ATP 3-90.96
MCTP 12-10E

ARCTIC AND EXTREME COLD WEATHER OPERATIONS

FEBRUARY 2025

INCORPORATING CHANGE 1, (MARCH 2025)

DISTRIBUTION RESTRICTION: Approved for public release; distribution is unlimited.

This publication supersedes MCRP 12-10A.4 Cold Regions Operations, dated January 2011.

HEADQUARTERS, DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES MARINE CORPS

ATP 3-90.96, C1

Change 1
Army Techniques Publication
No. 3-90.96

Headquarters
Department of the Army
Washington, DC, 31 March 2025

Marine Corps Tactical Publication
No. 12-10E

Training and Education Command
Headquarters,
United States Marine Corps
Washington, DC, 31 March 2025

ARCTIC AND EXTREME COLD WEATHER OPERATIONS

1. This change replaces the front cover, the last paragraph in the Preface, and missing USMC PCN and signature.
2. A plus character (+) marks new material.
3. ATP 3-90.96, (Date Pending), is changed as follows:

Prior Version Page(s)	Change Version Page(s)
Cover Page	Cover Page
Page IX	Page IX
Back Cover	Adds USMC PCN
Authentication Page	Adds USMC Signature

4. An updated Authentication Page has amended the prior authentication reflected in the rear of this publication.

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Washington, DC, 24 February 2025

ARCTIC AND EXTREME COLD WEATHER OPERATIONS

Contents

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Figures

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Preface

ATP 3-90.96/MCTP 12-10E, *Arctic and Extreme Cold Weather Operations*, is a dual-designated Army/Marine Corps manual that provides Soldiers/Marines with concepts and techniques associated with conducting arctic operations. This manual is designed to work in conjunction with and complement ATP 3-90.97, *Mountain Warfare and Cold Weather Operations*, TC 21-3, *Soldier's Handbook for Individual Operations and Survival in Cold-Weather Areas*, MCRP 12-10A.2, *Mountain Leader's Guide to Winter Operations*, and other manuals of the arms and Services.

ATP 3-90.96/MCTP 12-10E is the Army's/Marine Corps' manual for cold weather operations. The fundamentals of arctic and extreme cold weather operations apply in any cold region. ATP 3-90.96/MCTP 12-10E is an operations manual; it is not a survival manual. Only general survival considerations and risk mitigations are discussed in this manual. For in-detail survival techniques, reference TC 21-3. MCTP 12-10E supersedes MCRP 12-10A.4, *Cold Region Operations*, dated January 2011.

The principal audience for ATP 3-90.96/MCTP 12-10E includes all Army/Marine Corps commanders, leaders, staff, and Soldiers/Marines. Commanders and staffs of Army/Marine Corps headquarters serving as joint task force or multinational headquarters should also refer to applicable joint or multinational doctrine concerning the range of military operations and joint or multinational forces. Trainers and educators throughout the Army/Marine Corps will also use this publication.

Commanders, staff, and subordinates ensure that their decisions and actions comply with applicable United States, international, and in some cases host-nation laws and regulations. Commanders at all levels ensure their Soldiers/Marines operate in accordance with the law of armed conflict and the rules of engagement. (See FM 6-27/MCTP 11-10C for more on legal applications.)

ATP 3-90.96/MCTP 12-10E uses joint terms where applicable. Selected joint, Army, and Marine Corps terms and definitions appear in both the glossary and the text. Terms for which ATP 3-90.96/MCTP 12-10E is the proponent publication (the authority) are italicized in the text and are marked with an asterisk (*) in the glossary. Terms and definitions for which ATP 3-90.96/MCTP 12-10E is the proponent publication are boldfaced in the text. For other definitions shown in the text, the term is italicized and the number of the proponent publication follows the definition. Since this is a dual-designated Army and Marine Corps manual, the following protocol is used to distinguish the proponent for information and terms:

- Underlined text—Marine Corps specific terms, phrasing, or concepts.
- Terms in italics and definitions in plain text—joint and Army terms with proponent publication in parentheses.
- Terms in bold italic, definition in bold—terms for which ATP 3-90.96/MCTP 12-10E is the proponent publication.

ATP 3-90.96/MCTP 12-10E applies to the Active Army, Army National Guard, United States Army Reserve, United States Marine Corps, and the United States Marine Corps Reserve unless otherwise stated.

+ The proponent of ATP 3-90.96/MCTP 12-10E is the United States Army Combined Arms Center. The preparing agency is the Combined Arms Doctrine Directorate, United States Army Combined Arms Center. Send comments and recommendations on DA Form 2028 (*Recommended Changes to Publications and Blank Forms*) to Commander, United States Army Combined Arms Center and Fort Leavenworth, ATZL-MCD (ATP 3-90.96/MCTP 12-10E), 300 McPherson Avenue, Fort Leavenworth, KS 66027-2337; by email to usarmy.leavenworth.mccoe.mbx.cadd-org-mailbox@army.mil; or submit an electronic DA Form 2028. U.S. Marine Corps readers of this publication are encouraged to submit suggestions and changes to Doctrine Branch via email: usmc_doctrine@usmc.mil.

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Introduction

The Arctic is simultaneously an arena of competition, a line of attack in conflict, a vital area holding many natural resources, and key terrain for global power projection. As such, a ready and capable land force in arctic operations serves to deter threats to the U.S. homeland, its allies, and interests in the Arctic.

As an expeditionary force, the U.S. military stays prepared to meet the challenges of the Arctic and to fight and win in any environment, regardless of home station. Leaders and individuals must understand the effects of the Arctic and extreme cold weather environments and must have the training, stamina, and willpower to take the proper actions.

This manual provides the doctrinal foundation for Soldiers/Marines to understand the Arctic's operational environment and conduct arctic and extreme cold weather operations. The fundamentals of this manual are also applicable to all cold weather environments. This manual also informs DOTMLPF-P (doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy) improvements as the Army/Marine Corps regains arctic dominance.

The following briefly introduces and summarizes each chapter:

Chapter 1: The Arctic Environment provides a baseline for understanding the complex and unique arctic environment. It explains the significance of the Arctic, defines arctic operations, and describes the terrain, weather, and wildlife present in the Arctic. It also details how the arctic environment can affect troops and equipment while offering techniques commanders can implement to better adapt their forces to arctic operations.

Chapter 2: Operational Considerations for the Arctic analyzes the operational environment by detailing political, military, economic, social, information, infrastructure, physical environment, and time considerations. It describes the Arctic through the competition continuum: competition, crisis, and armed conflict. It also lists the fundamental principles of arctic operations.

Chapter 3: Planning and Executing Arctic Operations describes the planning and execution of arctic operations. It details tactics in the Arctic as well as operations in the maritime and air domains.

Chapter 4: Command, Control, and Information describes the impact of the Arctic on the Army and Marine Corps warfighting function of command and control, and the Marine Corps warfighting function of information. It provides essential elements of leadership, risk mitigation, and challenges to information systems.

Chapter 5: Movement and Maneuver/Maneuver describes the impact of the Arctic on the movement and maneuver/maneuver warfighting function. It describes techniques for infantry, armor, rotary-wing, and special operations in arctic operations.

Chapter 6: Intelligence describes the impact of the Arctic on the intelligence warfighting function and the intelligence process.

Chapter 7: Fires describes the impact of the Arctic on the fires warfighting function. It describes techniques for artillery and air defense artillery in arctic operations.

Chapter 8: Sustainment/Logistics outlines procedures for sustaining arctic operations. It explains the effect of the Arctic on all classes of supply, logistics, financial management, personnel services, and health service support.

Chapter 9: Protection/Force Protection describes the impact of the Arctic on the protection/force protection warfighting function.

Chapter 10: Training for Arctic Operations describes the training required to prepare for arctic operations.

Appendix A: Units of Measurement provides conversion charts for units of measurement.

Appendix B: Mobility Considerations provides an in-depth description of movement methods and mobility considerations in arctic operations.

Appendix C: Ice Considerations provides methods for ice assessment, reconnaissance, crossing, and demolition.

Appendix D: Cold Weather Injury Identification and Prevention provides information on cold weather injury identification, prevention, and treatment.

Appendix E: Potential Adversary Equipment provides descriptions of potential equipment that adversaries in arctic operations could use.

Appendix F: Planning Factors for Cold Weather Training and Operations provides clothing and equipment planning factors by temperature zone.

