foot

The earlier treatment for trench foot begins, the faster recovery will be and the less damage will be done. Handle the affected part gently. Do not rub or massage at this point. Immediately rewarm and dry the affected areas. Apply powder liberally to remove any moisture remaining on the skin. Elevate the feet slightly and air them out at room temperature. Circulating air around the feet with a fan will help to keep them dry.

Prevention of Immersion Foot

Wet socks and boots, poor nutrition, fear, fatigue and immobilization can all contribute to trench foot. The following practices will help to prevent such an occurrence:

- A sweat suppressant, deodorant type powder or spray will help to keep the feet dry.
- Dry socks are a must! Repeated changes during the day may be necessary to keep dry.
- Exercise feet while out in the cold. Toe raises and walking will improve foot circulation, as will wiggling toes and bending ankles. Tight boots which reduce circulation must not be worn.
- When socks are removed, massage feet and lower legs. This improves circulation and helps dry feet.
- Keep feet clean. Good hygiene will prevent fungus growth and keep feet healthy.

DEHYDRATION

Most people associate dehydration with hot weather, perspiration and inadequate consumption of fluids. Few people, however, recognize that dehydration can also occur in cold weather. This fact alone contributes significantly to the danger of cold weather dehydration. It is a definite problem and deliberate action must be taken to overcome it.

Dehydration, simply stated, is a lack of sufficient fluid intake to make up for fluids lost. Several factors contribute to dehydration in the cold. Increased water loss occurs from respiration, urination and perspiration.

Respiration is water lost when cold, dry air enters the lungs, heats up, picks up moisture and is breathed out.

The body reduces its amount of fluid through urination. When rewarmed, the body will need additional fluids.

Perspiration is not as noticeable in cold climates. Perspiring may increase when a person is overdressed.

The thirst mechanism is apparently not as strong in cold weather, perhaps because people associate being hot with being thirsty, and they don't notice their thirst. If no conscious effort is made to drink extra fluids, dehydration will occur.

Symptoms of dehydration are:

- Dark urine and urine stains on underwear
- Lethargy, sunken eyes, headaches, constipation, nausea
- Lack of saliva
- Loss of appetite

Forced drinking is necessary to avoid dehydration. Soups and broths are recommended because they provide both the necessary liquid and the salt lost to perspiration. Additionally, they provide a source of heat to help warm the body. Water, milk, hot chocolate and sweet hot drinks are also recommended. Avoid drinking excessive amounts of coffee, tea and high-caffeine carbonated beverages because the caffeine promotes additional water loss.

SKIN PROTECTION

Skin must be protected from extreme drying due to the cold, dry atmosphere. Commercial lip balms (e.g., Chap Stik) are usually adequate to prevent lips from cracking. Vaseline type ointments are helpful to those who suffer localized dry skin. These items should be made available to the crew.

MEDICAL EFFECTS

WOUNDS

Although wounds inflicted in cold weather are treated much like those in warm weather, the cold does have some detrimental effects. Shock and loss of blood are more severe at colder temperatures. Shock is a condition caused by effectively reducing the amount of blood in circulation. Unfortunately, shock produces a very similar reaction to that of the body when in severe cold. Therefore, if shock occurs when the body has already reduced the effective amount of blood in circulation due to the cold, it will usually develop more rapidly and progress more deeply than at warm temperatures. For this reason, prompt action must be taken to prevent the victim from going into shock.

Wounds will bleed more easily in the cold because the low temperature reduces blood clotting required to stop bleeding. Additionally, wounds open to extremely low temperatures will freeze more quickly. Heat is lost through the wound and through blood-soaked clothing, which makes it essential to stop any bleeding quickly, keep the victim warm and treat for shock immediately.

SNOW BLINDNESS

Snow blindness occurs when the retina of the eye is burned by infrared or ultraviolet rays reflected from ice and snow. These rays, unlike visible light rays, are readily passed by clear or colored glass. The danger of snow blindness is greatest not on a clear bright day but on dull cloudy days or when snow mist is present. On cloudy days, people frequently do not sense the need to protect their eyes from intense ultraviolet light. Glasses or goggles specifically treated to block ultraviolet light must be worn to prevent snow blindness. Typical, untreated sunglasses will not be effective.

Symptoms of snow blindness appear in about 6-8 hours, usually in the following order:

- Irritation and gritty feeling in the eyes
- Hot and sticky eyes with excessive tear flow
- Blurred sight
- Pain in and over the eyes
- Onset of photophobia (a fear of light)
- Development of "pinkish tinge" around objects

The only effective treatment for snow blindness is rest and darkness. Cold compresses on the eyes will relieve some of the pain and most minor cases will recover within 18 hours without medical treatment. Severe cases will take several days to heal.

Although aboard ship the dangers of snow blindness are slight, caution must be taken particularly when in areas of heavy sea ice or snowy mist.

DENTAL PROBLEMS

How could cold weather possibly affect one's teeth, other than the chattering that occurs when a person is cold? Knowing a few important facts about how the teeth are affected by cold may save a lot of time in the dentist's chair.

The thermal effect of cooling teeth by breathing in cold air through the mouth causes them to contract slightly. If teeth are then rapidly warmed, by a cup of piping hot coffee for example, they will expand slightly. This expansion and contraction are enough to cause cracks in fillings or weak teeth. Bacteria can then enter these cracks and cause tooth decay, even if one is careful about brushing.

Even slow cooling and rewarming can cause teeth to crack. That is why it's important to have one's teeth in excellent condition prior to cold operations. Every effort should be made to ensure the crew is in "Class 1" condition, particularly those with topside duties. ("Class 1" is the highest dental rating.)

To minimize thermal stresses on teeth, avoid "shocking" teeth with hot liquids immediately after exposure to extreme cold. Allow the teeth to adjust to warm air first or slowly warm them with warm liquids. Breathing through the nose instead of the mouth will also help to warm the teeth before drinking hot liquids.

ACHES AND PAINS

Very briefly, aches and pains are generally more severe in the cold. Whether it be an old injury which hasn't properly healed or simply muscle soreness from overexertion, the body's neuromuscular system is often more sensitive to the cold, causing discomfort and greater difficulty of movement. Cold can significantly contribute to fatigue, stress and reduced performance.

FATIGUE

Certainly fatigue is not unique to cold climates. It is largely attributed to overwork, poor nutrition, lack of sleep and mental stress. Cold weather can, however, increase fatigue in several ways:

- Exposure to the cold increases the loss of body heat, even for a properly dressed person. The body burns additional energy to maintain its temperature and thereby consumes more of its reserves.

- Wearing heavy, bulky clothing restricts free movement, making it harder to perform even routine tasks. Periods of extreme exertion may result in sweating, followed by inactive periods which cause rapid heat loss when clothes are wet.

- The severity of weather in cold climates, including high winds and rough seas, requires greater effort to perform even routine tasks. Experience has shown that routine tasks can exhaust someone operating in cold weather in one-fourth the normal time.

It is particularly important that every level of the crew understand how fatigue can affect the safe and effective operation of the ship and the added effects of cold weather on fatigue. The younger crewmen in particular are prone to the "indestructible youth" syndrome and will have a difficult time accepting their limitations in the cold. Be prepared to adjust operating tempo and watchstation rotations to prevent the rapid onset of fatigue. Proper amounts of sleep, adequate rest periods, good nutrition and good health all help to eliminate fatigue.

PSYCHOLOGICAL EFFECTS

Just as the body is physically affected by the cold, the mind is also affected. Not only does the lower temperature interrupt normal functions, but the thought of being subjected to the cold also alters a person's behavior. Psychological effects of cold are important because they influence the effectiveness of the crew. Few people, for example, would look forward to long hours of exposure to icy winds, blinding snow and pitching seas that toss the ship like a cork. The weather will have a big impact on crew morale.

The most obvious psychological effect will be increased stress due to the added hardship of the environment. Tempers will be shorter, mental alertness will diminish and mental fatigue will occur more quickly. Seemingly simple tasks may become obviously difficult due to the compounding effects of stress. The biggest inherent danger will be lack of concern or awareness for safety.

The behavior of work crews should be monitored to detect signs of reduced alertness or impaired judgement. Look for reduced hand-eye coordination as a sign of danger. It is important that all supervisors be sensitive to the effects of cold and adjust working conditions as required.

Shipmates who notice behavioral changes in others should notify their supervisors. Proper medical and psychological treatment should be obtained if necessary.

PERSONAL HYGIENE

Close attention must be given to personal cleanliness to maintain good health and prevent the spread of disease. In a cold climate, there is a general tendency not to bathe as often as normal because one usually doesn't sweat as much. This kind of thinking can easily lead to skin rashes and poor health. Bathe as often as practical, paying particular attention to the feet and groin areas. Also, due to the increased susceptibility to colds and the flu, be particularly careful not to spread germs by coughing and sneezing without covering the mouth and nose. Frequently wash hands to prevent spreading diseases, since this is one of the primary ways that germs are spread.

APPENDIX A

TERMS AND DEFINITIONS

ANTARCTIC - The Southern Ocean extending northward to the northern limit of seasonally ice covered and partially ice covered waters. This will generally be no further north than 50 degrees South latitude.

ARCTIC - Geographic area extending from the North Pole to the Northern timberline. The Arctic Ocean and all adjacent seas extending southward to the southern limit of the seasonal ice cover including partial ice cover. This includes the Bering Sea, Sea of Okhotsk, Norwegian Sea, Barents Sea, Gulf of Bothnice, Gulf of Finland, Bohai Sea, Northern Sea of Japan and the Labrador Sea.

ASW - Anti-Submarine Warfare.

AURORAL ZONES - Zones of variable RF propagation in higher latitudes, due to charged particles ejected from the sun and deflected by the earth's magnetic field.

BEAUFORT GYRE - A current system centered near 78°N 140°W which moves ice in a counterclockwise rotation before dispersing it into the Transpolar Drift or along the coasts of Ellsmere Island and Greenland.

BERGY BITS - Pieces of ice about the size of a small house which often float near icebergs.

BESET - Situation of a vessel surrounded by ice and unable to move.

BUMMOCK - From the point of view of the submariner, a downward projection from the underside of the ice canopy; the counterpart of a hummock.

CALVING - The breaking away of a mass of ice from an ice wall, ice front or iceberg.

CLOSE ICE - Floating ice whose concentration is 7/10 to 8/10 composed of floes mostly intact.

COMPACT PACK ICE - Pack ice in which the concentration is 10/10 and no water is visible.

CONCENTRATION - The ratio in tenths of the sea surface actually covered by ice to the total area of sea surface, both ice-covered and ice-free, at a specific location or over a defined area.

CONSOLIDATED PACK ICE - Pack ice in which the concentration is 10/10 ice, with no water and the floes are frozen together.

CRACK - Any fracture which has not parted.

CRREL - Cold Regions Research and Engineering Laboratory, U.S. Army, Hanover, New Hampshire.

DCA - Damage Control Assistant.

DEADLIGHT - Ventilation cover fitted with light-obstructing baffles, for a ship's airport, to permit ventilation without the escape of light.

DEADMEN - Timber or a similar object buried in ice or in the ground to secure tackles on a ship's lines. If in ice, can also be called an ice anchor.

DEHYDRATION - A lack of sufficient fluid intake to make up for fluids lost.

DIFFUSE ICE EDGE - Poorly defined ice edge limiting an area of dispersed ice; usually on the leeward side of an area of pack ice.

DRIFT ICE - Sea ice that is drifting freely.

DTRC - David Taylor Research Center, with principal laboratories located in Carderock, Maryland and Annapolis, Maryland.

ECW - Extreme Cold Weather.

EMBRITTLEMENT - The process of materials becoming brittle from extreme cold weather.

FAST ICE - Sea ice that forms and remains attached to the coast. Fast ice extends to about the 10 fathom curve in late winter.

FIRST-YEAR ICE - Sea ice of not more than one winter's growth; thickness varies from 1 foot to 6.5 feet, generally white in color.

FLAW - A narrow separation zone between pack ice and fast ice, where the pieces of ice are in chaotic state; it forms when pack ice shears under the effect of a strong wind or current along the fast ice boundary.

FLAW LEAD - A passage-way between pack ice and fast ice which is navigable by surface vessels.

FLOATING ICE - Any form of ice found floating in water. The principal kinds of floating ice are lake ice, river ice and sea ice, which form by the freezing of water at the surface, and glacier ice (ice of land origin) formed on land or in an ice shelf. The concept includes ice that is stranded or grounded.

FLOE - Any relatively flat piece of sea ice 20 miles or more across. Floes are subdivided according to horizontal extent as follows:

GIANT: Over 10 km across.

VAST: 2-10 km across.

BIG: 500 - 2,000 m across.

MEDIUM: 100-500 m across.

SMALL: 20-100 m across.

FOD - Foreign Object Damage.

FPC - Fluorocarbon Penetrating Coating.

FRACTURE - Any break or rupture through very close pack ice, compact pack ice, consolidated pack ice, fast ice or a single floe resulting from deformation processes. Fractures may contain brash ice and/or be covered with nilas and/or young ice. Length may vary from a few metres to many kilometers.

FRAZIL ICE - Fine spicules or plates of ice, suspended in water.

FREE COMMUNICATION - Occurs if the hull is ruptured so that one or more compartments are open to the sea.

FREE SURFACE - Effect from ship's tank(s) or void(s) when only partially filled and the liquid contents "slosh" back and forth.

FRESHWATER ICING - When ice form on the ship's surfaces from drops of rain, damp snow or other fresh water source.

FROSTBITE - The freezing of any part of the body. The water in the tissue cells turns to ice and disrupts the normal functions of the tissue.

FROSTNIP - Superficial frostbite, affecting only the skin or the tissue immediately beneath it.

GLACIER - A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. The principal forms of glacier are: inland ice sheets, ice shelves, ice streams, ice caps, ice piedmonts, cirque glaciers and various types of mountain (valley) glaciers.

GREASE ICE - A later stage of freezing than frazil ice when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matte appearance.

GREEN WATER - Solid sea water (waves), not sea spray, which comes over the ship when in heavy seas. Is dangerous because it can damage equipment, break windshields and antennas and can wash people overboard.

GROWLERS - Smaller piece of ice than a bergy bit or floeberg, (about the size of a piano) often transparent but appearing green or almost black in color, extending less than 1 meter above the sea surface.

HALO - Commonly a ring of light of radius 22° or 46° with the sun or moon at the center, caused by refraction of light by ice crystals in the atmosphere. Occasionally, a faint white circle with a radius of 90° appears around the sun.

HUMMOCK - A hillock of broken ice which has been forced upwards by pressure. May be fresh or weathered. The submerged volume of broken ice under the hummock, forced downwards by pressure, is termed a bummock.

HYDROPHOBIC COATING - A coating incapable of dissolving in water.

HYPOTHERMIA - A condition that occurs when the body is unable to maintain adequate warmth and the body core temperature drops below normal.

ICE ACCRETION - The building up of ice which occurs when airborne moisture comes in contact with cold metal.

ICEBERG - A large mass of floating ice broken away from a glacier or a large mass of ice, floating or aground, that has calved from a glacier, i.e., fresh water ice.

ICE BLINK - A whitish glare on the underside of low clouds caused by the sun's reflection off the surface of pack ice.

ICE CAKE - Any relatively flat piece of sea ice from 6 to 60 feet across.

ICE COVER - The ratio of an area of ice of any concentration to the total area of sea surface within some large geographic locale; this locale may be global, hemispheric, or prescribed by a specific oceanographic entity such as Baffin Bay or the Barents Sea.

ICE EDGE - The demarcation at any given time between the open sea and sea ice of any kind.

ICE-FREE - An area with no ice present.

ICE LIMIT - Climatological term referring to the extreme minimum or extreme maximum extent of the ice edge in any given month or period based on observations over a number of years. Term should be preceded by minimum or maximum.

ICE-PHOBIC COATINGS - Coatings applied to topside weather surfaces to reduce ice accretion.

LAMPS - Light Airborne Multi-Purpose System.

LEAD - Any fracture or passageway through sea ice that is navigable by surface vessels; long open cracks.

LOOMING - When as a result of temperature inversion accompanied by rapid decrease in humidity, refraction becomes greater than normal, objects which are normally below the horizon become visible.

MARGINAL ICE ZONE (MIZ) - The region from the ice edge (where ice is first encountered) to a point that is sufficiently far from the ocean boundary so as not to be affected by the presence of the open ocean, i.e., no evidence of wave action, swell, etc.

MEAN ICE EDGE - Average position of the ice edge in any given month or period based on observations over a number of years. Other terms which may be used are mean maximum ice edge and mean minimum ice edge.

METABOLISM - The rate of burning of calories by the body.

MIRAGE - An optical phenomenon in which objects appear distorted, displaced (raised or lowered), magnified, multiplied, or inverted due to varying atmospheric refraction which occurs when a layer of air near the earth's surface differs greatly in density from surrounding air.

MRC - Maintenance Requirement Card.

MULTI-YEAR ICE - Sea ice which has survived at least two summers' melt. Features a light blue color and pressure ridges that are somewhat rounded and gradual in contour. May be up to 150 feet thick in ridges but is normally 6-9 feet thick in level areas.

NASL - Naval Applied Science Laboratory.

NAVSAT - Navigational Satellite.

NAVY/NOAA JOINT ICE CENTER (JIC) - Housed at the Naval Polar Oceanography Center, Suitland, Maryland. Provides sea ice tracking services, including global sea analysis and forecasting.

NEW ICE - A general term for recently formed ice that includes frazil ice, slush and shuga. These types of ice are composed of ice crystals that are only weakly frozen together (if at all) and have a definite form only while they are afloat.

NILAS - A thin elastic crust of ice, easily bending on waves and swell under pressure, thrusting in a pattern of interlocking "fingers."

NOAA - National Oceanic and Atmospheric Administration, Washington, D.C.

NPOC - Naval Polar Oceanography Center, located in Suitland, Maryland.

OLD ICE - Sea ice which has survived at least one summer's melt. Most topographic features are smoother than on first-year ice. May be subdivided into second-year ice and multi-year ice.

OPEN PACK ICE - Pack ice in which the ice concentration is 4/10 to 6/10 (3/8 to less than 6/8), with many leads and polynyas, and the floes are generally not in contact with one another.

OPEN WATER - A large sea of freely navigable water in which sea ice is present in concentrations less than 1/10. When there is no sea ice present the area should be termed ice-free, even though icebergs may be present.

PACK ICE - Term used in a wide sense to include any area of sea ice, other than fast ice, no matter what form it takes or how it is disposed.

PANCAKE ICE - Predominantly circular pieces of ice from 10 inches to 9 feet in diameter, and up to about 4 inches in thickness, with raised rims due to pieces striking against one another. It may be formed on a slight swell from grease ice, shuga, or slush or as a result of the breaking ice rind, nilas or under severe conditions of swells or waves of grey ice.

PMS - Planned Maintenance System.

POLAR REGIONS - The regions poleward of the Arctic and Antarctic Circles.

POLYNYA - Any nonlinear-shaped opening enclosed in ice. Polynyas may contain brash ice and/or be covered with new ice, nilas or young ice.

RAFTING - Pressure processes whereby one piece of ice overrides another. Most common in new and young ice.

RAM - An underwater ice projection from an ice-wall, ice front, iceberg or floe. Its formation is usually due to a more intensive melting and erosion of the unsubmerged part.

RAST - Recovery Assist, Securing and Traversing.

RESPIRATION - Water lost when cold, dry air enters the lungs, heats up, picks up moisture and is breathed out.

RIDGE - A line or wall of broken ice forced up by pressure. May be fresh or weathered. The submerged volume of broken ice under a ridge, forced downwards by pressure, is termed an ice keel.

ROTTEN ICE - Sea ice which has become honeycombed and which is in an advanced state of disintegration.

RTV - Room temperature vulcanizing.

SATCOM - Satellite Communication.

SEA ICE - Ice having its origin and entire development in the sea or along its coastal periphery.

SEA SMOKE - A phenomenon which occurs when very cold air over open water produces steaming on the surface, occasionally to a height of several hundred feet.

SEASONAL SEA ICE ZONE (SSIZ) - Characterized by the periodic presence of ice cover and is not synonymous with the polar region.

SECOND-YEAR ICE - Old ice which has survived only one summer's melt. Because it is thicker and less dense than first-year ice, it stands higher out of the water. In contrast to multi-year ice, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.

SHAREM - Ship Antisubmarine Warfare Readiness and Effective Measurement.

SHORE LEAD - A lead between pack ice and the shore or between pack ice and an ice front.

SHUGA - An accumulation of spongy whitish ice lumps, a few centimeters across; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface.

SINS - Ship's Inertial Navigation System.

SMALL ICE CAKE - Any relatively flat piece of sea ice less than 6 feet across.

SNOW BLINDNESS - Occurs when the retina of the eye is burned by infrared or ultraviolet rays reflected from ice and snow.

SOAKING - Long-term exposure of the ship to subzero temperatures and near freezing seas. The ship is soaked when it reaches equilibrium with its environment.

SOPA - Senior Officer Present Afloat.

SORM - Ship's Organization and Regulation Manual.

SPRAY ICING - Occurs at air temperatures below freezing when the spray of seawater hitting the ship's surfaces freezes and creates a shell of ice.

STRIP - Long narrow area of pack ice, about 1 km or less in width, usually composed of small fragments detached from the main mass of ice, and run together under the influence of wind, swell or current.

SWR - Standing wave ratio.

TOP HEAVY - The result of topside weight increase, resulting in the ship's center of gravity being raised.

TRANS POLAR DRIFT - Ice flowing from the Pacific Gyre, carried from the eastern Siberian Sea across the pole and generally down the eastern coast of Greenland.

TRENCH FOOT - Also known as immersion foot, is a cold injury to the feet (and possibly the hands) resulting from prolonged exposure to dampness and temperatures below 50°F.

UNREP - Underway Replenishment.

UREA - A white crystalline or powdery compound synthesized from ammonia and carbon dioxide used to help remove or prevent the formation of ice.

VACAPES - Virginia Capes.

VERTREP - Vertical replenishment.

VERY CLOSE PACK ICE - Pack ice in which the concentration is 9/10 to less than 10/10.

VISCOSITY - Fluid flow resistance.

WATER SKY - The darkening of the underside of low clouds indicating the presence of open water beneath the clouds.

WAXING - The formation of wax in the engine fuels due to extreme cold weather.

WEATHERING - Processes of ablation and accumulation which gradually eliminate irregularities in an ice surface.

WHITEOUT - A phenomenon which occurs when snow obliterates surface features, and the sky is covered with a uniform layer of cirro stratus or alto stratus clouds so that there are no shadows. The horizon disappears and earth and sky blend together, forming an unbroken expanse of white without features.

WMO - World Meteorological Organization.

APPENDIX B

COLD WEATHER LUBRICANTS

This appendix contains a brief description of various lubricants and hydraulic fluids which are suitable for use aboard ships operating in a cold weather environment. In most cases, the materials listed are authorized for shipboard use by Chapter 262 of the Naval Ships' Technical Manual (NSTM) entitled "Lubricating Oils, Greases, Hydraulic Fluids and Lubrication Systems" and military handbook MIL-HDBK-267(SH) entitled "Guide for Selection of Lubricants and Hydraulic Fluids for Use in Shipboard Equipment." This appendix does not include lubricants and hydraulic fluids designated for use in aircraft, weapons systems and electronics systems, or materials used only for corrosion protection or in maintenance operations. The information provided for each cold weather lubricant or hydraulic fluid includes the specification number, the name, a brief statement of the intended use, the minimum or range of operating temperatures and the National Stock Number (NSN) for various available container sizes. In cases where two or more types of a given material are available for use under different ambient temperature conditions, information is usually provided only for the type having the lowest recommended operating temperature or lowest pour point temperature.

CAUTION

The use of an incorrect lubricant or hydraulic fluid can cause serious damage to system or component. Before adding to or changing the lubricant or fluid in any system or component, refer to the appropriate technical manual or PMS Maintenance Requirement Card (MRC) to determine the proper material for each application. These materials should not be used in non-specified applications without prior performance evaluation.

<u>Lubricating Greases</u>

MIL-G-6032: Grease, plug valve, gasoline and oil resistant.

Uses: General plug valve service in systems where gasoline, oil, alcohol or water resistance is required.

Minimum Operating Temperature: -65°F

National Stock Numbers:

8 oz. can	9150-00-190-0926
1 lb. can	9150-00-257-5360

MIL-G-18458: Grease, wire rope and exposed gear.

Uses: Lubrication and corrosion-resistant externally-applied grease for use on wire running ropes and exposed gears.

Minimum Operating Temperature: -60°F

National Stock Number:

120 lb. drum	9150-00-530-6813

DOD-G-24508: Grease, high performance, multipurpose (METRIC).

Uses: Ball and roller bearings, flexible couplings and steam plant valves and fittings.

Operating Temperature Range: -65°to 300°F

National Stock Numbers:

1 lb. can	9150-00-149-1593
5 lb. can	9150-01-117-2928

MIL-G-27617, Type I: Grease, aircraft and instrument, fuel and oxidizer resistant.

Uses: Taper plug valves in fuel and oil systems, high pressure air systems, oxygen systems and nitrogen systems.

Operating Temperature Range: -65° to 300°F

National Stock Numbers:

8 oz. tube	9150-01-007-4384

Lubricating Oils

MIL-L-2104: Grade 10 lubricating oil, internal combustion engines, tactical service.

Uses: Shipboard diesel engines operating at ambient temperatures less than 32°F where JP-5 is used as fuel.

Minimum Operating Temperature: -25°F

National Stock Numbers:

1 qt. can	9150-00-189-6727
5 gal. can	9150-00-186-6668
55 gal. drum	9150-00-191-2772
Bulk	9150-00-183-7807

MIL-L-2105: Grade 75W and 80W90 lubricating oil, gear, multipurpose.

Uses: Heavy duty enclosed gear units, automotive gear units and universal joints.

Operating Temperature Range: -65° to 275°F

National Stock Numbers:

1 qt. can	9150-00-035-5390
1 gal. can	9150-01-048-4593
5 gal. can	9150-01-035-5391

MIL-L-6085: Lubricating oil, instrument, aircraft, low volatility.

Uses: Instruments and electronic equipment.

Minimum Operating Temperature: -65°F

National Stock Numbers:

1.5 oz. bottle	9150-00-664-6518
4 oz. can	9150-00-257-5449
8 oz. can	9150-00-971-6643
1 qt. can	9150-00-223-4129
5 gal. can	9150-01-018-8959

MIL-L-23699: Lubricating oil, aircraft turbine engines, synthetic base.

Uses: Marinized aircraft turbine engines used for shipboard main propulsion and auxiliary applications and also in engine accessory equipment.

Minimum Operating Temperature: -60°F

National Stock Numbers:

8 oz. can	9150-00-180-6266
1 qt. can	9150-00-985-7099
55 gal. drum	9150-00-681-5999

DOD-L-24574: Lubricating fluid for low and high pressure oxidizing gas systems (METRIC)

Uses: Crankcase lubricant for air, oxygen or nitrogen compressors.

Operating Temperature Ranges:

Type I:	-50° to 32°F
Type II:	-4° to 104°F
Type III:	68° to 158°F

National Stock Numbers:

Type I: 1 qt. can	9150-01-101-8834
Type II: 1 qt. can	9150-01-101-8835
Type III: 1 qt. can	9150-01-101-8836

Hydraulic Fluids

MIL-H-17672: Hydraulic fluid, petroleum, inhibited.

Uses: Submarine external hydraulic systems, surface ship deck equipment, hydraulic steering gear and other applications.

Minimum operating temperature: -20°F

National Stock Numbers:

1 qt. can	9150-00-985-7231
5 gal. can	9150-00-985-7232
55 gal. drum	9150-00-985-7233

MIL-H-22072: Hydraulic fluid, catapult.

Uses: Fire resistant (water-glycol) fluid for catapults and weapons elevators. This fluid is not interchangeable with any other type of hydraulic fluid.

Minimum Operating Temperature: -30°F

National Stock Numbers:

1 gal. can	9150-01-080-5961
55 gal. drum	9150-01-080-5962

MIL-H-83282: Hydraulic fluid, deck machinery.

Uses: Synthetic hydraulic fluid used in some deck machinery and some small craft hydraulic systems.

Minimum Operating Temperature: -65°F

National Stock Numbers:

1 qt. can	9150-00-149-7431
1 gal. can	9150-00-149-7432
5 gal. can	9150-00-281-6191
10 gal. can	9150-01-009-7709
55 gal. drum	9150-00-180-6290

Miscellaneous Lubricants

VV-P-216: Penetrating oil.

Uses: Freeing corrosion-seized parts.

Minimum Operating Temperature: -40°F

National Stock Numbers

1 pt. can	9150-00-261-7899
1 pt. can (pressurized)	9150-00-529-7518
1 qt. can	9150-00-262-8990
1 gal. can	9150-00-223-4119

APPENDIX C

ICE ACCRETION REDUCTION COATINGS

The Navy is embarked on an accelerated effort to identify coatings to prevent ice accumulation on ship's topside structures and equipment. Considerations for selection include ease of application, durability, effectiveness in reducing ice accretion, color or transparent nature of the coating, weight and cost. The coatings presented here have been utilized in varying degrees of evaluation efforts to prove the effectiveness in meeting these qualifications.

A few of the coatings are in use on weather data collection stations. To date, research has not been completed to identify the most acceptable products, though several show promise. The following coatings may be used in specific applications to minimize the build-up of surface ice. While no coating will totally prevent ice accretion, generally they work to reduce some ice adhesion and facilitate ease of ice removal.

Coatings should be applied prior to ship's deployment into regions known for icing conditions. Manufacturers' guidelines should be consulted for the coatings listed in Appendix C to estimate the quantity needed.

It is important to assess the timeframe for all phases, including suppliers' delivery time, surface preparation, application (application equipment such as special sprayers or rollers may need to be procured), curing time and probable weather conditions affecting such activities to determine total lead time required before deployment.

Local SIMA, NAVSUP or NAVSEA (Code 05M) should be consulted to determine availability of application equipment and the approval status of various coatings listed here.

Copolymer Coating GE LR-5630

Cold Regions Research & Engineering Laboratory
Hanover, NH 03755
(603) 646-4200

Application and Procurement Information:

Approximate cost: $100/gallon
Covers approximately 150 sq. ft./gallon

The purpose of this coating is the reduction of atmospheric ice accretion on antenna platforms. Spray application: need special applicator and training (provided by CRREL personnel) for application. Limited quantities available. Large order required to obtain operational stock levels.

Fluorocarbon Penetrating Coating (FPC)

Fluorocarbon Technologies, Inc.
7047-A Bembe Beach Rd.
Annapolis, MD 21403
(301) 268-6451

Undergoing tests and evaluations by DTRC and NAVSEA.

Application and Procurement Information:

Approximate Cost: $65.00/gallon
Covers 350 sq. ft./gal.

Easy surface preparation. Wash with mild degreaser. Air spray at 60 psi. Buff with rotary buffer. Color: white/clear. Operating temperature: -100°F to +750°F, non-flammable.

Hycote 151

Underwater Technology Corporation
Canning Vale Complex
2 Bell Street
Canning Vale 6155
Western Australia

Sales and Technical Service
International Paint Company
Union, NJ
(201) 686-1300

Undergoing evaluation by CRREL

Application and Procurement Information:

Approximate cost: $85/gal
Covers approximately 160 sq. ft./gal. (above water)

Two-part product consisting of epoxy resin and polyamine-based curing agent. Does not require prime coat. Hard, smooth finish with low drag coefficient. Requires special applicator. Non-toxic when cured. Colors: black, red, yellow are standard. Other colors prepared to order.

The following coatings may not be compatible with every coating currently in use in the fleet. Exercise care before using any of these products.