Appendix G: Sample Risk Assessment Considerations for Arctic Operations provides sample deliberate risk assessments considerations for a variety of arctic training and operations.

Introductory Table-1 lists new terms.

Introductory Table-1. New terms

arctic operations	new term
extreme cold weather operations	new term
cold weather capability	new term
arctic determination	new term

Chapter 1
The Arctic Environment

The environment is a dynamic force. He who recognizes it and understands this force can use it; he who disregards or underestimates it is threatened with failure or destruction.... The climate does not allow a margin of error for the individual or the organization.

FM 31-71, *Northern Operations* (1963)

This chapter provides a baseline for understanding the complex and unique arctic environment. It is separated into three sections. Section I – Understanding the Arctic details the significance of the region and defines arctic operations. Section II – The Physical Environment describes the impact of the climate, weather, and terrain on operations. Section III – Environmental Hazards details risks and challenges imposed by the environment.

SECTION I – UNDERSTANDING THE ARCTIC

1-1. This section serves as a foundation for understanding the Arctic, its significance, its many descriptions, and arctic operations.

THE ARCTIC'S SIGNIFICANCE

1-2. The Arctic is one of the most challenging operational environments (OEs) in the world with extreme cold that can reach sustained temperatures below -40 °F, limited communications reliability, and complicated sustainment. (See Appendix A for conversion charts for units of measurement.) The arctic environment is unforgiving. Where errors and oversights might cause inconvenience or mission failure in other regions, the same mistakes in the Arctic can be deadly.

1-3. Although there has been no armed conflict in the Arctic since World War II, the region holds substantial national security significance in the coming decades for two reasons. First, there is an increased probability of political tension over newly accessible economic resources and sea lines of communication (LOCs) because of global warming and ice thaw. Second, there is a requirement for continued deterrence against peer threats in the region.

1-4. Historically, the Arctic has been viewed as inaccessible and desolate. However, climate change is beginning to alter this notion and make the region increasingly more accessible. Rapid arctic warming is thawing ice, opening new shipping lanes in the Arctic Ocean, and making previously untapped oil, minerals, and natural resources increasingly available. Not all changes are positive though. As climate change softens terrain once frozen for hundreds of years, it disrupts wildlife ecosystems and weakens infrastructure to the point of collapse. These combined factors increase the Arctic's international significance as well as increase the potential for political dispute over territorial and resource claims, thereby increasing the need for security in the region.

> **Arctic Deterrence and Homeland Defense**
>
> The United States Military has long recognized the significance of the Arctic in deterrence and homeland defense, especially during World War II and the Cold War. With only 2.4 miles between Big Diomede (Russia) and Little Diomede (Alaska), the Arctic stands as the first line of defense for the United States.
>
> During the Battle of Attu in May 1943, Servicemembers defended the U.S. Arctic against one of the only foreign invasions of U.S. soil during World War II. During this battle, Imperial Japanese Forces occupied the Alaskan Attu Island and sought to use it as a strategic foothold to launch attacks on Alaska, Washington, and California. On 11 May 1943, the 7th Infantry Division launched an amphibious assault to retake the island. The battle lasted a grueling 19 days in the cold and ended in hand-to-hand combat in the snowy tundra. With its victory, the 7th Infantry Division, based out of sunny California at the time, showed that all units, regardless of home station, must be prepared to defend the nation, its interests, and its allies in the most extreme of conditions—including the Arctic.

THE ARCTIC

1-5. The Arctic is described in many ways depending on the political, economic, scientific, or academic purposes for which it is being used. To avoid confusion, Soldiers and Marines need to understand the different ways the term "Arctic" can be used. Most descriptions fall into one of three categories, or a combination thereof:

- Latitude.
- Climate.
- Terrain.

Each category has tactical significance for a commander. An increase in latitude amplifies periods of daylight and darkness, as well as solar disruptions to communications. Climate influences the severity of the cold and other unique arctic weather phenomena. Finally, terrain shapes mobility considerations and signifies stark shifts in tactical approach from region to region. Paragraphs 1-6 through 1-9 summarize each category that will be discussed in depth later in the manual.

LATITUDE

1-6. A latitude description distinguishes the Arctic by a specified latitude on a map. The most common latitude definition is 66°33' N, which creates the boundary for the Arctic Circle. This latitude is based on the lowest part of the northern hemisphere where 24 hours of daylight or darkness is still experienced during the solstice. Although 66°33' N is commonly accepted approximation, some nations and organizations describe the Arctic's border at lower latitudes based on climate or other considerations.

1-7. Title 15 of the U.S. Code uses a latitude description. It defines the Arctic as "all United States and foreign territory north of the Arctic Circle and all United States territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim Rivers; all contiguous seas, including the Arctic Ocean and the Beaufort, Bering, and Chukchi Seas; and the Aleutian chain." (See Figure 1-1 for the U.S. Code's border of the Arctic.)

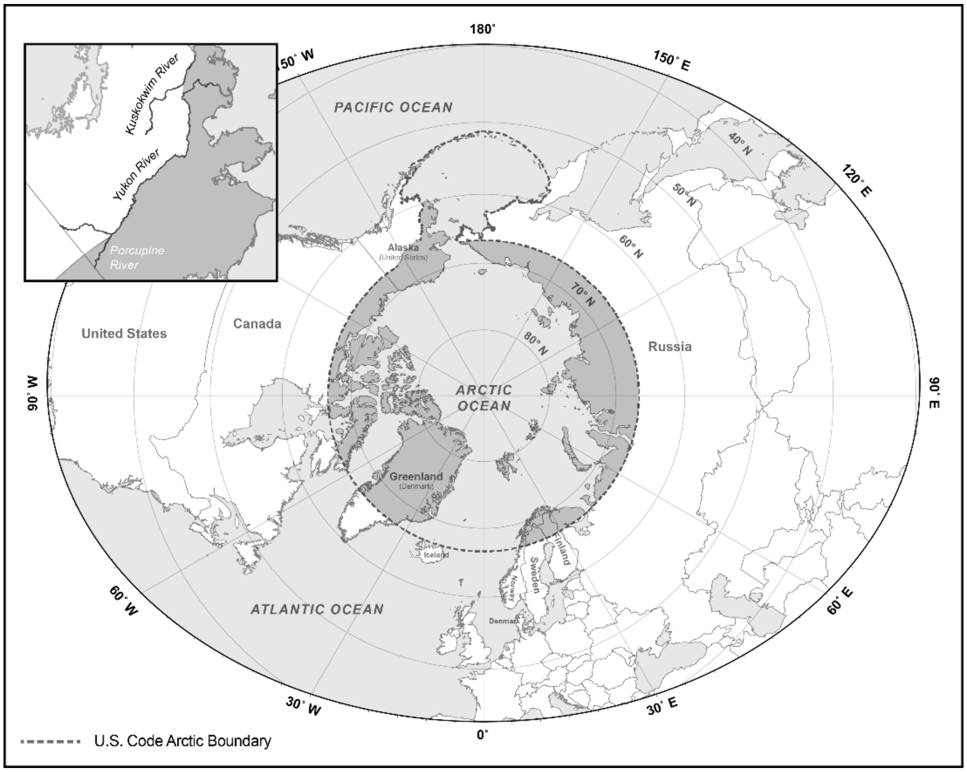

Figure 1-1. U.S. Code definition of the Arctic

CLIMATE

1-8. A climate description separates the Arctic and subarctic based on long-term weather patterns. Temperature is generally the most defining characteristic that separates arctic and subarctic climates (see Figure 1-2 for arctic and subarctic areas; See Appendix A for temperature conversions). For a detailed description of climates, see the discussion beginning on paragraph 1-15.

- **Arctic climate**. Regions with average temperatures in the warmest month less than 50 °F and an annual temperature below 32 °F.
- **Subarctic climate**. Regions that average below freezing (32 °F) during their coldest month and have only one to three months averaging above 50 °F.

TERRAIN

1-9. A terrain description separates the Arctic into regions based on terrain, vegetation, and permafrost conditions (see Figure 1-2 for arctic terrain regions). The terrain regions are ice cap, tundra, and boreal. Ice cap and tundra regions are considered to make up the Arctic, while the boreal region is regarded as the subarctic. The most notable boundary is the "tree line" (the area where the boreal forests meet the open tundra), which is often considered the border between the arctic and subarctic regions.