Polyurethane Coating PR-475-S

Products Research and PR-Chemical Corp.
5430 San Fernando Road
P.O. Box 1800
Glendale, CA. 91209
(818) 240-2060

410 Jersey Avenue
Gloucester City, NJ 08030
(609) 456-5700

Application and Procurement Information:

Approximate cost: $48.00/gallon (comes in cases of 4 gallons)
Covers approximately 83 sq. ft. for cured film thickness of 12 dry mil.

Two-part polyurethane coating. Requires 2 part primer. Top coat sprayed. Airless sprayer preferred. Components are toxic. Full hoods and respirators required. Colors: black, blue, gold. Temperature range: -40°F to 200°F, combustible.

Polyurethane Coating Zebron

Reliance Universal Co.
P.O. Box 1113
Houston, TX 77251
(713) 672-6641

Application and Procurement Information:

Approximate cost: $100.00/4 litres; $48/gallon in 55-gallon drum.
Covers approximately 400 sq. ft./gallon.

Non-solvented polyurethane coating. Can be applied by spray, brush, roller or mastic. Surface must be prepared. Colors: gray, red.

Polyurethane Coating Inerta 160 and Epoxy Coating Intershield EGA 103

International Paint (USA) Inc.
2270 Morris Avenue
P.O. Box 386
Union, NJ 07083
(201) 686-1300

Application and Procurement Information:

Approximate cost: $60.00/gallon - Inerta 160
$20.00/gallon - EGA 103

Spread rate: 40 sq. ft. at 40 mils thickness up to 76 sq. ft. per gal.

Difficult preparation. Surface to be blast cleaned to Sa 2 1/2 to 3. Controlled environment required. Inerta 160 requires dual component pumps and a skilled operator. Inerta 160 is 100% solid material. Intershield EGA 103 is a low solid material, and is easier to use.

Spread rate for the follow-up coats are 192 sq. ft. per gal. and the spread rate for the primer coat is 400 sq. ft. per gal. The normal spec. is 6 mil dry film. Recommended coverage is 1 coat primer, 2 follow-up coats. Designed for operation at temperatures to -50°C.

Vellox 140

M-Chem Corp.
9 Bishop Road
Ayer, MA 01432

Sales and Technical Service
Clifford W. Estes Co.
P.O. Box 907
Lindhurst, NJ 07071
(201) 935-2550

Undergoing tests and evaluations by DTRC and NAVSEA.

Application and Procurement Information:

Approximate Cost: Top coat: $66.00/gallon
Primer: $84.00/gallon

Coverage: Top coat: 90-120 sq. ft./gallon
Primer: 350-400 sq. ft./gal.

Various forms of primer/topcoat and one-part systems exist, some of which are flammable. Primer can be applied by roller, brush or spray; topcoat must be sprayed. Has powdery, flock-like finish. Not abrasion resistant. Can be applied at temperatures between 25° to 100°F.

Vydax 550

E. I. duPont de Nemours & Company, Inc.
Specialty Chemicals Division
Customer Service Center
Wilmington, DE 19898
1-800-441-9442

Application and Procurement Information:

Approximate Cost: $80.50/gallon
Coverage: depends on coverage of paint with which VYDAX 550 is mixed.

Teflon wax-like substance. Wiped/brushed on and buffed. Color will be the same as the paint with which it is mixed.

Graphite Paint

Superior Graphite Company
120 South Riverside Plaza
Chicago, IL 60606
(312) 559-2999

Application and Procurement Information:

Approximate Cost: $25.40/gallon (sold in 4-gallon cases)
Covers approximately: 200 sq.ft./gallon

Preparation of surfaces/application information:

—All grease and dirt must be removed.
—Strip any existing paint.
—Primer is not necessary; apply to bare metal.
—No cleanup between coats is necessary.
—Spray, roll, brush, flow, or dip to apply.
—Drying thoroughly between coats is essential.
  Dries to the touch in 1 & 1/2 hours
  Let coating set overnight
—Buff with a dry cloth to clean

Unaffected by temperature changes when dry (from -75°F to approximately 400°F).
Color: dark gray.

APPENDIX D

CLOTHING DESCRIPTION AND STOCK NUMBERS

GOVERNMENT ISSUE CLOTHING

BOOTS

Navy Standard Boots, Cold Weather. Blucher type. Insulated vulcanized rubber boot. Black with buff colored sole and heel. Flexible non-slip outer sole and molded heel. Eyelets and laces for ankle and leg adjustment. Used where moisture and cold are critical factors.

Approximate Cost: $72

8430-00-913-3409	6	Regular
8430-00-913-3410	6	Wide
8430-00-913-3411	7	Regular
8430-00-913-3412	7	Wide
8430-00-913-3413	8	Regular
8430-00-913-3414	8	Wide
8430-00-913-3415	9	Regular
8430-00-913-3416	9	Wide
8430-00-913-3417	10	Regular
8430-00-914-0341	10	Wide
8430-00-913-3418	11	Regular
8430-00-913-3419	11	Wide
8430-00-913-3420	12	Regular
8430-00-913-3421	12	Wide
8430-00-913-3422	13	Regular
8430-00-913-3423	13	Wide

GLOVES

Navy Standard (new style) Mitten Set, Extreme Cold Weather. Supported chloroprene dipped outer shell. Flame bonded, polyurethane film laminate, nylon tricot fabric and polyurethane foam liner. Water impermeable. Improved dexterity. Three fingers plus thumb. Suited for wet environment.

Approximate Cost: $28

8415-01-150-6198	Small
8415-01-150-6199	Medium
8415-01-150-6200	Large
8415-01-150-6201	X-Large

Navy Standard (old style) Mittens, Extreme Cold Weather. Double coated nylon twill outer shell. Knitted nylon fleece inner shell. Leather reinforced patches on palm and upper thumb. For cold and wet/cold. Worn with liner. Inferior to and replaced by mitten set described above.

Approximate Cost: $36

8415-00-965-1752	Small
8415-00-965-1753	Medium
8415-00-965-1754	Large
8415-00-965-1755	X-Large

Mitten Set, Extreme Cold Weather. Wind-resistant sateen cotton/nylon shell; full grain deerskin leather palm, thumb and sidewalls; wool pile backing; and quilted polyester batting liner. Intended for use in cold, dry conditions.

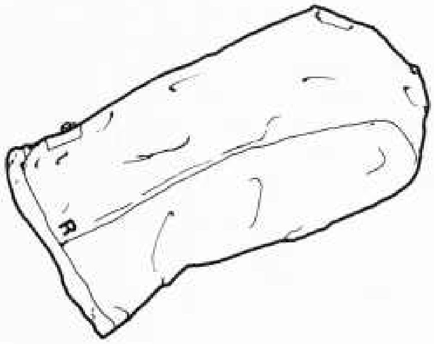
Approximate Cost: $24

8415-00-782-6715	Small
8415-00-782-6716	Medium
8415-00-782-6717	Large

Anti-Exposure Mittens. Chloroprene-coated nylon inner and outer layers; inflatable liner. Intended to provide protection for aircrew members' hands in the cold.

Approximate Cost: $42

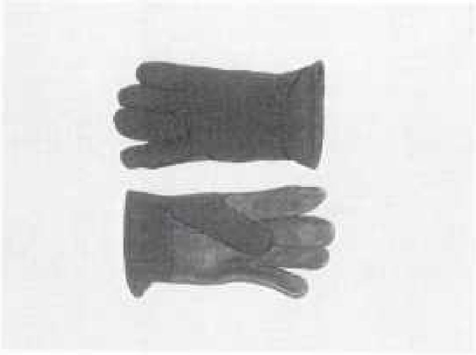
8415-00-460-2825   Universal size



Gloves, Cloth, Anti-contact. Gunn-cut design with leather reinforced palm, fingers and a Bolton thumb. For use in cold wet/dry regions where dexterity and protection from cold metal contact are required.

Approximate Cost: $10

8415-00-227-1220	Small
8415-00-227-1221	Medium
8415-00-227-1222	Large



Glove Inserts, Wool-Nylon. 75% wool/25% nylon knit. Ambidextrous design with knitted hands, fingers and thumbs. Worn with various glove shells for added warmth.

Approximate Cost: $2

8415-00-682-6673	1
8415-00-682-6674	2
8415-00-682-6675	3
8415-00-682-6676	4
8415-00-682-6677	5

Gloves, Shells, Leather. Full grain, black chrome-tanned cattlehide or horsehide shells. Water-resistant treated. For use in light-duty work, mosquito protection or with wool glove inserts for dry cold wet applications.

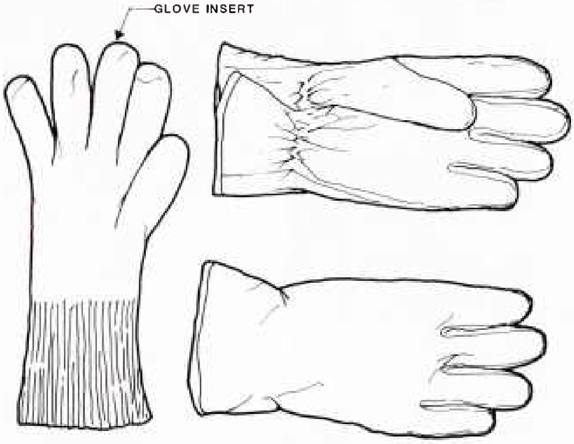
Approximate Cost: $13

8415-00-634-4794	1
8415-00-634-4793	2
8415-00-269-5700	3
8415-00-269-5701	4
8415-00-269-5702	5

Lined Glove, HAU-6/P. Brown intermediate-weight leather glove shell. Designated for use by all aircrew members to supplement cold weather protection. Worn with wool-nylon glove inserts.

Approximate Cost: $10

8415-00-261-4771	Small	3
8415-00-261-4770	Medium	4
8415-00-261-4769	Large	5
8415-00-261-4768	X-Large	6



HEADGEAR

Navy Standard Hood, Extreme Cold Weather. Nylon twill, chloroprene rubber-coated on the underside; nylon fleece knitted lining; visor and protective nose flap. Hook and pile nylon tape fastening. Attached to garments with loops. Waterproof. For cold and cold/wet conditions

Approximate Cost: $9

8415-00-472-4695 Without ear pods

Navy Standard Hood, Extreme Cold Weather. Same as above, with the addition of ear pods.

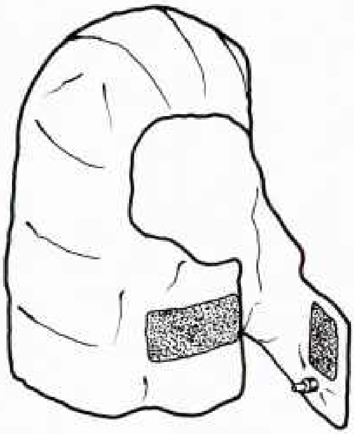
8415-00-472-4696 With ear pods for phones or oral sound protections

Navy Standard Hood, Extreme Cold Weather (Shore). Similar to hood described above. Features a fur ruff and chest slide fastener closure. Head size in inches shown after size below.

Approximate Cost: $16

8415-00-753-5603	Small	6 5/8 - 6 3/4
8415-00-753-5604	Medium	6 7/8 - 7
8415-00-753-5605	Large	7 1/8 - 7 1/4
8415-00-753-5606	X-Large	7 3/8 - 7 1/2

Anti-Exposure Hood. Chloroprene coated nylon life preserver cloth. Inflatable hood has an oral valve and snap fastener closure.



Approximate Cost: $71

8475-01-255-7490 Universal size

Mask, Extreme Cold Weather (white). Nylon knitted and cotton jersey cloth laminated together. Contoured covering with adjustable head harness, eyeglass retention holders, a padded malleable aluminum nosebridge stiffener.

Approximate cost: $8

8415-01-006-3468 Universal size

Mask, Extreme Cold Weather. Olive green, vinyl coated nylon mask with wool felted lining. Waterproof outer surface. The mask is contour shaped with adjustable head straps, and snap fastened nose and mouth coverings. For use in extreme low temperatures.

Approximate Cost: $8

8415-00-243-9844 Universal size

Navy Standard Mask, Extreme Cold Weather. Laminated composite: Nomex/Kevlar, polytetraflouroethylene film, polyurethane foam and cotton knit. Adjustable head straps. Hook and loop nose fastener. Fire- and water-resistant.

Approximate Cost: $11

8415-01-181-1398 Universal size

Navy Standard Cap, Cold Weather (A-2). Olive green, cotton/nylon shell with nylon linings. Visor and fold-down ear covering.

Approximate Cost: $5

8415-00-753-6507	Small	6 5/8 - 6 3/4
8415-00-753-6508	Medium	6 7/8 - 7
8415-00-753-6509	Large	7 1/8 - 7 1/4
8415-00-753-5610	X-Large	7 3/8 - 7 1/2

Navy Standard Cap, Knit (watch). Enlisted personnel's watch cap. Navy blue wool.

Approximate Cost: $2

8405-01-006-1074 Universal size.

Cap, Cold Weather Insulating Helmet Liner. Fully lined, cold weather head covering having a turndown forehead flap (sinus protector), three-piece crown, a stretch gusset with an elastic strap at the center back and earflaps with nylon fastener hook and pile tape overlap closure. Worn alone or as a liner for helmet.

Approximate Cost: $10

8415-00-782-2916	6 1/2
8415-00-782-2917	6 3/4
8415-00-782-2918	7
8415-00-782-2919	7 1/4
8415-00-782-2920	7 1/2
8415-00-782-2921	7 3/4

JACKETS, TROUSERS AND SUITS

Navy Standard A-1 Extreme Cold Weather Jacket. Green, chloroprene rubber-coated nylon twill. Features a quilted lining, cotton corduroy collar and knitted cuffs. Single-breasted with zipper closure and buttoned extension flap. Used with trousers and hood in cold and wet cold areas

Approximate Cost: $47

8415-00-349-9313	Small	34-36
8415-00-349-9314	Medium	38-40
8415-00-349-9315	Large	42-44
8415-00-349-9316	X-Large	46-48
8415-00-349-9317	XX-Large	50-52

Navy Standard A-1 Extreme Cold Weather Trousers. Waterproof and insulated. Zipper and button fly closure. Equipped with belt and suspender loops, and adjustable take-up straps near bottom of trousers. For use with above jacket in cold and wet cold areas.

Approximate Cost: $41

8415-00-575-1225	Small	27-30
8415-00-575-1230	Medium	31-34
8415-00-575-1240	Large	36-38
8415-00-575-1246	X-Large	39-42
8414-00-575-1247	XX-Large	43-46
8415-00-349-9317	XXX-Large	50-52

Navy Standard A-2 Intermediate Cold Weather Jacket. Olive green permeable cotton, nylon sateen cloth jacket. Knitted nylon fleece lining and knitted wool cuffs. Single-breasted design with zipper and buttoned over-flap. Water-repellent treated.

Approximate Cost: $24

8415-00-753-5611	Small
8415-00-753-5612	Medium
8415-00-753-5613	Large
8415-00-753-5614	X-Large
8415-00-753-5615	XX-Large

Navy Standard A-2 Intermediate Cold Weather Trousers.
Olive green, permeable cotton nylon sateen. Lined with knitted nylon fleece. Zippered and buttoned fly closure. Patch pockets, belt loops and leg adjustment straps. Water- repellent treated.

Approximate Cost: $27

8415-00-013-4834	Small
8415-00-013-4835	Medium
8415-00-013-4836	Large
8415-00-013-4837	X-Large
8415-00-013-4838	XX-Large

Hood, Flyers. Sage green aramid twill cloth hood. Fire-resistant. Pile lining and synthetic fur ruff. For use by flight personnel for cold weather protection.

Approximate Cost: $41

8415-01-027-6034 Universal size

Cold Weather Flyer's Jacket, CWU-45/P. Outer shell with wristlets and waistband of aramid material, and a quilted lining. Emergency marker panel and pouch are included. Provides thermal anti-exposure protection at low temperatures.

Approximate Cost: $114

8415-00-310-1111	Small	34-36
8415-00-310-1126	Medium	38-40
8415-00-320-1133	Large	42-44
8415-00-310-1140	X-Large	46-48

ECWCS Bib Overall. Brown fiber pile. Elastic suspenders, full length side seam zippers, quick release buckles. Worn under trousers for temperatures below -25°F. (Pictured with ECWCS Undershirt from page 20.)

Approximate Cost: $22

8415-01-228-1323	X-Small	Short-Regular
8415-01-228-1324	X-Small	Long
8415-01-228-1325	Small	Short-Regular
8415-01-228-1326	Small	Long
8415-01-228-1327	Medium	Short-Regular
8415-01-228-1328	Medium	Long
8415-01-228-1329	Large	Short-Regular
8415-01-228-1330	Large	Long
8415-01-228-1331	X-Large	Short-Regular
8415-01-228-1332	X-Large	Long

Extended Cold Weather Parka. Camouflaged, three-layer laminated material. Windproof and waterproof. Allows perspiration to pass through. Integral hood, pockets, waist cord and wrist closures. +40° to -25°F.

Approximate Cost: $123

8415-01-228-1306	X-Small	X-Short
8415-01-228-1307	X-Small	Short
8415-01-228-1308	X-Small	Regular
8415-01-228-1309	X-Small	Long
8415-01-228-1310	Small	X-Short
8415-01-228-1311	Small	Short
8415-01-228-1312	Small	Regular
8415-01-228-1313	Small	Long
8415-01-228-1314	Medium	X-Short
8415-01-228-1315	Medium	Short
8415-01-228-1316	Medium	Regular
8415-01-228-1317	Medium	Long
8415-01-228-1318	Large	Short
8415-01-228-1319	Large	Regular
8415-01-228-1320	Large	Long
8415-01-228-1321	X-Large	Regular
8415-01-228-1322	X-Large	Long

ECWCS Extended Cold Weather Trousers. Same as parka.

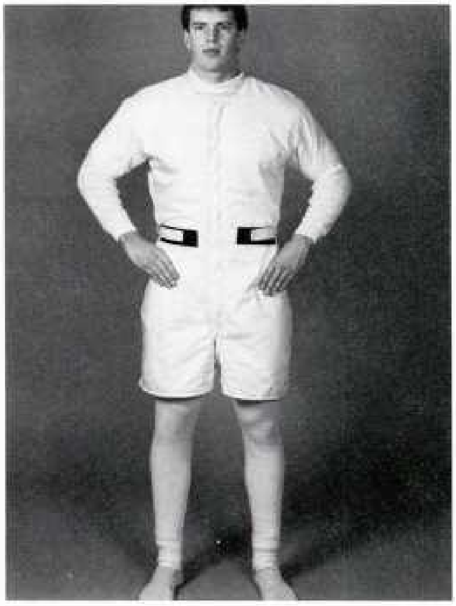
Approximate Cost: $79

8415-01-228-1336	X-Small	X-Short
8415-01-228-1337	X-Small	Short
8415-01-228-1338	X-Small	Regular
8415-01-228-1339	X-Small	Long
8415-01-228-1340	Small	X-Short
8415-01-228-1341	Small	Short
8415-01-228-1342	Small	Regular
8415-01-228-1343	Small	Long
8415-01-228-1344	Medium	X-Short
8415-01-228-1345	Medium	Short
8415-01-228-1346	Medium	Regular
8415-01-228-1347	Medium	Long
8415-01-228-1348	Large	Short
8415-01-228-1349	Large	Regular
8415-01-228-1350	Large	Long
8415-01-228-1351	X-Large	Regular
8415-01-228-1352	X-Large	Long

Anti-Exposure Flying Coverall, CWU62/P. Designed for continuous wear. Provides aircrews with protection from cold water, wind and spray in the event of emergency over-water aircraft egress. Dry-type, one-piece suit, constructed of Nomex/Gore-tex that is moisture/vapor permeable. Entrance opening across chest is sealed with water and pressure sealing zippers. Worn with CWU-62/P liner pictured below and other insulating clothing.

Approximate Cost: $386

8475-01-179-9992	Small	Short
8475-01-174-2047	Small	Regular
8475-01-176-9158	Small	Long
8475-01-176-9159	Medium	Short
8475-01-176-9160	Medium	Regular
8475-01-176-9161	Medium	Long
8475-01-176-9162	Large	Short
8475-01-176-9163	Large	Regular
8475-01-176-9164	Large	Long
8475-01-176-9165	X-Large	Short
8475-01-176-9166	X-Large	Regular
8475-01-176-9167	X-Large	Long



Anti-Exposure Flying Coverall, Liner CWU-72/P. Liner is a one piece garment worn directly under coverall and over other clothing.

Approximate Cost: $70

8475-01-204-2638	Small	Short
8475-01-204-9145	Small	Regular
8475-01-237-7846	Small	Long
8475-01-216-4259	Medium	Regular
8475-01-237-7847	Medium	Long
8475-01-204-2639	Large	Regular
8475-01-237-7848	Large	Long
8475-01-204-2640	X-Large	Regular
8475-01-237-7849	X-Large	Long

Navy Standard Coveralls, Anti-Exposure. Orange chloroprene coated nylon coveralls. Features centerfront zipper, set in sleeve type, hook-pile fastener tape wrist adjustment and leg cuff closure and attached hood. Interlined with plastic foam for emergency buoyancy. Provides in-water protection from hypothermia up to 16 hours in 45°F water.

Approximate Cost: $99

8415-00-011-5051	Small	34-36
8415-00-011-5052	Medium	38-40
8415-00-011-5053	Large	42-44
8415-00-011-5054	X-Large	46-48

Liner, Extreme Cold Weather Parka. Nylon faced quilted polyester batting liner. Olive green, single-breasted with button attachment. Used with extreme cold weather parka.

Approximate Cost: $12

8415-00-782-2881	X-Small
8415-00-782-2882	Small
8415-00-782-2883	Medium
8415-00-782-2884	Large
8415-00-782-2885	X-Large

Extreme Cold Weather Trousers, CWU-18/P. Low temperature-resistant aramid material. Shell reinforced with patches on the seat and knees. Knitted ankle cuffs and quilted lining; zippered fly closure; knife pocket, two hip pockets, two thigh pockets and side pass-through; zippered leg openings; waist adjustment straps on back, belt loops and button on elastic suspenders.

Approximate Cost: $202

8415-01-065-4956	28
8415-01-065-4957	30
8415-01-065-4958	32
8415-01-065-4959	34
8415-01-065-4960	36
8415-01-065-4961	38
8415-01-065-4962	40
8415-01-065-4963	42

Man's Cold Weather Field Coat. Hip length, wind-resistant, water-repellent cotton and nylon sateen cloth coat. Attached hood with drawcord adjustment; slide fastener fly front closure with snap fasteners; two breast pockets and two lower inside pockets with flaps; waist and hem drawcords; and buttons for attaching liner.

Approximate Cost: $30

8415-01-062-0679	X-Small	X-Short
8415-01-027-6032	X-Small	Short
8415-00-782-2933	X-Small	Regular
8415-00-782-2935	Small	Short
8415-00-782-2936	Small	Regular
8415-00-782-2937	Small	Long
8415-00-062-0678	Medium	X-Short
8415-00-782-2938	Medium	Short
8415-00-782-2939	Medium	Regular
8415-00-782-2940	Medium	Long
8415-00-782-2941	Large	Short
8415-00-782-2942	Large	Regular
8415-00-782-2943	Large	Long
8415-00-782-2945	X-Large	Regular

Cold Weather Field Trousers, Combat and Training. Olive green, water-repellent cotton and nylon sateen. Features a slide fastener fly closure, adjustable waist straps, suspender loops, inside button tabs for liner, pockets and leg hem drawcords.

Approximate Cost: $22

8415-00-782-2948	X-Small	Regular
8415-00-782-2950	Small	Short
8415-00-782-2951	Small	Regular
8415-00-782-2952	Small	Long
8425-00-782-2953	Medium	Short
8415-00-782-2954	Medium	Regular
8415-00-782-2955	Medium	Long
8415-00-782-2957	Large	Regular
8415-00-782-2958	Large	Long
8415-00-782-2960	X-Large	Regular
8415-00-782-2961	X-Large	Long

Parka, Extreme Cold Weather. Olive green cotton and nylon parka. Water-repellent treated, single-breasted design with zipper and snap-fastened protective flap. Equipped with draw cords at waist and coat bottom. Separate removable liner available.

Approximate Cost: $26

8415-00-782-3216	X-Small
8415-00-782-3217	Small
8415-00-782-3218	Medium
8415-00-782-3219	Large
8415-00-782-3220	X-Large

Extreme Cold Weather Flying Coverall New CWU-64/P. This coverall is fabricated from the same Nomex fabric used in the CWU-45/P Jacket outer shell. A Nomex or Thinsulate batt is sewn to a Nomex scrim (thinner piece of cloth) and then sewn into the shell to provide the insulation required. This coverall should be available within 6 months and will be used by both Air Force and Navy personnel. It also has a thin cloth hood in the collar of the coverall to provide a windbreak if needed.

Approximate Cost: $240

8415-01-225-4740

SWEATERS, SHIRTS, UNDERWEAR AND SOCKS

Navy Standard Blue, Knitted Wool Sweater. Pullover type with a mock-turtleneck and full length sleeves. Moth proofed.

Approximate Cost: $13

8405-01-005-2550	X-Small	32-34
8405-01-005-2551	Small	36-38
8405-01-005-2552	Medium	40-42
8405-01-005-2553	Large	44-46
8405-01-005-2554	X-Large	48-50

Navy Standard Olive Drab, Wool Knit Sweater. Pullover type with full length sleeves, convertible collar, high neck opening and five button closure on the front yoke. Moth proofed and shrink-resistant treated.

Approximate Cost: $23

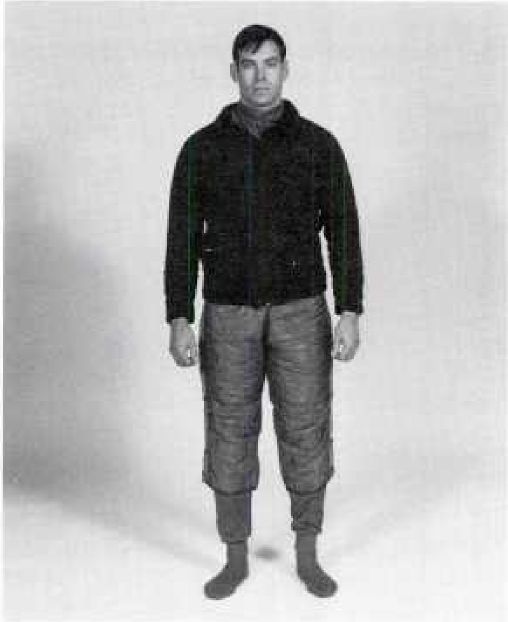
8405-00-163-8907	Small	34-36
8405-00-163-8906	Medium	38-40
8405-00-163-8905	Large	42-44
8405-00-163-8908	X-Large	46-48

Cold Weather Shirt. Olive green wool and nylon flannel shirt. Coat style button front closure and buttoned sleeve cuffs, a convertible collar, long sleeves and patch pockets with flaps.

Approximate Cost: $11

8415-00-188-3794	X-Small
8415-00-188-3792	Small
8415-00-188-3791	Medium
8415-00-188-3798	Large
8415-00-188-3793	X-Large

ECWCS Shirt. Knitted polyester fiberpile. Brown, front zipper, reinforced elbow patches and shoulders, elastic draw cord waist, two chest pockets, two hand-warmer pockets. +40° to -25°F. (Pictured with quilted lining for Extreme Cold Weather Trousers, CWU-18/P from page 14.)



Approximate Cost: $39

8415-01-228-1353	X-Small
8415-01-228-1354	Small
8415-01-228-1355	Medium
8415-01-228-1356	Large
8415-01-228-1357	X-Large

Navy Standard Extreme Cold Weather Drawers. Natural color cotton, knitted waffle-type drawers. Ankle length with rib knit anklets, boxer style fly and an elastic waistband.

Approximate Cost: $5

8415-01-051-1175	X-Small	23-26
8415-00-782-3226	Small	27-30
8415-00-782-3227	Medium	31-34
8415-00-782-3228	Large	35-38
8415-00-782-3229	X-Large	39-42

Navy Standard Extreme Cold Weather Undershirt. Natural color, cotton waffle knit undershirt. Rib knit wristlets and collarette. Long sleeves, pullover type.

Approximate Cost: $5

8415-01-051-1174	X-Small
8415-00-270-2012	Small
8415-00-270-2013	Medium
8415-00-270-2014	Large
8415-00-270-2015	X-Large

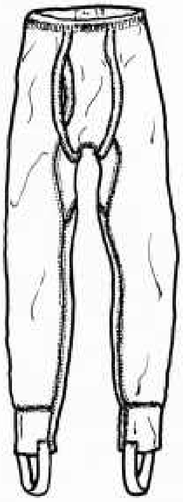
Cold Weather Undershirt, CWU-44/P. Nomex with full sleeves and tight knit weave cuffs and neck

Approximate Cost: $13

8415-01-043-8275	X-Small
8415-00-485-6547	Small
8415-00-485-6548	Medium
8415-00-485-6680	Large
8415-00-485-6681	X-Large

Cold Weather Drawers, CWU-43/P. Full length with snug ankles, boxer style fly, elastic stirrups and elastic waistband. Made of Nomex for high temperature resistance.

Approximate Cost: $11

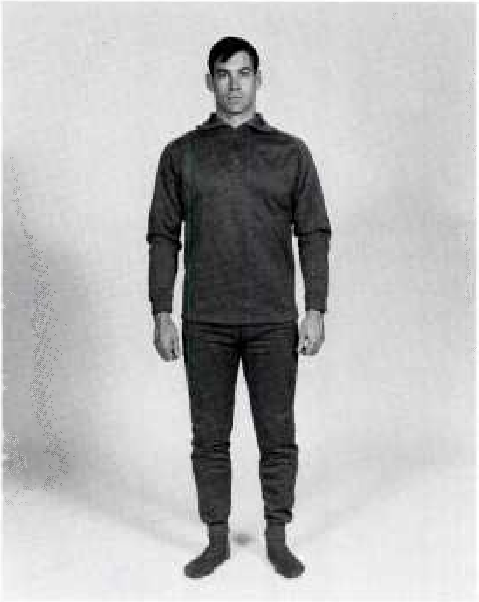


8415-01-043-4036	X-Small
8415-01-467-4075	Small
8415-01-467-4076	Medium
8415-01-467-4078	Large
8415-00-467-4100	X-Large

ECWCS Undershirt. Knitted, brushed, multifilament polypropylene. Acts as a moisture wicking layer next to the skin. Brown turtleneck with zipper from neck to chest. +40° to -25°F. Warning: May melt at high temperatures, burning skin.

Approximate Cost: $18

8415-01-227-9547	X-Small
8415-01-227-9548	Small
8415-01-227-9549	Medium
8415-01-227-9550	Large
8415-01-227-9551	X-Large



ECWCS Drawers. Same as undershirt.

Approximate Cost: $16

8415-01-227-9542	X-Small
8415-01-227-9543	Small
8415-01-227-9544	Medium
8415-01-227-9545	Large
8415-01-227-9546	X-Large

Socks, Extreme Cold Weather. White wool felt socks. High top design

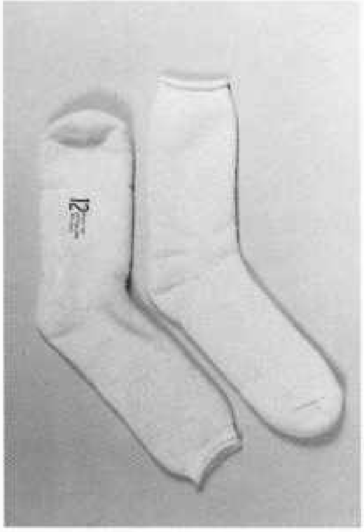
Approximate Cost: $7

8415-00-177-7992	Small
8415-00-177-7993	Medium
8415-00-177-7994	Large

Navy Standard Socks, Men's Winter. 75% wool/25% cotton.