- **Ice cap**. Extensive fields of permanent ice that are characterized by a complete lack of vegetation. In this region, annual temperatures do not support life, and the terrain consists of rock and ice. The ice cap region is also referred to in the international community as the "High Arctic."
- **Tundra**. A polar desert. The tundra has snow-covered planes in the winter and short mosses and bushes in the summertime. It is characterized by underlying permafrost, and tree life is not supported. In the northern hemisphere, it is located south of the ice cap region and north of the tree line. The tundra region is also referred to in the international community as the "Low Arctic."
- **Boreal**. Composed of coniferous forests with ground conditions that are highly impacted by seasonal shifts. Boreal terrain has numerous lakes, ponds, peat bogs, and swamps. In the northern hemisphere, it is located south of the tree line The boreal region is also referred to in the international community as the "subarctic."

(For a more detailed definition of terrain regions, see paragraph 1-21.)

DEFINING ARCTIC OPERATIONS

1-10. ***Arctic operations*** **are actions executed in ice cap, tundra, and boreal terrain that require special techniques and equipment.** Arctic operations include those in arctic and subarctic climates in both warm and cold seasonal conditions and account for limited mobility, degraded communications, and challenging sustainment.

Note. For purposes of this manual, the term “Arctic” is used to describe those areas where U.S. forces conduct arctic operations.

1-11. The Army/Marine Corps definition of arctic operations is based on terrain, but naturally incorporates the most significant factors of latitude and climate, such as cold temperatures and long periods of darkness. While extreme cold temperature is one of the most prominent factors of arctic operations, it is not the only factor. Swift seasonal changes and their effects on varied terrain can have a significant impact on success or failure in the region. Therefore, latitude, climate, and terrain are all important aspects to consider when conducting arctic operations.

1-12. ***Extreme cold weather operations*** **are actions executed at -25 °F or below.** Extreme cold weather operations are a subset of arctic operations that pertain to the various skills and techniques required to overcome low temperatures. Figure 1-2 depicts the regions in which U.S. forces conduct arctic and extreme cold weather operations in the northern hemisphere. Table 1-3 on page 28 describes cold temperature zones.

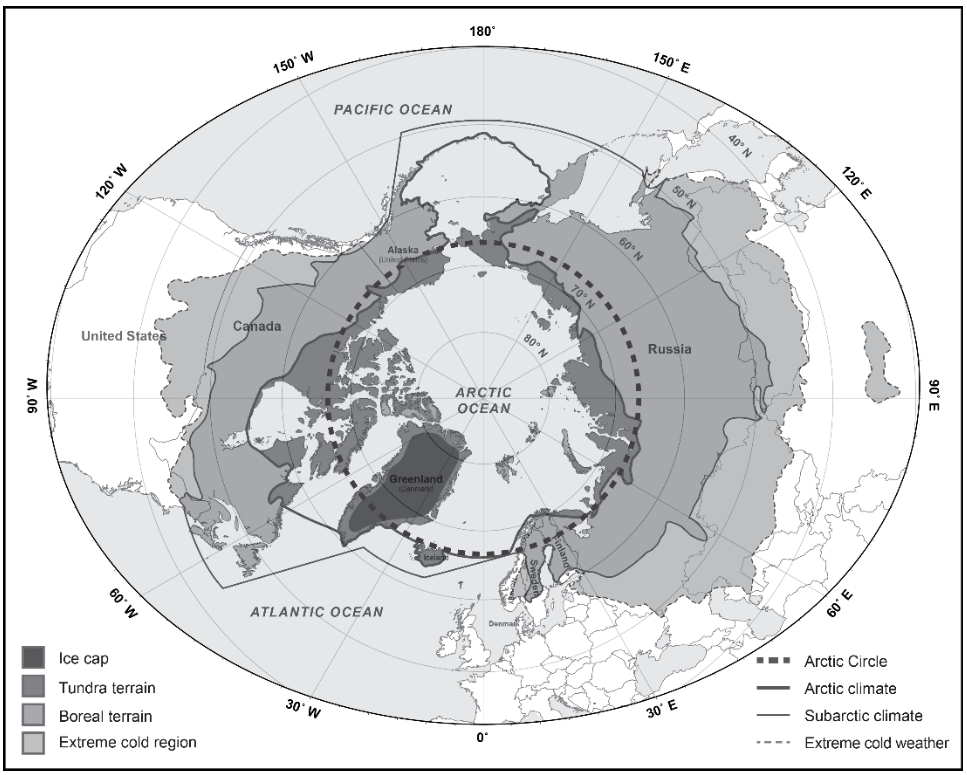

Figure 1-2. Area of arctic and extreme cold weather operations

Note. Terrain and climate regions are based on AR 70-38 classifications and U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory data. The area of extreme cold weather operations depicts the region where temperatures at -25 °F or below can be expected annually. Mountainous regions may also experience extreme cold weather due to high altitude, even in dry, hot climates. Occasionally, polar vortexes blow extreme cold air into more temperate regions as far south as 30°N.

1-13. The principles and techniques described in this manual focus on overcoming the extreme challenges of the Arctic and extreme cold. However, Soldiers/Marines can modify them for use in other regions. For instance, considerations for ice cap operations apply to the Antarctic region. Additionally, Soldiers/Marines can apply many of the basics of arctic operations in any cold region. For instance, cold weather readiness, mobility considerations in snow and mud, and challenges in sustainment are all applicable in winter periods of more temperate climates.

SECTION II – THE PHYSICAL ENVIRONMENT

1-14. The Arctic has many unique characteristics and phenomena that do not exist elsewhere in the world. These conditions have a significant effect on operations in ways that often drastically differ from experiences in a more temperate climate. Even simple tasks may require substantially different planning considerations. Therefore, the first step in conducting arctic operations is to fundamentally understand the physical environment and the additional considerations it imposes. This section details the attributes and features of the physical environment that affect operations.

POLAR CLIMATES

1-15. The polar arctic region occupies approximately 17 percent of the Earth's land area and is located at high latitudes with a climate controlled by polar and arctic air masses. This area is generally cool with severely low temperatures in the winter. This region has low annual precipitation, most of which occurs in the summer. Because of the low air and soil temperatures, total annual evaporation is also limited. Polar climates are divided into two additional categories: the Arctic and subarctic.

1-16. Throughout this region, the environmental factors of greatest concern are low temperatures, high winds, ice fog or white out, frozen soil, surface snow and ice, precipitation (snow, freezing rain, hail, and rain, depending on season and temperature), the difficulty of movement over thawed ground, and landforms such as mountain ranges and lowlands or peatlands where seasonal conditions especially impact mobility.

ARCTIC CLIMATE

1-17. The arctic climate is classified as regions with average temperatures in the warmest month less than 50°F and an average annual temperature below 32 °F. This region includes ice cap and tundra terrains. Ice cap regions consist of areas of perpetual frost where average annual temperatures constantly stay below freezing, with low amounts of annual precipitation occurring as snow. Tundra regions have long, severe winters and short, cool summers. The average monthly temperature of the warmest month in tundra regions is between 32 °F and 50 °F. Annual precipitation is less than eight inches.

SUBARCTIC CLIMATE

1-18. The subarctic has at least one, but no more than three months of the year with an average monthly temperature above 50 °F. These regions are south of the 50 °F Isotherm and exist as far down as the 50°N latitude in some areas. However, the boundaries are defined by the ecosystem and not by latitude. Precipitation is concentrated in the three summer months. Snow cover exists for at least six months in the lowlands; surrounding mountains can have perennial snow cover.

1-19. In the subarctic, the climate tends to be more continental, with colder winters and milder summers compared to the arctic region. The presence of boreal forests, also known as taiga, is a notable feature of the subarctic, with coniferous trees adapted to the colder climate. Maritime influences can moderate temperatures and influence snow and rainfall amounts. The subarctic climate is also influenced by arctic climate patterns and may share some similarities in terms of ecosystem dynamics and environmental changes, although to a lesser extent.

TERRAIN

1-20. The arctic terrain is heavily impacted by the climate, weather, and seasonal shifts. Understanding these relationships is key to forecasting the operational effect land has and determining tactical approach. Although the Arctic is characterized by its bitter cold and snow, short warm seasons do exist. Seasonal shifts drastically reshape the landscape and can rapidly flip advantages into disadvantages. What was once hard snow-covered ground favorable for offensive maneuver, can quickly become wet mudded soil favorable for defensive obstacles. Warming events can even happen in winter, causing roads and rivers to melt and become impassable until frozen again. (See paragraph 1-99 for more information on freeze-thaw cycles.)