Approximate Cost: $3

8440-00-153-6717	10
8440-00-153-6718	11
8440-00-153-6719	12
8440-00-153-6720	13
8440-00-153-6721	14



Boots, Extreme Cold Weather. Mukluk type. Sage green cotton duck upper, rubber sole and heel. Non-slip outer sole of cleated or heavily knurled design. Equipped with two removable felt insoles. For use under dry, cold conditions in temperatures below 15°F. Sized for wear over two pairs of ski socks or one pair of felt socks.

Approximate Cost: $26

8430-00-269-0098	Small	6 1/2 - 7 1/2
8430-00-269-0099	Medium	8 - 9
8430-00-269-0100	Large	9 1/2 - 10 1/2
8430-00-269-0101	X-Large	11 - 12

Boots, Extreme Cold Weather, Insulated (White). Approximately 28.75 centimeters in height. Incorporates 6 pairs of eyelets. Insulation consists of 3 layers of wool fleece hermetically sealed within an outer and inner layer of rubber. For use at temperatures down to -20°C.

Approximate Cost: $77

8430-00-823-7924

Cold Weather Mitten Inserts (trigger finger). Wool/Nylon blend. Worn on either hand. Used with mitten shell.

Approximate Cost: $4

8415-00-160-0769	Medium
8415-00-160-1376	Large

Cold Weather Mitten Shell (trigger finger). Deerskin palms. Insulating polyester batting, cotton/nylon back of hand. Adjustable wrist strap.

Approximate Cost: $13

8415-00-926-1526	Medium
8415-00-926-1527	Large

Headover Scarf. Circular-knitted two-ply yarn of fleece wool. Tube 54 inches long, 9 inches wide, open both ends. Wraps around neck or pulls over neck and lower face.

Approximate Cost: $5

8440-00-823-7520	One size

Men's Cold Weather Field Trousers. 100% wool serge. Green with slide fastener fly closure and finished bottoms. Equipped with belt loops, suspender straps, adjustable waist straps and pockets.

Approximate Cost: $20

8415-00-231-7213	X-Small	Short
8415-00-231-7212	X-Small	Regular
8415-00-231-7207	Small	Short
8415-00-231-7206	Small	Regular
8415-00-231-7205	Small	Long
8415-00-231-7204	Medium	Short
8415-00-231-7203	Medium	Regular
8415-00-231-7202	Medium	Long
8415-00-231-7200	Large	Regular
8415-00-231-7199	Large	Long
8415-00-231-7209	X-Large	Regular
8415-00-231-7208	X-Large	Long

Mitten Shells. Cream colored chrome-tanned cattlehide leather. Water-repellent treated. For use with mitten inserts or wool gloves.

Approximate Cost: $7

8415-00-240-4645	Universal size

COMMERCIAL CLOTHING

In the event it is not possible to procure standard Navy issue cold weather clothing, the following commercial clothing suppliers are presented to assist with procurement. This does not necessarily represent a complete list of cold weather clothing manufacturers and is not intended to serve as an endorsement for any company.

PARKAS/WINDPANTS/COVERALLS

Eddie Bauer
Box 3700
Seattle, WA 98130-0006

1-800-426-8020

L.L. Bean, Inc.
Freeport, ME 04033

1-800-221-4221

Cabela's, Sidney
812-13th Ave.
Sidney, NE 69160

1-800-237-4444

Mustang Mfg. Inc. (Mustang Survival Suit)
P.O. Box 5844
Bellingham, WA 98227

1-206-676-1782
1-800-553-5628

Ramsey Outdoor
P.O. Box 1689
Paramus, NJ 07653-1689

1-201-261-5000

Refrigiware (-50° Suit)
Inwood, NY

1-516-239-7022

BOOTS/MUKLUKS

Cabela's, Sidney
812-13th Avenue
Sidney, NE 69160

1-800-237-4444

Gander Mountain, Inc.
Highway W, P.O. Box 248
Wilmot, WI 53192

1-800-558-9410

North Winds
271 E. Orvis Street
Massena, NY 13662

1-315-769-9966

HATS/GLOVES/UNDERWEAR/ACCESSORIES

Eddie Bauer
P.O. Box 3700
Seattle, WA 98130-0006

1-800-426-8020

L.L. Bean, Inc.
Freeport, ME 04033

1-800-221-4221

Campmoor
810 Route 17 North
P. O. Box 997-F
Paramus, NJ 07653-0997

1-800-526-4784

Damart
1811 Woodbury Ave.
Portsmouth, NH 03805-0001

1-800-258-7300

Early Winters, Inc.
2800 Hoover Road
Stevens Point, WI 54481

1-715-345-2770

Gander Mountain, Inc.
Highway W, P.O. Box 248
Wilmot, WI 53192

1-800-558-9410

Mass Army Navy Store
15 Fordham Road
Boston, MA 02134

1-800-343-7749

Ramsey Outdoor
P.O. Box 1689
Paramus, NJ 07653-1689

1-201-261-5000

Recreational Equipment, Inc.
P.O. Box C-88125
Seattle, WA 98188-0125

1-800-426-4840

Sportsman's Guide
965 Decatur Avenue North
Golden Valley, MN 55427

1-800-328-7222

BOOT CARE

Many factors are involved in keeping your feet warm and protected: boot construction, boot care, personal hygiene and proper boot wear. The use of your boots is intended to be for the normal day-to-day work routine. Whenever you anticipate extended or prolonged exposure to extreme cold other foot wear should be used (i.e., Mukluks or Bunny Boots).

The following are basic tips on boot preparation and care.

1. Ensure your boots fit comfortably. If they don't try to exchange them for another.
2. Apply a water-repellent sealer compound to all welts, seams and exposed leather. Apply the coating evenly over the entire surface of the boot.

NOTE

Be very liberal with the sealer at all welts and seams.

3. Allow the coating of sealant time to penetrate, at least one hour before wearing.
4. Take a common shoe brush and buff. If mink oil is used, this step is not necessary.
5. Wear your boots for a period of 1 or 2 days to begin breaking them in. Do this before actual intended time of need.
6. After 2 days wear repeat steps 1, 2 and 3.
7. Continue wearing boots and after a day or so, apply a good shoe shine to your boots.
8. Reapply sealant as necessary to your boots, at least twice a month.
9. At day's end after the normal wearing of your boots, remove the fibrous insoles and allow them and the boots to air dry for at least 6 hours. If a device is available, try to air blow dry your boots for at least an hour. If more than 1 pair of insoles came with your boots, try to wear them on alternate days.
10. A weekly shoe shine will ensure extended boot life and contribute to foot warmth.

- from "BOOT CARE - The Care and Feeding of"

APPENDIX E

PREDEPLOYMENT PREPARATIONS/PROCUREMENT CHECKLIST

alkaline flashlight batteries
antenna scanner
antennas and insulators, spare
antifreeze (drums, bags, bottles)
artificial horizon sextant
baseball bats
batteries, spare
battery parts, spare, for telephones/transceivers/microphones
brooms, fiber
brooms, wire
calcium chloride, flake
canvas skirts for gun mounts
canvas
capstan windlass
ceramic insulators
chemlites
clothing
cocoa mats
cover, light weight, non-reflective, for MK 38 Mod 0 Radar
davit winches
deicing materials (see Table 3-2)
denatured ethyl alcohol
dessicant bags to absorb moisture
dessicant to lower relative humidity
dipstick heaters
drop lights
electric auxiliary heaters for small boat engines
electrical heater tape (duct tape)
ether canisters
ethylene glycol
fiberglass reinforced plastic traction mats
fiberglass insulation for FLTSATCOM antenna pedestal
fiberglass covers
fire hose (extra)
fireplug covers
flashlight batteries
flight deck covers
flood lights
fluid (deicing) & dispensers
fog/ice preventive compound
food (extra, i.e., hot chocolate, soup)
freezer bags (inner cover for sound-powered phone boxes)

fuels
garden sprayers (fill with ethylene glycol)
gaskets
greases, cold weather
hair dryers, portable
handheld anemometers (2 per ship)
heat gun, portable
heat lamps
heaters for boat batteries
heaters (oil) for radars, portable
heating strips for gun mounts
hose lay, steam, deicing, 3/4" x 50 ft.
hydraulic fluids
hydraulic fittings
ice removal equipment (see Table 3-1)
ice accretion reduction coatings
incandescent light bulbs
insulation blankets
insulation or lagging
isopropyl alcohol
lifelines (additional)
line to tie down covers
mallet, nylon
mallet, rawhide
mallet, wooden
materials to fabricate exhaust deflectors & plows
navigation charts
    Modified Lambert Conformal Projection
    Polar Stereographic Project
    Polyconic Projection
    Transverse Mercator Projection
Navy/NOAA Joint Ice Center Pre-Sail Infomation Book
O-rings
oils
plan for extra stowage
plastic covers
protective covers
radar reflector devices
radio direction finders
rock salt, coarse
rubber gloves
rubber boots
safety lines (additional)
safety goggles
safety equipment for handling calcium chloride
sand, sharp
seals
shovels, steel, grain scoop
silicon to coat whip antennas
snow shovels
SRBOC chaff launcher cover
steam hoses, lance tips, valves & nozzles (where steam is available)
steam lance (where steam is available)
tie-downs & chains
thermometers, clinical, low-reading

torpedo space heater
towline (extra)
urea pellets
waterproof covers
whistles, hand-held
window ice scrapers
windscreens, temporary shelters
windshield wiper blades for MK 13 GMLS
zodiac-type boat

APPENDIX F

BATTERY MAINTENANCE

DAILY - See that all parts of the ventilation system in battery rooms and battery lockers are in proper condition. Clean battery hydrometers.

WEEKLY - Observe the height of electrolyte in cells and measure and record cell specific gravity and temperature readings for all batteries (when batteries are in relatively warm rooms). Fill water batteries (only with distilled water) if the height of electrolyte is at the low mark or will drop below the low mark before the next weekly inspection. Check the charging rate of engine battery charging generators and voltage at which batteries are being floated.

MONTHLY - Clean batteries and grease the terminals with petrolatum as necessary. Examine battery connections and correct any faulty condition such as breaks, frayed insulation or grounds. Inspect for broken or cracked battery cases or jars. Give all batteries an equalizing charge, except those charged from their own generator or being floated. Take a complete set of voltage, temperature and specific gravity readings on all batteries which have been given an equalizing charge.

QUARTERLY - Give all batteries which are charged from their own generators or are being floated an equalizing charge and take a complete set of voltage, temperature and specific gravity readings.

SEMI-ANNUALLY - Give each battery a test discharge at a five-to-ten hour rate or as specified on the battery nameplate. A test discharge is the most reliable means of determining storage battery conditions, but functional testing may be done in lieu of a test discharge if authorized by the ship's maintenance requirement cards.

Functional testing of Navy-type portable storage batteries for various shipboard applications varies with usage, size of battery and load. Test requirements are:

- Engine starting batteries should be capable of starting an engine at least once a week.
- Portable lantern batteries (using storage lead-acid batteries) should be capable of providing sufficient light for a period of one minute without dimming and should be tested at least once a week.
- Gyrocompass batteries should be functionally tested for a twenty-minute period on battery power alone, once a month.
- Telephone batteries should be functionally tested during a peak load period for four hours on battery power alone, once a month.

Functional testing of other portable storage battery service not covered above may be obtained upon request from NAVSEA. You will need this information for new applications.

In case of failure, give the battery an equalizing charge, then retest. If the retest fails, replace the failed battery.

Batteries subjected to the cold should be heated, if possible, and must be kept fully charged to prevent freezing. If you use heaters or a warm air supply to heat boat engines, heat the batteries by the same method. Battery chargers should be provided for all boat batteries if possible. The battery charger should be placed in the same temperature environment as the battery being charged since they have a temperature compensation feature for charging voltage.

Battery chargers located in heated spaces, used to charge boat batteries by long leads outside the spaces, should have their charging voltage output adjusted for the exterior temperature, by using the formula:

$$V = [2.35 + 0.003(80 - T)] \times N$$

where V is the charging voltage, T is the exterior temperature in °F and N is the number of cells in the battery.

Any acid batteries which are required to operate consistently in temperatures below 40°F may have the average specific gravity raised to 1.280 (between limits of 1.270 to 1.285) by adding diluted acid. NAVSEA requires that this be done by authorized personnel only, as described in NSTM, Chapter 313. Safety precautions for handling electrolytes are covered in Chapter 9 of this Handbook.

APPENDIX G

GUIDE FOR TREATMENT OF IMMERSION HYPOTHERMIA

Immersion hypothermia (significant loss of body heat) is a potential hazard to personnel who fall overboard in cold weather regions. A person falling overboard in cold waters must be brought aboard before serious complications arise. Body heat must be restored.

A person falling overboard in cold weather regions may quickly lose muscle strength and the ability to concentrate due to a rapid loss of body heat. He may become irrational or confused. A rescue swimmer may be needed to assist in the recovery of the victim. Expeditious recovery is of major importance. Continued chilling can result in unconsciousness and eventual death of the victim.

Diagnosis of hypothermia is easy if the condition is suspected, but may be complicated by additional injuries. The skin of the victim will be cold. He may shiver violently or, with severe hypothermia, lose the shivering response and lapse into an apathetic state. Profound hypothermia may so depress the heartbeat and respiration that the victim appears to be dead.

In accidents where severe hypothermia is suspected and the victim appears to be dead, resuscitation and rewarming should be started immediately, even though the victim has not been breathing for some time. Resuscitation should be continued until the victim has been rewarmed. THE VICTIM SHOULD NOT BE CONSIDERED DEAD UNTIL HE IS COMPLETELY REWARMED AND CONTINUES TO BE UNRESPONSIVE TO PROPERLY APPLIED RESUSCITATION EFFORTS.

Hypothermia is treated by rewarming. This is especially important in the situation where the victim has lost the shivering response since he is unable to generate any internal body heat. Hypothermia severe enough to cause loss of shivering, confusion or unconsciousness is a medical emergency and rewarming should be started immediately.

The quickest and most efficient way to rewarm the victim is immersion in a warm water bath using water at temperatures between 40°-44°C (104°-110°F). Using warmer water may burn the victim's skin. The victim should not be allowed to smoke. If no hot water is available the next alternative is to dry the victim and provide him with warm clothes or blankets and a warm room, or heat from another source. Studies indicate that personnel suffering from heat loss often report feeling warm again very soon after they stop shivering, when rewarming is only half complete. A simple indicator that rewarming is complete is the onset of sweating.

SOURCES :

Walt, Alexander J. and Robert F. Wilson. Lea & Febiger, Philadelphia. (1975)

Naval Sea Systems Command, *U.S. Navy Diving Manual,* Vol. 1, NAVSEA 0994-LP-001-9010). (1985)

APPENDIX H

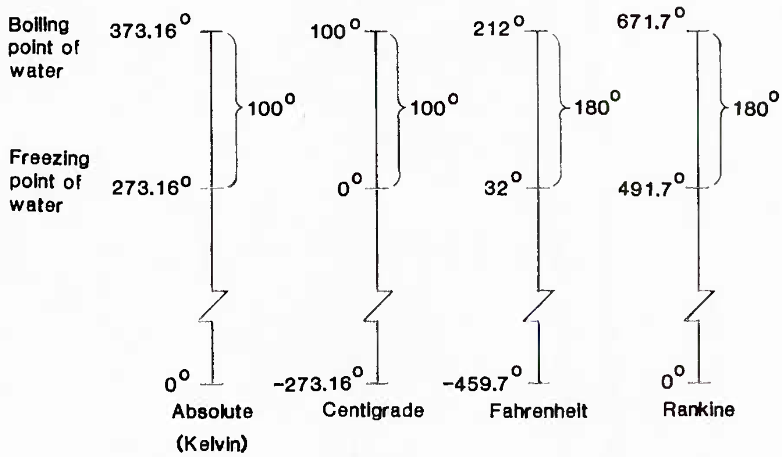
METRIC/ENGLISH CONVERSION CHARTS

Centigrade-Fahrenheit Conversion

C	F	C	F	C	F	C	F
-75	-103	40	104	155	311	537.8	1000
-73.3	-100	43.3	110	160	320	550	1022
-70	-94	45	113	165	329	593.3	1100
-67.8	-90	48.9	120	165.6	330	600	1112
-65	-85	50	122	170	338	648.9	1200
-62.2	-80	54.4	130	171.1	340	650	1202
-60	-76	55	131	175	347	700	1292
-56.7	-70	60	140	176.7	350	704.4	1300
-55	-67	65	149	180	356	750	1382
-51.1	-60	65.6	150	182.2	360	760	1400
-50	-58	70	158	185	365	800	1472
-45.6	-50	71.1	160	187.8	370	815.6	1500
-45	-49	75	167	190	374	850	1562
-40	-40	76.7	170	193.3	380	871.1	1600
-35	-31	80	176	195	383	900	1652
-34.4	-30	82.2	180	198.9	390	926.7	1700
-30	-22	85	185	200	392	950	1742
-28.9	-20	87.8	190	204.4	400	982.2	1800
-25	-13	90	194	225	437	1000	1832
-23.3	-10	93.3	200	232.2	450	1037.8	1900
-20	-4	95	203	250	482	1050	1922
-17.8	0	98.9	210	260	500	1093.3	2000
-15	5	100	212	275	527	1100	2012
-12.2	10	104.4	220	287.8	550	1148.9	2100
-10	14	105	221	300	572	1150	2102
-6.7	20	110	230	315.6	600	1200	2192
-5	23	115	239	325	617	1204.4	2200
-1.1	30	115.6	240	343.3	650	1250	2282
0	32	120	248	350	662	1260	2300
4.4	40	121.1	250	371.1	700	1300	2372
5	41	125	257	375	707	1315.6	2400
10	50	126.7	260	398.9	750	1350	2462
15	59	130	266	400	752	1371.1	2500
15.6	60	132.2	270	425	797	1400	2552
20	68	135	275	426.7	800	1426.7	2600
21.1	70	137.8	280	450	842	1500	2732
25	77	140	284	454.4	850	1537.8	2800
26.7	80	143.3	290	475	887	1550	2822
30	86	145	293	482.2	900	1593.3	2900
32.2	90	148.9	300	500	932	1600	2912
35	95	150	302	510	950	1648.9	3000
37.8	100	154.4	310	525	977	1650	3002

Temperature may be expressed in terms of any of these scales: Centigrade (°C), Absolute or Kelvin (°A or °K), Fahrenheit (°F), or Rankine (°R).

°K = °A – (°C + 273.16)
°K = °A = °R 5/9
°K = °A = (°F – 32) 5/9 + 273.16
°C = A – 273.16
°C = (°F – 32) 5/9
°C = °R 5/9 – 273.16
°F = °C 9/5 + 32
°F = (°A – 273.16) 9/5 + 32
°F = °R – 459.7
°R = °F + 459.7
°R = °A 9/5
°R = (°C + 273.16) 9/5



Motion - Rectilinear

Linear Velocity (LT^{-1})

Multiply	By	To Obtain	Multiply	By	To Obtain
centimeters/second	1.968	feet/minute	kilometers/min	1,666.7	centimeters/sec
feet/hour	30.48	centimeters/hr	kilometers/min	54.68	feet/sec
feet/hr	0.01667	feet/min	kilometers/min	32.397	knots
feet/hr	$1.646/10^4$	knots	kilometers/min	37.28	miles/hour
feet/hr	$1.894/10^4$	miles/hour	knots	51.44	centimeters/sec
feet/min	0.5080	centimeters/sec	knots	101.27	feet/min
feet/min	0.01667	feet/sec	knots	1.6878	feet/sec
feet/min	0.009875	knots	knots	1.852	kilometers/hour
feet/min	0.3048	meters/min	knots	1	nautical miles/hr
feet/min	0.01136	miles/hr	knots	1.1508	miles/hr
feet/sec	30.48	centimeters/sec	meters/min	1.667	centimeters/sec
feet/sec	1.097	kilometers/hr	meters/min	196.85	feet/hr
feet/sec	0.5925	knots	meters/min	0.0547	feet/sec
feet/sec	0.6818	miles/hr	meters/min	0.032397	knots
inches/hr	0.04233	centimeters/min	meters/min	0.03728	miles/hr
inches/min	152.4	centimeters/hr	meters/sec	196.85	feet/min
inches/min	0.0423	centimeters/sec	meters/sec	3.281	feet/sec
inches/min	0.001389	feet/sec	meters/sec	1.944	knots
inches/sec	152.4	centimeters/min	meters/sec	2.2369	miles/hr
inches/sec	0.08333	feet/sec	miles/hr	44.70	centimeters/sec
inches/sec	0.05682	miles/hr	miles/hr	88	feet/min
kilometers/hr	27.78	centimeters/sec	miles/hr	1.4667	feet/sec
kilometers/hr	54.68	feet/min	miles/hr	17.6	inches/sec
kilometers/hr	0.9113	feet/sec	miles/hr	1.6093	kilometers/hr
kilometers/hr	0.53996	knots	miles/hr	0.86898	knots
kilometers/hr	0.6214	miles/hr	miles/hr	0.4470	meters/sec

Linear Acceleration (LT^{-2})

Multiply	By	To Obtain
centimeters/sec/sec	0.036	kilometers/hr/sec
centimeters/sec/sec	1.342	mph/min
centimeters/sec/sec	0.0224	mph/sec
feet/sec/sec	1.097	kilometers/hr/sec
feet/sec/sec	0.3048	meters/sec/sec
feet/sec/sec	0.6818	mph/sec
kilometers/hr/sec	27.78	centimeters/sec/sec
kilometers/hr/sec	0.9113	feet/sec/sec
meters/sec/sec	3.6	kilometers/hr/sec
meters/sec/sec	2.237	mph/sec
mph/sec	44.70	centimeters/sec/sec
mph/sec	1.467	feet/sec/sec
mph/sec	1.609	kilometers/hr/sec
mph/sec	0.4470	meters/sec/sec

Equations

Velocity: the rate of change of displacement with respect to time:

$$v = ds/dt, \quad v\ dv - a\ ds$$

when a is constant

$$V_t = V_o \ , at$$

Displacement: the amount of change in position

$$ds = v\ dt$$

when a = constant

$$S = V_t^{\,2} - V_o^{\,2} / 2a$$

$$S = V_o t \ \ , at^{2} / 2$$

Acceleration:

$$a = dv/dt$$

when a = constant

$$a = \frac{V_t - V_o}{t}$$

Length (L)

Multiply	By	To Obtain
angstrom	0.1	nanometer
angstrom units	$1/10^{10}$	meters
centimeters	0.3937	inches
centimeters	0.01	meters
centimeters	393.7	mils
decimeters	0.1	meters
dekometers	10	meters
fathoms	6	feet
feet	0.3048	meters
furlongs	660	feet
furlongs	40	rod
hands	4	inches
hectometers	100	meters
inches	25.40	millimeters
inches	1000	mils
kilometers	3281	feet
kilometers	1000	meters
kilometers	0.6214	miles
kilometers	0.53996	nautical miles
kilometers	1094	yards
leagues	3	miles
light years	5.88×10^{12}	miles
links (engineer's)	12	inches
links (surveyor's)	7.92	inches
meters	3.2808	feet
meters	39.37	inches
meters	$6.214/10^4$	miles
meters	1.0936	yards
micron	1	micrometer
microns	$1/10^6$	meters
microns	0.03937	mils
miles	5280	feet
miles	1609	meters
miles	1760	yards
millimeters	0.03937	inches
millimeters	0.001	meters
millimeters	39.37	mils
mils	0.001	inches
mils	0.02540	millimeters
myriameters	10,000	meters
nautical miles	6076.1	feet
nautical miles	1852	meters
nautical miles	1.1508	miles
nautical miles	2025.4	yards
rods	16.5	feet
statute miles	1760	yards
statute miles	5280	feet
statute miles	1.6094	kilometers
statute miles	0.8690	nautical miles
yards	0.9144	meters
yards	$5.682/10^4$	miles
yards	$4.937/10^4$	nautical miles

Area (L^2)

Multiply	By	To Obtain
acres	43,560	square feet
acres	0.004047	square kilometers
acres	4047	square meters
acres	0.001563	square miles
acres	4,840	square yards
centares	1	square meters
circular mils	$5.067/10^6$	square centimeters
circular mils	$0.7854/10^6$	square inches
circular mils	$5.067/10^4$	square millimeters
circular mils	0.7854	square mils
hectares	10,000	square meters
square centimeters	1.973×10^5	circular mils
square centimeters	0.001076	square feet
square centimeters	0.1550	square inches
square centimeters	$1/10^4$	square meters
square centimeters	100	square millimeters
square feet	929.0	square centimeters
square feet	144	square inches
square feet	0.09290	square meters
square feet	1/9	square yards
square inches	1.273×10^6	circular mils
square inches	6.452	square centimeters
square inches	0.006944	square feet
square inches	$6.452/10^4$	square meters
square inches	654.2	square millimeters
square inches	10^6	square mils
square kilometers	247.1	acres
square kilometers	10.76×10^6	square feet
square kilometers	10^6	square meters
square kilometers	0.3861	square miles
square kilometers	1.196×10^6	square yards
square meters	$2.471/10^4$	acres
square meters	10.76	square feet
square meters	1.196	square yards
square miles	640	acres
square miles	27.88×10^6	square feet
square miles	2.590	square kilometers
square miles	3.098×10^6	square yards
square millimeters	1,974	circular mils
square millimeters	0.00155	square inches
square millimeters	$1/10^6$	square meters
square millimeters	1550	square mils
square mils	1.273	circular mils
square mils	$6.542/10^6$	square centimeters
square mils	$1/10^6$	square inches
square mils	$6.452/10^4$	square millimeters
square yards	9	square feet
square yards	1,296	square inches
square yards	0.8361	square meters

Volume (L^3)

Multiply	By	To Obtain
acre-feet	43,560	cubic feet
acre-feet	1,233	cubic meters
acre-feet	3.259×10^5	gallons
barrel (US)	0.1589	cubic meters
board-feet	144	cubic inches
bushels	1.244	cubic feet
bushels	0.03524	cubic meters
bushels	35.24	liters
bushels	4	pecks
bushels	32	quarts (dry)
centiliters	0.01	liters
cord-feet	4 ft x 4 ft x 1 ft	cubic feet
cords	8 ft x 4 ft x 4 ft	cubic feet
cubic centimeters	0.06102	cubic inches
cubic centimeters	0.001	liters
cubic centimeters	0.03381	fluid ounces
cubic centimeters	0.002113	pints (liquid)
cubic feet	0.80357	bushels
cubic feet	1,728	cubic inches
cubic feet	0.02832	cubic meters
cubic feet	1/27	cubic yards
cubic feet	7.481	gallons
cubic feet	28.32	liters
cubic feet	62.4	lbs of water 39.2F
cubic feet	29.92	quarts (liquid)
cubic inches	16.39	cubic centimeters
cubic inches	$5.787/10^4$	cubic feet
cubic meters	28.38	bushels
cubic meters	35.31	cubic feet
cubic meters	61,023	cubic inches
cubic meters	1.308	cubic yards
cubic meters	264.2	gallons
cubic meters	1,000	liters
cubic meters	2,203	lbs of water 39.2F
cubic yards	21.70	bushels
cubic yards	27	cubic feet
cubic yards	46.656	cubic inches
cubic yards	0.7646	cubic meters
cubic yards	202.0	gallons
cubic yards	764.5	liters
cubic yards	1,685	lbs of water 39.2F
cupfuls	1/2	pints (liquid)
deciliters	1/10	liters
dekaliters	10	liters
fluid ounce (UK)	28.413	cubic centimeters
fluid ounce (US)	29.574	cubic centimeters
gallons	0.1337	cubic feet
gallons	231	cubic inches
gallons	3,785	cubic centimeters
gallons (US)	0.003785	cubic meters

Multiply	By	To Obtain
gallon (UK)	4546.1	cubic centimeters
gallons	3.785	liters
gallons	8	pints (liquid)
gallons	8.34	lbs of water 39.2F
gallons (Imperial)	1.201	gallons
gills	7.219	cubic inches
gills	1/4	pints (liquid)
hectoliters	100	liters
kiloliters	1,000	liters
liters	0.02838	bushels
liters	1,000	cubic centimeters
liters	0.03532	cubic feet
liters	61.03	cubic inches
liters	0.001308	cubic yards
liters	0.2642	gallons
liters	2.113	pints (liquid)
liters	2.20	lbs of water 39.2F
liters	0.9081	quarts (dry)
liters	1.057	quarts (liquid)
microliters	$1/10^6$	liters
mil-feet (circular)	$1.545/10^4$	cubic centimeters
mil-feet (circular)	$9.425/10^6$	cubic inches
mililiters	0.001	liters
pecks	1/4	bushels
pecks	8.81	liters
pecks	8	quarts (dry)
perches	24.75	cubic feet
perches	0.7008	cubic meters
pints (dry)	33.60	cubic inches
pints (dry)	1/2	quarts (dry)
pints (liquid)	28.88	cubic inches
pints (liquid)	0.8594	pints (dry)
pints (liquid)	1.042	lbs of water 39.2F
pints (liquid)	1/2	quarts (liquid)
lbs of water 39.2F	0.01602	cubic feet
lbs of water 39.2F	27.68	cubic inches
lbs of water 39.2F	0.1198	gallons
lbs of water 39.2F	0.4536	liters
quarts (dry)	1/32	bushels
quarts (dry)	67.20	cubic inches
quarts (dry)	1.101	liters
quarts (dry)	1.164	quarts (liquid)
quarts (liquid)	946.4	cubic centimeters
quarts (liquid)	57.75	cubic inches
quarts (liquid)	0.9463	liters
quarts (liquid)	2	pints (liquid)
quarts (liquid)	0.8594	quarts (dry)
steres	1,000	liters
tablespoons	1/16	cupfuls
teaspoons	1/3	tablespoons

Properties of Air
General Properties of Air

9 =	Graviational acceleration	- ft/sec^2
P =	Absolute pressure	- lb/ft^2
q =	Dynamic pressure	- lb/ft^2
v =	Specific volume	- ft^3/lb
T =	Absolute temperature	- °R
R =	Universal gas constant	- ft lb/lb/°R
V =	Velocity	- ft/sec
n =	Polytropic exponent	- Dimensionless
ρ =	Mass density	- $lb\ sec^2/ft^4$
μ =	Absolute viscosity	- $lb\ sec/ft^2$
ν =	Kinematic viscosity μ/ρ	- ft^2/sec
σ =	Relativedensity	- Dimensionless

Composition of Air

(Standard atmosphere) (ARDC model atmosphere)
The air of the standard atmosphere is assumed to be dry and to have the following composition at altitudes to 300,000 ft.

Constituent Gas	Mol. Fraction, Percent	Molecular Weight (0 = 16.0000)
Nitrogen (N_2)	78.09	28.016
Oxygen (O_2)	20.95	32.0000
Argon (A)	0.93	39.944
Carbon dioxide (CO_2)	0.03	44.010
Neon (Ne)	1.8×10^{-3}	20.183
Helium (He)	5.24×10^{-4}	4.003
Krypton (Kr)	1.0×10^{-4}	83.7
Hydrogen (H_2)	5.0×10^{-5}	2.0160
Xenon (Xe)	8.0×10^{-6}	131.3
Ozone (O_3)	1.0×10^{-6}	48.0
Radon (Rn)	6.0×10^{-18}	222.0

Sea Level Properties

t_o	Standard temperature	59.0°F
T_o	Standard temperature (absolute)	518.67°R
P_o	Standard pressure	29.921260 in Hg 2116.22 lb/sq ft
ρ_o	Standard density	0.076474 lb/cu ft
M_o	Molecular weight	28.9644 (dimensionless)
ω_o	Standard specific weight	0.07647455 lb/cu ft
R°	Gas constant (dry air)	8314.32 joules/kg/°K 53.35 ft lb/lb/°R
c_{so}	Speed of sound	1116.4 ft/sec
μ	Coefficient of absolute viscosity	3.7371674×10^{-7} lb sec/sq ft
η_o	Coefficient of kinematic viscosity	1.57232×10^{-4} sq ft/sec
g_o	Standard gravitational acceleration	32.1741 ft/sec/sec

APPENDIX I

QUOTATION SOURCES

Quotations used in the Cold Weather Handbook for Surface Ships were from:

Chief of Naval Operations
Admiral James D. Watkins

Chief of Naval Operations
Admiral Carlisle A. H. Trost

Deputy Chief of Naval Operations, Surface Warfare
Vice Admiral Joseph Metcalfe

Assistant Deputy Chief of Naval Operations, Surface Warfare
Rear Admiral James G. Storms, III

Oceanographer of the Navy
Rear Admiral John R. Seesholtz

Chief of Naval Research
Rear Admiral John B. Mooney, Jr.