REGIONS

1-21. Three major terrain regions exist within the Arctic and subarctic (see Figure 1-2 on page 4):

- Ice cap.
- Tundra.
- Boreal.

The change from boreal to tundra signifies the transition from subarctic to arctic climates and requires a shift in operational approach. As climate change continues to warm the Arctic, these borders will continue to shift, including movement of the tree line toward the north.

Ice Cap

1-22. Ice cap regions have extensive fields of permanent ice and exist in the arctic climate. These regions remain permanently frozen with multiyear snow and ice. The ice cap regions are largely uninhabited, supporting little to no animal or plant life. They exist in very high latitudes, primarily Greenland and parts of the Canadian Arctic Archipelago. The largest northern ice-covered region is Greenland, which is an ice sheet that is almost entirely glaciated. Populations in these regions are generally coastal. Figure 1-3 shows an image of ice cap terrain.

Note. For simplicity, this manual uses the term “ice cap” to refer to the common characteristics of both ice cap and ice sheet terrain forms. Ice caps are glaciated regions of less than 50,000 square kilometers. Ice sheets are glaciated regions of more than 50,000 square kilometers. Ice sheets only exist in Greenland and Antarctica.

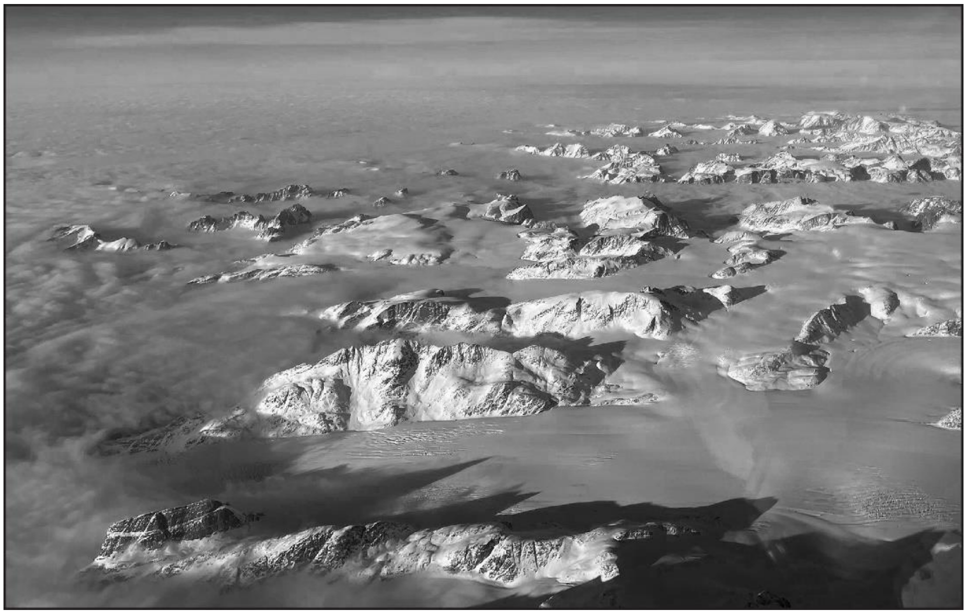

Figure 1-3. Ice cap terrain

1-23. Despite the harsh environmental challenges of ice cap regions, military operations such as sled patrols, austere airfields, and ice camps are still possible, but require significant planning and sustainment to achieve. Specialized activities may require operations on permanent ice and snow-covered areas for support and protection. In such instances, operations will normally involve small units. However, the total effort required will be large because of the extreme difficulties of operating in such a harsh environment. Commanders carefully consider the necessity of operating in these regions and implement appropriate risk mitigations.

1-24. Operations on an ice cap steeply contrast with operations in other areas of the Arctic. Units on an ice cap require different techniques of operation. The absolute absence of usable resources requires units to transport every item needed for operation into the operating area. It is mandatory that personnel be provided with protection from the high winds and extreme cold. As a result, support requirements are extremely high.

1-25. Specialized equipment for negotiating ice cap areas is required. This equipment includes snow tractors, low-ground-pressure vehicles, crevasse detectors, trail-marking equipment, navigational aids, living shelters, and related items.

Tundra

1-26. The tundra lies in the arctic climate and is a polar desert with snow-covered planes in winter and very short growing seasons producing only low-growing grasses, lichens, mosses, and brush with treeless plains. The tundra predominately consists of coastal plains, low-interior and high-interior plains, and lesser areas of low and high-relief mountains. Most development and infrastructure of military interest centers around ports and areas with valuable natural resources (such as oil and natural gas). Few roads or towns exist. For the most part the high latitudes are treeless, but river corridors may have trees extending far into the tundra areas. A skilled enemy will know this and keep these corridors under observation at a minimum. (Figure 1-4 shows images of tundra during winter and summer to display the distinct difference the seasons have on the terrain)

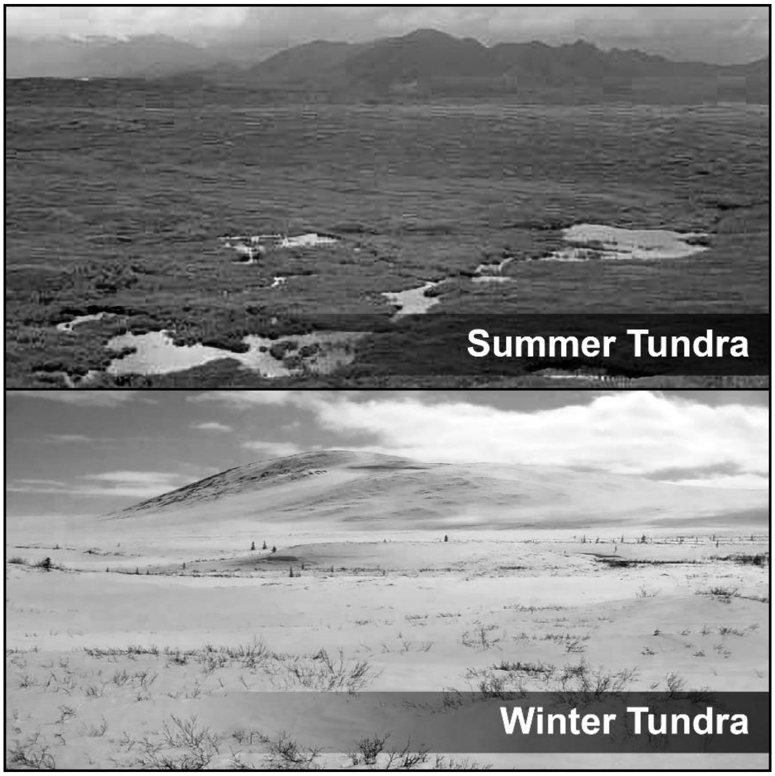

Figure 1-4. Tundra terrain in winter and summer

1-27. The long winter hosts open terrain covered in snow with little to no significant land features and extensive hours of darkness. Snow-covered tundra favors high-mobility tracked or ski-equipped platforms for mobility. Dismounted formations can be at a disadvantage in this environment due to the extreme lack of cover and concealment provided by the environment. Commanders should weigh heavily the trade-off of armored protection versus mobility in this region.

1-28. Persistent wind over the tundra hardens snow and provides a more solid base to maneuver. Windblown snow may support foot traffic and over-snow vehicles, but might not support other wheeled vehicles. However, deep snow in the tundra is still difficult for wheeled vehicles to traverse. Engineer assets or tracked vehicles may need to compact snow to make suitable passageways for wheeled vehicles. Over-snow vehicle assets with low ground pressure tracks or tires are a significant advantage. Troop movement through large open and observable snow areas makes imprints that are difficult to conceal from enemy observation.

1-29. Defense is complex in this region. Due to the vast expanses of empty terrain, it is challenging to control. Terrain seldom provides additional protection, and enemies can attack from all sides. LOCs and support nodes are particularly vulnerable. During the summer and freeze-thaw periods, movement in the tundra becomes extremely difficult for both mounted and dismounted troops. Drainage in these areas is typically poor due to the permanently frozen ground (permafrost), which creates muddy summertime conditions. The tundra has been known to engulf vehicles as they sink into the swampy ground. Vegetation of various grasses and mosses develop into tussocks with standing pools of water between clumps, which can be difficult for vehicles to traverse and especially challenging and slow for dismounted movement.

Boreal

1-30. The boreal region is composed of boreal forests (also known as taiga) characterized by coniferous trees adapted to the subarctic climate. It forms a transition zone between the tundra and temperate regions. It consists of coastal plains, high-relief and low-relief mountains, lesser areas of low-interior and high-interior plains, and extensive areas of rock and noncohesive sand. There are typically more infrastructure and developed areas than the arctic region, but vast undeveloped areas with few roads dominate. The largest temperature range in the world exists here.

1-31. Needle-leaf forests and open woodlands in this region provide cover and concealment favorable to light formations employing surprise. However, this region's vegetation significantly hinders larger vehicles and cross-country mobility. Forested regions also protect against wind and snowstorms in the winter but can burn easily in the summer.

1-32. Ground condition in the boreal subarctic is heavily impacted by seasonal shifts, especially during the summer when ground conditions and muskeg (a type of bog or wetland prevalent in the Arctic) make the terrain unstable and difficult for vehicles to traverse. Numerous lakes, ponds, peat bogs, and swamps exist because of poor subsurface drainage and further limit mobility. Figure 1-5 shows images of boreal forests during winter and summer to display the distinct difference the seasons have on the terrain.

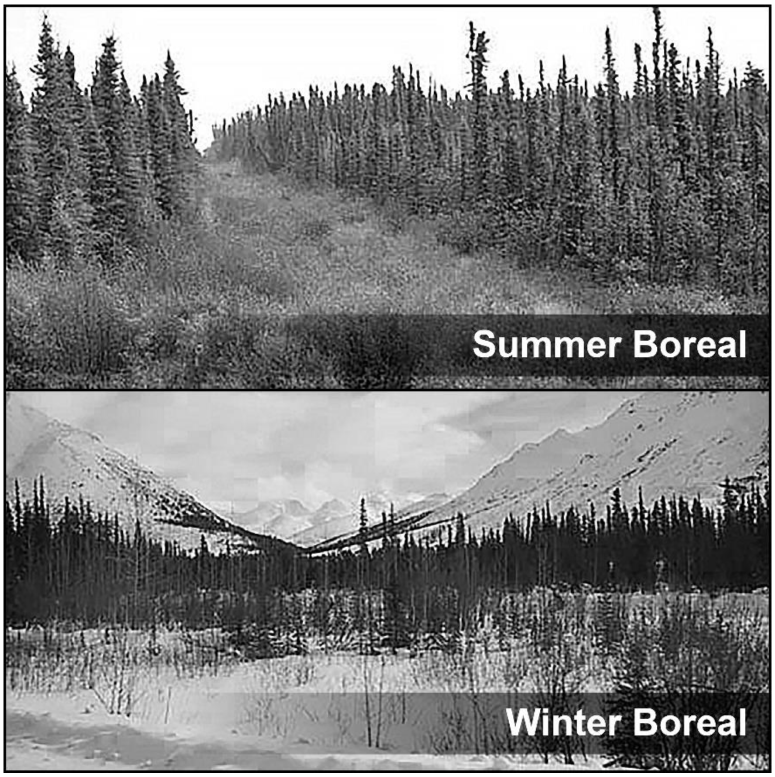

Figure 1-5. Boreal terrain in winter and summer

LAND CHARACTERISTICS

1-33. Throughout the terrain regions, variations in landforms, slope, relief, and roughness affect cross-country mobility of both Soldiers/Marines and equipment. Variations in land characteristics may also affect sensors, artillery effectiveness, communications, concealment, and detectability. Some prevalent land characteristics that heavily impact terrain and ground conditions in the Arctic are—

- Snow cover.
- Ice cover.
- Mountain ranges.
- Permafrost.
- Muskeg.
- Tussocks.
- Pingos.

Snow Cover

1-34. Snow cover is the most prominent terrain feature of the arctic winter. It can reduce mobility and leave tracks that reveal unit positions of troops lacking proper equipment and training. However, snow can also enhance the movement of troops suitably equipped and trained.

1-35. Snow cover varies in consistency, depth, and density. These conditions greatly affect specialty equipment and techniques required to traverse snow cover effectively but can be difficult to estimate.

1-36. See Table 1-1 for the five categories of snow based on water content by volume present in the snow.

Table 1-1. Categories of snow based on water content by volume

Name	*Volume*	*Description*
Dry	0 percent water content by volume	Temperature is usually below 32 °F. Snow grains have little ability to adhere to one another when compressed. It is difficult to make a snowball.
Moist	less than 3 percent water content by volume	Temperatures are typically near 32 °F. Snow tends to stick together when compressed, but liquid water is not visible even with a hand lens.
Wet	3 to 8 percent water content by volume	Snow temperature is 32 °F. This snow adheres well with moderate pressure and is the perfect snow for making snowballs.
Very wet	8 to 15 percent water content by volume	Water can be squeezed out with moderate pressure, but the snow matrix still contains a considerable amount of air.
Slush	more than 15 percent water content by volume	The snow is saturated with water and contains only isolated air bubbles. Cohesion is minimal and actually increases as water is pressed out. Water drips freely from sample.

1-37. There are five categories of snow density (very soft, soft, medium, hard, and very hard). Density can be calculated from a weighed sample of known volume, or by electrical methods. However, the hand hardness test explained below provides quick means to estimate snow density. See Table 1-2 for snow density. For more information on the effects of snow depth and density on mobility, see Appendix B.

Table 1-2. Snow density

Name	*Durability*	*Trafficability*
Very Soft	Snow can be broken with a fist.	Low resistance and more trafficable as long as the snow depth does not exceed vehicle limitations.
Soft	Snow cannot be broken with a fist but can be broken with four fingers held together with an open palm.	Mild resistance and more trafficable as long as the snow depth does not exceed vehicle limitations.
Medium	Snow cannot be broken with four fingers held together with an open palm but can be broken with one finger.	Somewhat trafficable. Very light vehicles can ride on top of the snow with good trafficability, but most vehicles will sink and be met with high resistance.
Hard	Snow cannot be broken with one finger but can be broken with a thin pointed wooden object such as a pencil.	Trafficable. Some vehicles can ride on top of hard snow with good trafficability. Very heavy vehicles with high ground pressure will sink into hard snow and lose trafficability.
Very Hard	Snow cannot be broken with a pencil but can be broken with a sharp metal object such as a knife.	Very trafficable. Unarmored vehicles can ride on top of very hard snow. Vehicles riding atop snow may have less traction than normal and be prone to sliding.

1-38. Areas may require advance reconnaissance to determine the feasibility of movement over different snow types. Troops use a combination of individual observation, unmanned aircraft systems (UASs), satellite imagery, and ground instrumentation to construct a snow analysis. In areas of operations that have limited shared environmental information, forward reconnaissance becomes critical before movement.

1-39. Warmer coastal regions present different challenges. Warmer coastal regions have wet snow. Interior regions have dry snow. Wet dense snow can support an individual Soldier/Marine and heavier ruck on snowshoes, whereas the weight of an average Soldier/Marine and ruck will sink on snowshoes in dry, uncompacted snow. This emphasizes the need for deliberate environmental assessment.

1-40. Freezing and thawing of off-road surfaces can impede mobility, creating ice-covered and muddy surfaces. For more information on the effects of freeze and thaw on mobility, see the discussion beginning with paragraph B-17.

1-41. Engineer estimates of structural capacities must consider the snow load (weight of the snow on a surface or structure).

Ice Lenses and Crusts

1-42. Ice lenses (clear ice layers) and crusts (mixed ice layers) form when the snow surface melts (from the sun, ambient temperature, or rain) and refreezes. Ice lenses and crusts may be visible on the snow surface or buried under additional layers of snow. For most manned vehicles in seasonal snow covers, crusts and lenses typically reduce mobility. Often a vehicle requires more force to break the crust or ice layer under its wheels, control arms, or other vehicle components that interact with the layer. Furthermore, ice lenses can make foot travel difficult without snowshoes or skis as the ice layer intermittently breaks underfoot and then scrapes against feet and legs. However, for low ground pressure, over-snow, or small unmanned vehicles, ice or compacted snow layers can increase the mobility by providing a support layer allowing the vehicle to float over the snowpack.