APPENDIX J

COLD WEATHER EXERCISES/CONFERENCES

The following exercises and cold weather conferences were sources of information for this Cold Weather Handbook:

Exercises

CSG-1 UNREP (Commander Service Group 1)

- February 1977
- Bering Sea
- Participants

  USS ROANOKE (AOR 7)
  USNS TALUGA (T-AO 62)

- To investigate UNREP capabilities and to identify problem areas in UNREP equipment maintenance and operation in this cold environment.

  "Underway Replenishment in Cold Weather"
  Mr. George Lyon, NSWSES

SHAREM 55

- March 1984
- SHAREM = SHip Antisubmarine Warfare Readiness and Effective Measurement
- Conducted north of Iceland in an area bounded on the West by the Greenland ice pack and to the east by Jan Mayen Island.
- Participants:

  USS SPRUANCE (DD 963)
  USS BOWEN (FF 1079) W/LAMPS MK I
  USS THOMAS C. HART (FF 1092) W/LAMPS MK I
  USS MCCLOY (FF 1038)
  USS MILWAUKEE (AOR 2) W/H-46

- How to effectively locate enemy submarines hiding under the ice and how to operate in order to be in position to intercept and attack any submarines which may be flushed out from under the ice pack.

  "SHAREM Cold Weather Experience"
  LCDR John R. Oaks, USN

Ocean Safari

- August/September 1985
- North Atlantic
- Participants:

  USS TICONDEROGA (CG 47)
  USS PETERSON (DD 969)
  USS VREELAND (FF 1068)
  USS AYLWIN (FF 1081)
  USS PHARRIS (FF 1094)

SHAREM 62

- November 1985

- Notre Dame Bay, northeast coast of Newfoundland

- Canadian Government provided a Canadian submarine as the opposition for the ASW force.

- Participants:

  USS ARTHUR W. RADFORD (DD 968)
  USS VALDEZ (FF 1096)
  USS NICOLAS (FFG 47)
  USS FAHRION (FFG 22)
  USS TRUCKEE (TAO 147)

- SHAREM conducted to provide ASW protection to a carrier operating in a simulated Norwegian fjord environment.

  "SHAREM Cold Weather Experience"
  LCDR John R. Oaks, USN

Kennel Freelance

- January 1986

- Sea of Japan (Pacific area north of Japan)

- USS KIRK (FF 1087)

- Subjected to heavy topside icing; encountered significant amounts of sea ice.

Kernel Potlatch

- January 1987

- Aleutian Islands; Bering Sea

- Participants:

  USS CARL VINSON (CVN 70)
  USS VINCENNES (CG 49)
  USS LEAHY (CG 16)
  USS JOUETT (CG 29)
  USS PAUL F. FOSTER (DD 964)
  USS ROANOKE (AOR 7)

LEWEX

- March 1987
- Newfoundland
- Participants:

  CS QUEST
  DS TYDEMAN

NORPAC Fleet Exercise (Vice Admiral D. Hernandez)

- November 1987
- Gulf of Alaska; Aleutian Islands
- USS ENTERPRISE
- Exercise which allowed technical representatives from the Navy to observe flight operations, inspect flight decks and elevator surfaces, to check the integrity of nonskid coatings and to determine possible modifications for mechanically or chemically removing freezing precipitation from yellow gear. Significant icing of flight decks occurred.

Icing Incidents

- January 1985
- Virginia Coast
- Participant: USS CAPODANNO (FF 1093)

- Gulf of Finland
- Participants:

  USS JOHN RODGERS (DD 983)
  USS JACK WILLIAMS (FFG 24)

Conferences

The First U.S. Navy Symposium on Arctic/Cold Weather Surface Ship Operations

- December 1985
- Washington, D.C.
- Definition of the Cold Weather Program for Surface Ships presented, with executive summaries from Chief of Naval Research and Oceanographer of the Navy. Papers presented on the Arctic environment, topside icing experiences, SHAREM 55 and 62, helo operations, cold weather concerns for propellers, propulsion plants and combat systems.

The Second U.S. Navy Symposium on Arctic/Cold Weather Surface Ship Operations

- 19-20 November 1987
- Naval Surface Warface Center
  White Oak, Maryland
- First-hand results of NORPAC, KIRK and Kernel Potlatch exercises presented. Latest research findings in areas of ice removal, weather forecasting, cold weather clothing, UNREP, helo operability and winter data collection in the MIZ discussed.

Symposium And Workshop On Arctic And Arctic-related Environmental Sciences

- 27-30 January 1987
- Department of Defense

U.S. Marine Corps/Norwegian Conference On Cold Weather Exercises

- 18-24 June 1987

- Oslo, Norway

- Participants: (Speakers from)

  U.S. Marine Corps
  U.S. Navy
  U.S. Army
  U.S. Air Force
  Royal Marines
  Royal Navy
  Norwegian Army
  Norwegian Navy
  Norwegian National Guard

- Current development efforts and experience gained from cold weather exercises and training to identify and develop recommended courses of action to reduce or eliminate cold weather warfighting deficiencies.

Other Sources of Fleet Cold Weather Information:

Source	Identifier
Message, USS EL PASO	170400Z APR 85
Message, USS COMTE DE GRASSE	082115Z APR 85
Message, USS MOUNT WHITNEY	111443Z APR 85
Message, COMDESRON TEN	042027Z FEB 85
Message, COMCRUDESGRU EIGHT	192241Z APR 85
Message, COMCRUDESGRU TWELVE	011424Z MAY 85
Message, COMSERVGRU TWO	301210Z APR 85
Message, USS AUSTIN	200501Z APR 85
Message, USS VREELAND	112000Z OCT 85
Message, COMNAVSURFGRU FOUR	261311Z APR 85
Message, USS GALLERY	172136Z FEB 82
Letter, USS CLIFTON SPRAGUE	3470 Ser 084 FEB 82
Message, COMNAVSURFLANT NORVA	280824Z APR 84
Message, USS O'BANNON	142130Z APR 85
Message, USS TICONDEROGA	211831Z SEP 85
Message, USS TICONDEROGA	051830Z SEP 86
Message, COMNAVSURFPAC SAN DIEGO (FLEETEX 83)	172246Z MAY
Message, COMNAVSURFPAC SAN DIEGO (FLEETEX 83)	161430Z MAY 83
Memorandum, CINCLANTFLT	Ser N431/006282 of 17 JUN 86

APPENDIX K

EXAMPLE COLD WEATHER BILL

The Cold Weather Bill is part of the *Ship's Organization and Regulations Manual (SORM)* OPNAVIST 3120.32A. This Example Cold Weather Bill (patterned around gas turbine propulsion) provides guidance in preparation for operation in areas of cold weather. The Cold Weather Bill should be updated regularly to reflect new fleet experiences, equipment and practices.

6303. USS ______________________ COLD WEATHER BILL

Ref: *COLD WEATHER HANDBOOK FOR SURFACE SHIPS*

ATP 17: *NAVAL ARCTIC MANUAL*

COMNAVSURFLANTINST 3470.1 *COLD WEATHER HANDBOOK*

Ship's Systems and Equipment Technical Manuals

NAVSHIPS TECHNICAL MANUAL

I. Purpose: To assign responsibilities and set forth procedures to be followed in preparing the ship for cold weather and during the conduct of cold weather operations. Key objectives are:

- o To protect the ship and its personnel
- o To maintain maximum operational capability
- o To minimize damage from environmental stress
- o To provide rapid restoration of lost capability after severe environmental incidents

II. Responsibility for the Bill: The (navigation officer) is responsible for maintaining the adequacy and currency of this Bill. He shall make all changes thereto with the approval of the (operations) officer.

III. Implementation of this Bill: As directed by the Executive Officer, appropriate portions of this bill shall be implemented annually before the onset of winter weather. The total bill shall be implemented prior to deployment to severely cold operating areas and remain in effect during such a deployment. Preparation for cold weather deployment shall be executed when advised deployment to cold weather areas is probable.

IV. Preparation and Planning Consideration Responsibilities

A. The Executive Officer is responsible for seeing this bill is put into effect in a timely manner. He shall supervise overall preparations for cold weather conditions. He shall require the following briefings to be prepared for all officers and appropriate petty officers.

Topic	Briefer
The operating area; weather, climate, oceanography	Navigation Officer
Cold weather effects on combat systems	Combat Systems Officer
Cold region effects on communication and deck operations	Operations Officer
Cold weather effects on the engineering plant and systems	Chief Engineer
Fire fighting and other damage control in cold weather	Damage Control Assistant
Cold weather health and safety considerations	Medical Officer or Senior HM

B. Prior to deployment for cold weather operations, the Executive Officer will ensure the crew is provided with general orientation/training in:

(1) Cold weather terminology

(2) Hypothermia, first aid, survival, frostbite

(3) How to don and care for cold weather clothing

(4) Need for safety, not speed, in cargo operations

(5) Damage control equipment care

(a) Cutting out firemain risers to weatherdecks and draining plugs

(b) Proper stowage of hose and nozzles

(c) Stowage and operation of firefighting equipment

(6) Servicing and operating exposed deck machinery and equipment

(7) Care and operation of piping systems, tanks and related equipment

(8) Operating considerations of main propulsion and auxiliary machinery

(9) Operation and care of ventilation and heating systems

(10) Operation of radar equipment

(11) Deicing and snow removal

(12) General ship's winterization

(13) Basic seamanship, including:

(a) Maneuvering in ice

(b) Operating in fog

(c) Operating with an ice breaker

(d) Ice mooring

(e) Boat operations

(f) Navigation (dead reckoning in ice, magnetic compass limitations, shooting sun line for summer celestial navigation, etc.)

(14) Remember the COLD formula for staying warm (Clean, Overlapping Loose layers, Dry).

C. Department Heads shall:

(1) Prepare briefings as required

(2) Ensure that appropriate division check-off lists have been prepared and properly executed.

(3) Ensure that material and equipment requirements for pending conditions have been identified, and coordinate with the Supply Officer the timely satisfaction of these requirements.

(4) Supervise the general training programs in the department and the essential cross training that cold weather operations require.

D. The Navigation Officer shall:

(1) Be designated as the ship's Cold Weather Officer

(2) Act as cold weather expert advisor to the Commanding Officer, Executive Officer and Department Heads in planning for cold weather operations.

(3) Obtain all necessary publications pertaining to cold weather and ice navigation procedures and projected operating areas.

(4) Determine sources for weather advisories and arrange with the Communications Officer for their receipt.

(5) Establish a training program for in-port CDOs, OODs, JOODs on the cold weather environment, meteorology and ship icing.

(6) Ensure the efficient operation of all navigational and meteorological equipment and obtain spare parts and additional equipment as needed.

(7) Review the ship's gyro compass system and ensure steps are taken, if needed, to provide effectiveness in high latitudes. Know the limitations of the installed system.

E. The First Lieutenant shall:

(1) Determine and carry out the Navy's latest policy with regard to the use of ice-phobic coatings. If ice-phobic coatings have been designated for use, proceed accordingly.

(2) Complete preservation of all exposed areas to resist corrosion during extended periods when maintenance cannot be accomplished.

(3) Inspect, and replace as needed, all worn nonskid materials, both weatherdeck and interior.

(4) Develop an access plan (in port and at sea) and develop snow removal and ice removal plans to support the access plans.

(a) Consult with the Damage Control Assistant. Maintenance of access to fire fighting equipment is a high priority.

(b) Consult with the Engineer Officer. Control of heating loads may demand limiting access through the ship's envelope.

(5) Prepare additional safety lines and storm life lines.

(6) Ensure that appropriate cold weather covers are on board. Prepare additional covers and dodgers as needed.

(7) Ensure that tools for deicing, sand and chemical deicing agents for deck and window washer use are aboard and crew members are familiar with its use.

(8) Provide stowage for and develop plan for issue of foul weather and extreme cold weather clothing and special ice-traction foot gear.

(9) In conjunction with the Engineering Officer, designate well-heated drying for foul weather clothing and prepare proper drying arrangements.

(10 Ensure that appropriate batteries and chemical lights are on board for cold weather use on life jackets, marine markers and for fueling-at-sea.

(11) If the ship is to operate in ice fields, ensure that adequate numbers of 10-14 foot long camels are on board.

(12) Ensure extra nonskid materials are onboard.

(13) Install temporary shelters or windscreens for exposed personnel and topside watchstanders (e.g., lookouts).

(14) Strike below all mooring lines, hawsers and other deck gear not in actual daily use.

(15) Ensure that all weatherdeck doors and hatches are in good condition.

(16) Coat running rigging with cold weather grease.

(17) Make provision for the protection of ship's boats and life rafts and equip with cold weather survival gear.

(18) Review the Heavy Weather Bill. Cold region operations often involve heavy weather operations.

(19) Train boat crews in cold weather boat handling procedures and precautions.

(20) Consider issuing survival flotation suits, if available.

F. The Operations Officer shall:

(1) Approve changes to the ship's Cold Weather Bill.

(2) Ensure that communications systems are readied for cold weather.

(3) Have spare whip antennas procured as required.

(4) If appropriate, establish a training program on high latitude communications and assure that publications and radio propagation data are available.

(5) Ensure that appropriate cold weather batteries are on board for portable radios for ship's boats, landing parties and other use.

(6) Coordinate special cold weather tests and projects assigned to the ship, assign responsibilities to specific departments, and coordinate the assembly of data, summation of results and submission of reports required.

(7) Coordinate action with other operating units.

G. The Combat System Officer shall:

(1) Ensure that all radar antennas and drives are in good operating condition and lubricated for cold weather. Where fitted, heating systems should be tested.

(2) Ensure that combat systems equipment is protected with antifreeze where required.

(3) Ensure that operating mechanisms on all antenna safety switches are functioning.

(4) Ensure that all wave guide installations are in good condition; that dry air dehydration systems are in good order and appropriate spare parts are onboard.

(5) Establish a training program regarding monitoring of standing wave ratios and other appropriate measures to detect icing of antennas and wave guides.

(6) Ensure that instructions for gun and missile battery cold weather operations are prepared.

(7) Ensure that appropriate Electrostatic Discharge (ESD) materials for low humidity operation are on board and that personnel are trained in ESD protective procedures.

(8) Ensure that cold weather procedures outlined in individual equipment technical manuals and *NAVSHIP's TECHNICAL MANUAL* are followed explicitly.

H. The Weapons Officer shall:

(1) Provide for the protection of flight deck lighting and other aircraft lighting systems.

(2) Ensure that flight deck personnel are indoctrinated into cold weather procedures, cold weather FOD hazards and other hazards incident to cold weather operation.

(3) Ensure that appropriate cold weather clothing for flight deck personnel is onboard.

(4) Shift pallet trucks.

I. The Engineer Officer shall:

(1) Service all machinery to ensure its continued operation in cold weather.

(2) Review casualty control procedures for engineering casualties resulting from cold weather.

(3) Ensure that all combustion air systems are in good operating order and proper spare parts are on board. Particular attention shall be paid to:

(a) Proper functioning of louver heaters

(b) Proper functioning of blow-in door heater

(c) Tightness of the blow-in doors

(d) Tightness of fits of the coalescer and vane cage assemblies

(e) Bleed air heating of inlet air

(4) With the First Lieutenant, develop a plan for emergency deicing and snow removal of combustion air inlets; for safety lines for personnel working at inlets and for guard lines around inlets when blow-in doors are open.