Snow Drift

1-43. Snow drifts are piles of snow accumulated by blowing snow. Snowdrifts have both advantages and disadvantages on the battlefield. Snow fills in ditches and vehicle tracks. On rolling ground, snow tends to flatten the terrain. This drifting can negatively impact navigation by obscuring creek beds, trails, and some roads. One wind event can make a prominent trail disappear overnight. Main supply routes will require much maintenance.

1-44. The wind builds up snowdrifts and can change the contour of the ground a great deal. Leaders must continually study snow-covered terrain and use every feature. On the downwind side of every obstacle, tree, house, and bush, a hollow always exists. This hollow can provide an observation point or firing position.

1-45. The wind, particularly in open areas, may form long wavy snowdrifts, called sastrugi, that are almost natural snow trenches (see Figure 1-6 for sastrugi). Some sastrugi will be 1-foot (one-third meter) deep channels, but most are small surface ripples. The snow is usually very hard, and the walking surface is greatly improved. When deep enough, Soldiers/Marines use them as an approach to an objective.

Figure 1-6. Sastrugi

Avalanches

1-46. Snow avalanches present a natural hazard in mountainous areas. A snow avalanche occurs when a mass of snow, ice, and incorporated debris slides down a slope at high speed. Avalanche formation is a complex interaction among terrain, snowpack, and meteorological conditions and is difficult to predict in space and time. If possible, troops avoid areas where avalanches are possible. Such areas include areas with significant snow and unstable temperatures, or where there is evidence of existing slides. (For more information on avalanche safety, see paragraph 4-11.)

Ice Cover

1-47. Frozen rivers, lakes, and swamps turn bodies of water into terrain features that aid movement and operations. Ice covered rivers are considered key terrain because they can greatly increase vehicle, troop, and aircraft mobility in the winter. Units must beware of dangerous overflow, which are cracks caused by water pressure, which compromise the ice's stability.

Ice Thickness

1-48. Ice thickness is a commander's critical information requirement in the Arctic. Ice thickness determines safe travel over frozen water sources. (See Appendix C for information on calculating safe ice thickness for operations.)

DANGER

Failure to determine safe ice thickness for travel can result in severe injury or death.

1-49. Soldiers/Marines never venture out onto a frozen body of water without asking and confirming each of the following questions are negative:

- Are there signs of low spots or previous collapse? (Stop and look to the far side.)
- If the far bank is visible, is there frost on the trees in spots?
- Can water be heard running under the ice?
- Does the ice sound hollow? (Ski pole testing)

1-50. Leaders must pay particular attention to ice thickness during seasons of ice thaw and freeze. During thaw periods, ice becomes increasingly weaker. During freeze periods, ice can take several weeks before it becomes thick enough to support troops and vehicles. Ice bearing capacity is affected by many variables. Variables can include the following:

- Ice thickness, temperature, and quality.
- Snow cover.
- Type, speed, spacing, and number of repetitions of moving loads.
- Length of time of stationary loading.
- Depth of water.
- Presence of open cracks or zones of pressure buckling.
- Presence of springs, seepage inflow, and currents.

Overflow Ice

1-51. Overflow ice occurs when a layer of ice ruptures and water underneath flows up through the surface. Two conditions must exist for overflow ice to occur. First, temperatures must be below 32 °F, causing the water source to freeze from the top down. Second, subsurface water must be under pressure. If the water under the layer of ice is under pressure, the water forces its way through the ice and flows on top of it.

1-52. Overflow ice is difficult to detect and can occur throughout the winter despite extremely cold temperatures. Ice can rupture and refreeze many times, forming layer upon layer of ice, creating obstacles along roadways and frozen rivers. However, the presence of overflow ice may be given away by gray colored snow (as seen in Figure 1-7) or vapor rising through the snow (as seen in Figure 1-8).

Figure 1-7. Overflow ice

Figure 1-8. Open water vapor

1-53. Another means of detecting overflow ice is by the presence of surface hoar (as seen in Figure 1-9). Surface hoar are flakey ice structures that often resemble flowers and form as a result of water vapor freezing on top of a recently refrozen hole in the ice.

Figure 1-9. Surface hoar

Glaciers

1-54. A glacier is a mass of snow and ice that moves under the influence of gravity out over the land from an area of perennial snow, which is its source or head. Glaciers may be classified as one of three main types: valley, piedmont, or continental. A valley glacier (also called a mountain glacier) is an ice stream that flows from a snowfield down a steep-walled mountain valley. The merging of several valley glaciers at the foot of a mountain forms a piedmont glacier. Continental glaciers (also called ice sheets) are found only at high latitudes and cover vast areas. For example, Greenland is covered by such a glacier.

1-55. The flow or movement of glaciers is caused by gravity. Glaciers glide over a layer of meltwater between the underside of the glacier and the surface of the Earth. Glaciers and polar icecaps cover 10 percent of the Earth's surface. Alaska contains two percent of the total glaciers. Typically, glaciers occur in mountainous regions of the subarctic and temperate areas. Glaciers are the highway into the mountains and can be safer and easier to negotiate than the surrounding ridges and peaks. However, glaciers are dangerous if Soldiers and Marines are not familiar with the unique terrain found in this environment. Soldiers and Marines require specialized training and equipment to traverse and negotiate over and around crevasses and ice falls. Figure 1-10 shows an image of a glacier.

Figure 1-10. Glacier

Ice Crevasses

1-56. Ice crevasses are fractures, or deep cracks, in an ice sheet or glacier that form from the failure of ice under tension or shear forces generated by two semirigid pieces moving at different rates (see Figure 1-11 for a crevasse). In some places, crevasses are buried and covered with snow and therefore are not visible. Crevasses are significant safety hazards to both vehicles and personnel. Airborne- and ground-based radar can detect buried crevasses. Units can use optical remote-sensing data to identify the surface crevasse features and surface roughness.

Figure 1-11. Crevasse

Mountain Ranges

1-57. Mountain ranges exist throughout the Arctic and subarctic primarily in Alaska, the Scandinavian Peninsula, Eastern Russia, Greenland, and other North American Arctic Islands as noted in Figure 1-12. Commanders operating in these mountain regions and upper elevations of the world's high mountains are often confronted with vast glaciated areas. Snow can pose a serious threat to troops not properly trained and equipped for movement under such conditions. Massive glaciers can bury valleys in these areas and present additional hazards such as hidden crevasses and ice. Steep, snow-covered terrain presents the risk of snow avalanches as well. Avalanches have taken the lives of more troops engaged in mountain warfare than all other terrain hazards combined. Slope reconnaissance for avalanche risk is paramount to success. Additionally, snow-covered crevasses pose hidden, potentially fatal falling hazards. Some snow conditions aid travel by covering rough terrain with a consistent surface. Deep snow, however, impedes movement and requires troops to be well trained in using snowshoes, skis, and over-the-snow vehicles.

1-58. The mountain slopes of these peaks are often glaciated, and their surfaces comprise varying combinations of rock, snow, and ice. Although glaciers have peculiar hazards requiring special training and equipment, dismounted movement over valley glaciers may be the safest route through these areas. (For more information on mountain operations, see ATP 3-90.97, MCTP 12-10A, and MCRP 12-10A.1.)