(5) Ensure that engineering personnel are aware of the critical problems of combustion air in snow and icing situations and the need to carefully monitor pressure drop across the inlets.

(6) Knowing that cold region operations will produce high spray conditions and possible operation with blow-in doors open, stock extra quantities of detergent for gas turbine washing.

(7) Ensure that proper equipment for steam-out or blowing out of sea chests is in place. Train teams in the operation.

(8) With the First Lieutenant, develop an access plan placing major consideration upon minimizing heat loss from the ship.

(9) With the First Lieutenant, prepare foul weather gear drying rooms for use.

(10) Test the operations of preheaters, reheaters, temperature controls and condensate traps of heating systems in accordance with PMS procedures.

(11) Develop a plan to maintain temperatures between 66°F and 69°F in living spaces, and to operate the HVAC system at slight positive pressure to avoid ingestion of cold air.

(12) Keep boat engine starting batteries and pallet truck batteries fully charged.

(13) Install antifreeze in the boat engines primary coolant system for -20°F and keep the SW system fully drained.

(14) Replace greases and hydraulic fluid with low temperature materials for all topside machinery in accordance with PMS procedures.

(15) Review all machinery spaces for areas where cold air may blow on piping or electrical equipment. Where appropriate, rig deflectors: provide insulation or shields to prevent sweating from falling on switchboards or other electrical systems.

(16) Ensure that the Engineering Department is trained regarding possible problems involving overboard discharge freezing and vent freezing. Ensure appropriate materials for pipe thawing are on board.

(17) Review piping in unheated spaces that may be subject to freezing.

(18) Establish plans for in-port operation to provide immediate restoration of electric power, steam and firemain pressure in the event of loss of shore services.

(19) Check circuits and controllers for anti-icing windows.

(20) In port, coordinate with base facility to establish freeze control measures for firemain support, freshwater, steam and condensate lines and for sanitary systems.

(21) Ensure that lifeboats are properly equipped and maintained.

(22) Ensure all spaces have adequate heating (bridge windows, sea chests, living areas, cargo areas and tanks).

(23) Ensure that sufficient portable heaters and heat guns are available and have been safety checked.

(24) Establish cold weather ventilation procedures for operation of ventilation systems when air temperatures drop below -12°C.

(25) Establish electrical plant requirements based on additional portable electrical equipment (space heaters, etc.).

J. The Damage Control Assistant shall:

(1) Ensure that topside firemain cutoff valves are overhauled so that they are tight and easily operable.

(2) Secure and drain weatherdeck fireplugs and exposed firemain system.

(3) Ensure that exposed AFFF systems are drained.

(4) Establish a training program for fire parties (in port and at sea) concentrating on realistic scenarios involving:

(a) Recharging the firemain

(b) Removing covers from fire equipment and attacking a fire

(c) Draining and drying hoses and equipment

(d) Draining and drying charged fireplugs

(5) Ensure that adequate extra shoring, wedges, keel plates and other damage control equipment are carried in case of possible ice damage.

(6) Ensure supplemental fire hose and equipment is aboard and properly stowed.

(7) Stow P-250 pumps below decks, readily available for use when needed.

(8) Prepare calculation sheets for the prediction of the shift of center of gravity and the change of metacentric height caused by topside ice accumulation.

K. Medical Officer or Senior HM shall:

(1) Ensure medical supplies are adequate to treat cold weather injuries.

(2) Review current information on preventing and treating cold weather injuries such as frostbite, immersion foot, hypothermia dehydration and snow blindness.

(3) Ensure all crew members receive first aid training to include artificial respiration, cardiopulmonary resuscitation (CPR) (if a qualified instructor is available), detection and treatment of cold weather injuries and "mammalian diving response" for drowning casualties.

(4) Meals should be nutritious and high in caloric content to provide energy and strength for extended periods of exertion in cold weather.

L. The Supply Officer shall:

(1) Ensure that maintenance and repair parts are brought to full allowance, submitting requisitions as far in advance as possible. Requisitions shall clearly indicate the special purpose of the operation requiring the allowance.

(2) As in (1) ensure materials for the Cold Weather Kit are procured. Coordinate (1) and (2) with appropriate department heads.

(3) Ensure that full allowance of extreme cold weather clothing is onboard.

(4) Procure an adequate supply of paper cups, portable containers and provisions to serve the crew hot chocolate and hot soup.

(5) Review ration requirements for cold weather with the Medical Officer and procure stores accordingly.

V. Underway Operational Responsibilities

A. The Executive Officer is responsible for the appropriate integration of effort in the face of cold weather hazards. In his absence, in the in-port situation, this responsibility is that of the Command Duty Officer. (This assignment should not be interpreted to contravene the direct responsibility of the Officer of the Deck to the Commanding Officer for safe navigation and general operation of the ship at sea.)

B. Department Heads shall:

(1) Ensure that topside spaces, exposed equipment and exposed compartments under their cognizance are inspected at specified intervals during extreme cold or during conditions when icing may occur.

(2) Ensure that cognizant Division Officers take timely action for snow and ice removal from equipment and comply with the First Lieutenant's deicing plan.

(3) At conclusion of cold weather operations, prepare a repair work package for earliest availability. Document the time to repair major casualties for historical data.

C. The Navigation Officer shall:

(1) Keep the Commanding Officer, Executive Director, Officer of the Deck and Department Heads advised on existing and expected cold weather conditions, using all available weather forecasting information.

(2) Collect meteorological and oceanographic data for use by other units in the operating area, for the Fleet Weather Service and for analysis by cognizant service agencies. Coordinate with the Operations Officer.

(3) Maintain an accurate navigational tract during cold weather operations.

D. The First Lieutenant shall:

(1) Install storm lifelines, rig additional lifelines and install dodgers as may be required. (Note: This must be accomplished prior to icing and in advance of actual need.)

(2) Install appropriate covers on topside equipment (winches, windlasses, valves).

(3) Install lifelines and guard lines at the gas turbine air intakes, as requested by the Engineer Officer.

(4) Supervise snow removal or ice removal efforts in accordance with the plan. If steam hoses are to be used to aid ice removal, consult with the Engineer Officer.

(5) In the event of cold weather UNREP operations, assure timely rotation of personnel to minimize excessive cold fatigue and exposure.

(6) Ensure that personnel have adequate rest between UNREPs. Rest periods must be increased because of the high fatigue rate imposed by a cold environment.

(7) See that appropriate dry cells and chemical lights are in use for the temperature conditions encountered.

(8) Have frequent inspections made of ship's boats and life rafts to assure security of stowage and readiness for use.

(9) Assign deck watch to keep deck machinery heated and/or covered.

E. The Operations Officer shall:

(1) Have all communication and navigation antennas monitored for icing.

(2) Have the movable communication antennas frequently rotated to assure they are not frozen in place.

(3) Have fan antenna insulators deiced and cleaned, as necessary.

(4) Ensure that adequate personnel are assigned to lookout duties to provide rotation as often as every 15 minutes in severe cold. (Personnel from other departments may be required.)

(5) Ensure lookouts are properly instructed regarding regular and ice-lookout duties.

(6) Monitor the progress of special cold weather tests assigned to the ship.

(7) Record and log all equipment casualties associated with cold weather operation.

(8) Develop a ship class/ship specific lessons learned package for operations in cold weather.

F. The Combat System Officer shall:

(1) Ensure that the SPY antenna faces are cleaned when weather and sea conditions permit. In cold weather operations, cleaning cannot be done on a scheduled basis.

(2) Ensure that antennas are monitored, using SWR or other means, so that icing and possible deterioration of performance are recognized early.

(3) Have frequent visual checks made to identify icing conditions on antennas.

(4) Notify the OOD if any evidence of antenna icing appears.

G. The Weapons Officer shall:

(1) Supervise deicing of weapons systems when needed.

(2) Ensure frequent inspection of weapons system spaces, especially topside magazines. Particular attention should be paid to topside magazine sprinkling systems and the firemain water hydraulic controls for such systems.

(3) Supervise preparation of the flight deck for operations.

(4) Ensure that flight deck personnel are rotated frequently during flight operations to avoid excessive windchill and fatigue.

(5) Have weapons systems equipment exercised frequently to assist in the maintenance of hydraulic fluid and lubricant temperatures.

H. The Engineer Officer shall:

(1) Expect more maneuvering requirements.

(2) Have SW pumps monitored carefully for fluctuating pressures arising from ice in sea chests. If icing occurs, blow out sea chests as needed.

(3) If ice in sea chests becomes a repetitive problem, run as many pumps in parallel as possible. Lowering inlet velocity lessens the problems of ice in sea chests.

(4) Have careful watch maintained on inlet air intake pressure drops, as well as visual inspection of air intakes.

(5) In the event of possible snow blockage or inlet icing, reduce intake velocities by splitting plant.

(6) When all SSGTGs are not operating, lay up the waste heat boiler on the idle SSGTGs under dry lay up. (During severe cold conditions, a waste heat boiler under a steam blanket will freeze with consequent tube damage.)

(7) Carefully monitor feed water usage if steam is being used for deicing. Keep the First Lieutenant advised of steam resources available.

(8) Monitor electrical system for overload of system from portable heaters and portable electrical equipment usage.

(9) Issue special ventilation instructions to prevent water/sweat damage when moving from warm to cold climate.

(10) Have a heat patrol maintained to ensure adequate heating of living spaces and to detect heat losses and incipient equipment problems.

(11) Monitor exposed tank vents for icing. Tank vents must be kept clear.

(12) Monitor fuel use and advise the Commanding Officer of the best combination of propulsion and generator use to conserve fuel for extended operation.

I. The Damage Control Assistant shall:

(1) Keep the Commanding Officer advised of GM and trim during ship icing incidents.

(2) Monitor exposed firemain for accessibility and signs of damage.

(3) Develop a listing of the exposed valves in the firemain system. Maintain an open/close valve log as a guide for draining, training and recharging the firemain. This listing should be verified against the ship's damage control book and by physical verification.

(4) Place spare lengths of fire hose at protected fire stations as necessary.

J. The Supply Officer shall:

(1) Issue materials and foul weather clothing as needed for the operation.

(2) Ensure that hot drinks and soup are available on the mess deck 24 hours a day and available for lookouts and special weatherdeck details.

(3) Modify the daily ration to increase fat and carbohydrate content as advised by the Medical Officer.

(4) Make special plans for UNREP so that vegetables, canned goods and any sensitive items are struck below quickly and not subject to freeze damage.

(5) Modify laundry schedule to support cold weather watchstanders.

K. The Officer of the Deck shall:

(1) Have frequent patrols of the weatherdecks made to provide early knowledge of icing.

(2) Be alert for weather changes that can lead to icing.

(3) Ensure that the "buddy" system and safety lines are used for men on deck when icing is suspected or has been detected.

(4) Leave navigation lights on 24 hours per day.

(5) Leave radar antenna turning 24 hours per day.

(6) Have the Quartermaster make frequent wind speed and temperature readings to determine likelihood or rate of saltwater ocean spray freezing.

(7) Maintain constant watch of sea temperature. (Sometimes small bergs do not show on radar but a drop in sea temperature may indicate nearby presence.)

(8) Utilize searchlights for detecting ice, when possible.

(9) Train watch section in ice safety matters (i.e., learn to recognize ice blink, stay to windward of bergs).

(10) Run/test lifeboat engines more frequently than usual.

(11) Be prepared for the longer periods of fog which are usually associated with higher latitude cold fronts. Test ship's whistle frequently.

(12) Ensure watchstanders are properly dressed, sheltered and rotated frequently.

(13) Advise the Commanding Officer and appropriate departments when antenna icing or superstructure icing has been detected.

L. The Safety Officer shall:

(1) Prepare a brief for all hands as well as Plan of the Day notes concerning hazards to be encountered and safety precautions to be taken.

M. Division Officers shall:

(1) Carry out division training on the cold weather operations area and on cold weather safety precautions.

(2) Ensure that each man knows the symptoms of windchill, frost bite, dehydration and exposure and the measures to be taken.

VI. Reports and Data

Detailed cold weather data regarding the environment, the weather sequence, the ship response and individual ship system and equipment response are keys to improving Navy capability to meet cold weather challenges and to improving ship systems and equipment. Cases of "no problem" in a severe environment are as important as "problem" in a moderately severe environment. Routine records of cold weather operations should be detailed enough to provide this information to type commanders and to NAVSEA.

APPENDIX L

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Antarctic Region
Research station
Year-round
Summer only
Unoccupied
+3022 Elevation in meters
Azimuthal Equal-Area Projection
Scale 1:17,250,000
0 200 400 600 800
Kilometers
0 200 400 600 800
Nautical Miles
0 200 400 600 800
Statute Miles
South Atlantic Ocean
The Falkland Islands, South Georgia, and the South Sandwich Islands are administered by the U.K. and claimed by Argentina.
South Georgia
SANDWICH ISLANDS
SHAG ROCKS
Scotia Sea
FALKLAND ISLANDS (Islas Malvinas)
East Falkland
West Falkland
Stanley
Orcadas (Argentina)
SOUTH ORKNEY ISLANDS
Signy (U.K.)
Coronation I.
Argentina
Chile
Drake Passage
TIERRA DEL FUEGO
Cape Horn
Strait of Magellan
SOUTH SHETLAND ISLANDS
Clarence I.
Elephant I.
Joinville I.
Antarctic Peninsula
Weddell Sea
average minimum extent of sea ice
Antarctic Circle
SANAE III (South Africa)
Georg von Neumayer (Fed. Rep. of Germany)
Cape Norvegia
RIISER-LARSEN ICE SHELF
Camp Norway 3 (Norway)
Camp Norway 4 (Norway)
PRINCESS
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Halley (U.K.)
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Shackleton Range
FILCHNER ICE SHELF
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RONNE ICE SHELF
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PALMER LAND
Alexander Island
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Adelaide I.
Bellingshausen Sea
Siple (U.S.)
ELLSWORTH LAND
Ellsworth Mountains
MARIE BYRD LAND
Byrd (U.S.)
Amundsen Sea
Executive Committee Range
Ford Ranges
SULZBERGER ICE SHELF
Russkaya (Soviet Union)
Roosevelt Island
ROSS ICE
Ross
Peter I Island
ABBOT ICE SHELF
Thurston Island
Carney Island
Siple Island
Grant I.
GETZ ICE SHELF
South Pacific Ocean
South Pacific
Scott Island
Stations in the Antarctic Peninsula Area
1 Comandante Ferraz Brazil
2 Arctowski Poland
3 Bellingshausen Soviet Union
4 Jubany Argentina
5 Artigas Uruguay
6 Teniente Marsh/Frei Chile
7 Great Wall China
8 Capitán Arturo Prat Chile
9 Esperanza Argentina
10 General Bernardo O'Higgins Chile
11 Vicecomodoro Marambio Argentina
12 Teniente Matienzo Argentina
13 Primavera Argentina
14 Palmer U.S.
15 Yelcho Chile
16 Faraday U.K.
17 Presidente Videla Chile
18 Rothera U.K.
19 Teniente Carvajal Chile
20 General San Martin Argentina
21 Fossil Bluff U.K.
60°
90°W
120°
150°
70°


Indian Ocean
Dakshin Gangotri
Novolazarevskaya (Soviet Union)
Roi Baudouin (Belgium)
PRINCESS RAGNHILD COAST
Sør Rondane Mountains
Syowa (Japan)
PRINCE OLAV COAST
Molodezhnaya (Soviet Union)
N MAUD
AND
Mizuho (Japan)
ENDERBY LAND
Mawson (Australia)
MAWSON COAST
MAC. ROBERTSON LAND
AMERY ICE SHELF
Druzhnaya IV (Soviet Union)
Progress (Soviet Union)
Prydz Bay
Davis (Australia)
INGRID CHRISTENSEN COAST
American Highland
WEST ICE SHELF
Sovetskaya (Soviet Union)
Davis Sea
Komsomol'skaya (Soviet Union)
Pionerskaya (Soviet Union)
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Vostok (Soviet Union)
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