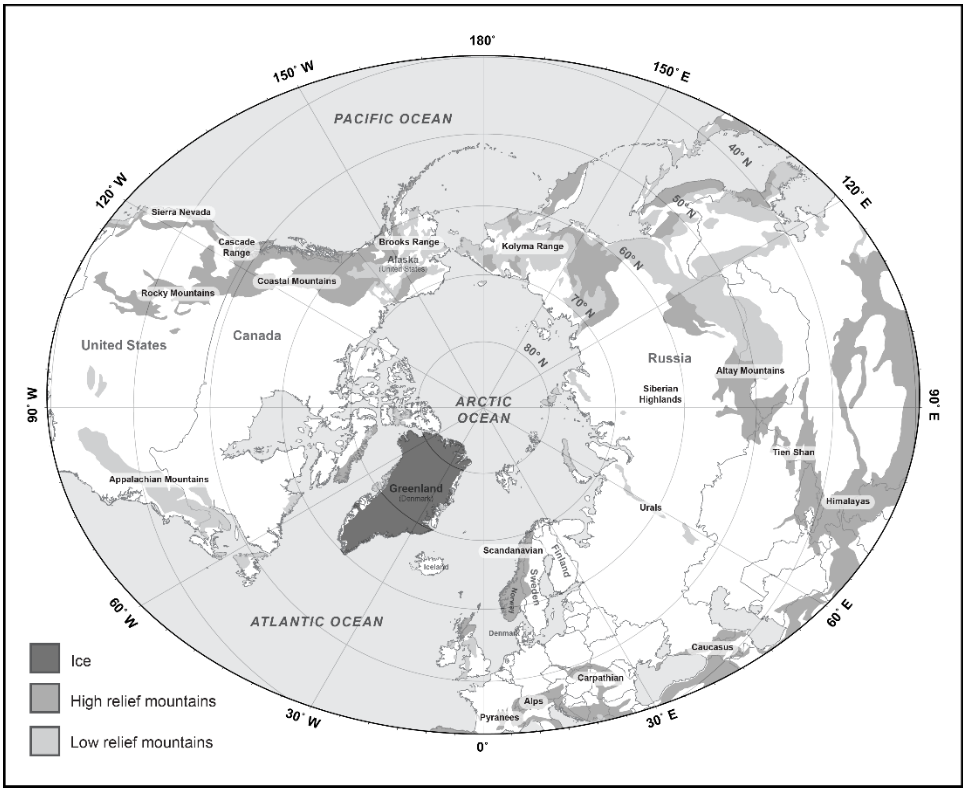

Figure 1-12. Mountain regions

Wildland Fires

1-59. In the summer season in forested areas, wildland fires commonly occur in the Arctic. Such fires can start from natural events such as droughts, heatwaves, and lightning strikes. Naturally occurring fires occur more often as climate change increases the potential season for wildland fires. Subsurface dry duff can also fuel the fires and can cause fires to spread rapidly in windy conditions. More often, wildland fires are sparked by human activity such as hot vehicle exhaust, artillery explosions, tracer rounds, and carelessness. Troops must take additional precautions with heat sources and munitions to avoid accidental fires. Wildland fires can spread rapidly and endanger troops and civilians with flames and smoke. Smoke may also limit aviation and surveillance operations due to low visibility and can also cause respiratory health problems from inhalation. Military units often provide defense support to civil authorities to assist with firefighting in Arctic regions.

Permafrost

1-60. Permafrost is perpetually frozen ground that does not thaw. It occurs when ground temperature is below 32 °F for two or more years, with some areas being frozen for thousands of years. The thickness of permafrost varies from a few feet to over a thousand feet in depth. In the summer, subsurface soil remains frozen, but upper layers can thaw and saturate the ground. The permafrost below prevents the moisture from draining and creates muddy or boggy conditions that limit mobility.

1-61. There are three main types of permafrost regions—continuous, discontinuous, and sporadic. Continuous permafrost regions are characterized by nearly uninterrupted frozen ground, covering 90 to 100 percent of the area and typically occurring in the coldest parts of the Arctic. Discontinuous permafrost regions consist of a mix of frozen and unfrozen ground, covering 50 to 90 percent of the area, and are common in the subarctic. Sporadic permafrost regions cover less than 50 percent of the area and feature isolated patches of permafrost influenced by local factors such as vegetation and topography. (See Figure 1-13 for examples of permafrost types.)

1-62. In areas where permafrost is present, Soldiers/Marines may have to build fighting positions above ground. Additionally, any dug-in fighting positions, including individual to tank hull down, will turn into mud pits during the summer. Even in winter, heat sources, such as those from vehicles, will likely thaw enough soil to create a mud pit or quagmire.

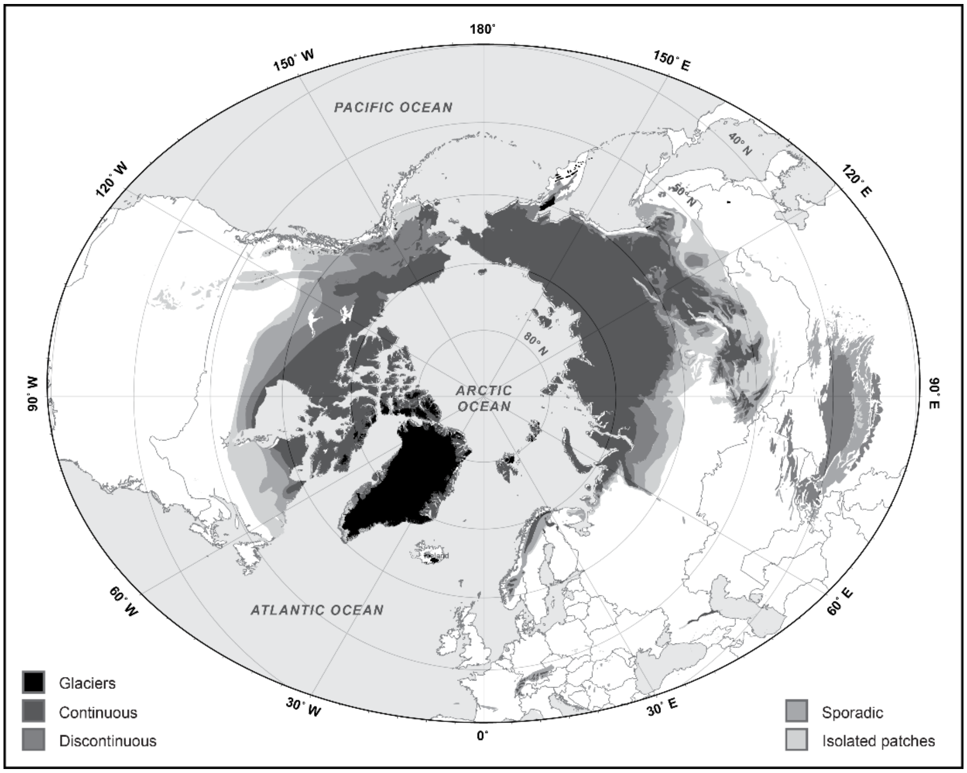

Figure 1-13. Extent of various types of permafrost

Frost Heaves and Thaw Weakening

1-63. Roads in permafrost regions typically require continuous maintenance. Water under roadways creates frost heaves when it expands during the freezing process. Frost heaves can warp roads and create an uneven driving surface. This action damages the wear surface and requires repair. During spring and intermittent warm spells, thawing results in settlement of the subgrade (known as thaw weakening). Thaw weakening can create ruts, surface cracks, and destabilized roads. (See Figure 1-14 for examples of road damage caused by frost heaves and thaw weakening.) Commanders consider the load-bearing capacity of roads and infrastructure in permafrost regions and the potential risks they pose to heavy equipment. During crisis or armed conflict, troops may need to divert engineer assets to maintain roadways in spring and summer to allow for continuous use.

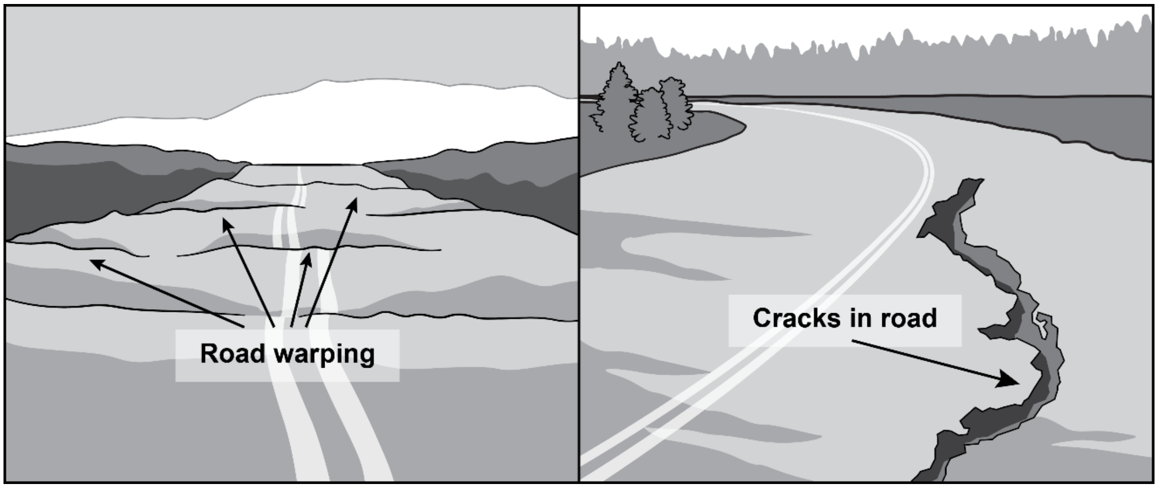

Figure 1-14. Frost heave and thaw weakening road damage

Thermokarst

1-64. Thermokarst is a broadly used term to denote pitted surfaces that form as a result of the melting of permafrost ground ice. These irregularly shaped landforms can form large craters, linear pits, and other types of depressions that pose a significant hazard to both personnel and vehicles. The time it takes for thermokarst to form is unpredictable. Landforms can emerge as quickly as one summer, but can also take multiple years to develop. (See Figure 1-15 for an illustration of thermokarst.) Over time these pits can form thermokarst lakes. (See Figure 1-16 for an image of thermokarst lakes.) Leaders must be cautious of thermokarst, especially when moving under limited visibility conditions.

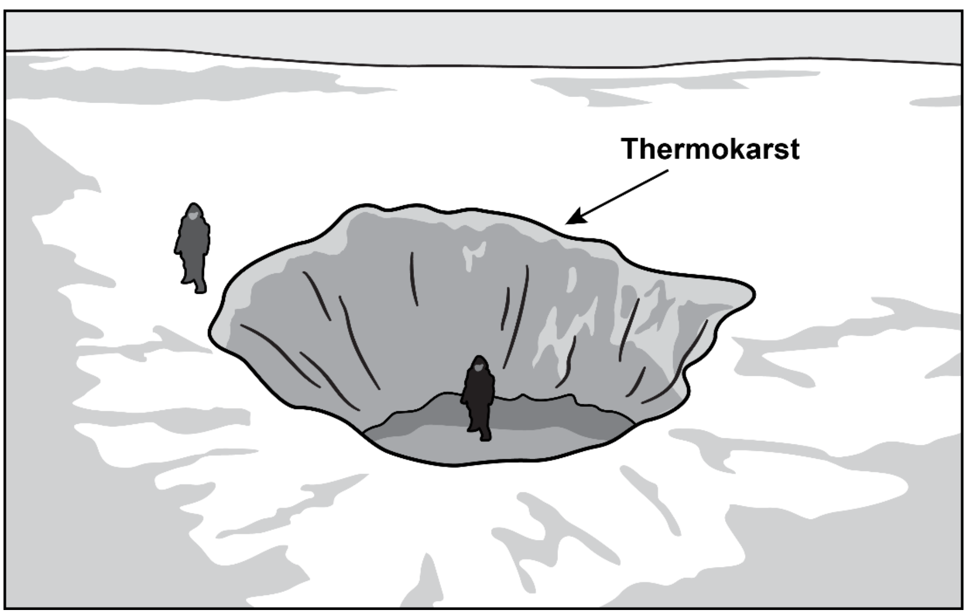

Figure 1-15. Thermokarst

Figure 1-16. Thermokarst lakes

Muskeg

1-65. Muskeg is a type of bog or wetland found in poorly drained areas on top of permafrost. In warm months, helicopters landing or vehicles moving over muskeg can become deeply stuck. Vehicles should proceed carefully through areas with muskeg or avoid them altogether if possible. Specially designed vehicles with low ground pressure are recommended. Such over-snow or small robotic vehicles can traverse weak organic soils without issue. Figure 1-17 shows images of aircraft and large vehicles stuck in muskeg.

1-66. Muskeg develops in areas with abundant rainfall and cool summers. Trapped by underlying permafrost, water moves little or not at all creating muddy, swamp-like conditions. Its presence increases the need for dedicated recovery assets and requires vehicles to have self- and like-recovery equipment such as winches, tow-straps, and towbars.

1-67. Muskeg also poses a threat to dismounted troop movements. It can act like quicksand when Soldiers/Marines fall into it. It can also form under a layer of vegetation, which can feel like walking on a waterbed. These are particularly dangerous as they can engulf whole squads when the weight of the combined individuals exceeds the holding capacity of the vegetation layer.

1-68. In colder months, muskeg becomes frozen solid and can be traversed. However, caution should be taken during early and late winter when the ground is only partially frozen, and these areas are more difficult to detect. Potential signs of muskeg include when black spruce (mainly in the subarctic), sphagnum moss, and sedges grow in abundance. Typically, the ground is soft and spongy, or it can be a vast shallow swamp.

Figure 1-17. Muskeg

Note. In Figure 1-17, the OH-58 Kiowa helicopter landed on the Fort Wainwright, Alaska, land navigation course during the summer months and became stuck. The aircraft had to be left until the winter to allow the ground to freeze sufficiently to bring in heavy recovery equipment.

Tussocks

1-69. Tussocks are uneven clumps of grass that are abundant in tundra. Tussocks create an extremely rough walking surface that can slow movement, pose a tripping hazard, or cause lower leg injuries. Figure 1-18 displays several groupings of tussocks.

Figure 1-18. Tussocks

Pingos

1-70. A pingo is a cone-shaped mound made by ice intrusions that occur throughout the tundra (see Figure 1-19 for a pingo). Units can use these small terrain features as cover and concealment in otherwise open terrain.

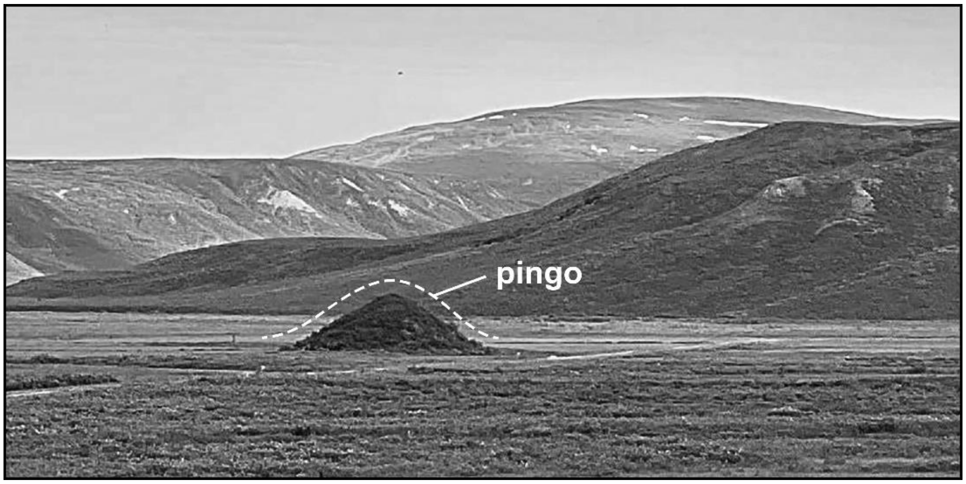

Figure 1-19. Pingo

Eskers

1-71. An esker is a long, winding ridge formed after glaciers recede (see Figure 1-20 for an esker). Eskers can hinder mobility but offer cover and concealment. They are usually tall enough to give an advantage, but short enough to not be shown by the contour interval on a 1:50,000 map. The sides are generally quite steep, and the sand and gravel can create problems for tanks and similar vehicles. The tops are typically the easiest area to travel. Roads through these areas are mostly built on top of eskers. The lands around them often have many small kettle lakes that can range in size from a half-acre up to several acres. These areas can be fantastic areas for a deliberate defense if they are oriented in the correct direction.

Figure 1-20. Esker

WATER CHARACTERISTICS

1-72. Water features are a major consideration in the Arctic that can constitute either an obstacle or an aid to movement. Water features are separated into two categories:

- Saltwater.
- Freshwater.

Saltwater

1-73. Oceans and seas consist of saltwater. In the Arctic, these include the Arctic Ocean, the Beaufort Sea, the Chukchi Sea, the East Siberian Sea, the Laptev Sea, the Kara Sea, the Barents Sea, the Greenland Sea, the Norwegian Sea, the Bering Sea, and the Baffin Bay. (See paragraph 2-9 for installations and major bodies of water.) Since the maritime domain heavily dominates the Arctic, commanders must consider ocean trafficability in any land-based operation close to shore or supported over water.

Sea Ice

1-74. Sea ice can significantly impact naval support to land operations including resupply, naval indirect fire support, or equipment or personnel transportation. Sea ice forms when ocean water freezes. Because the oceans are salty, the water freezes at approximately 29 °F (-1 °C), depending on the salinity level. During winter months, sea ice makes large portions of the Arctic impassable. Even during summer months, when the Arctic Ocean is considered "ice free," residual ice floes can hinder naval watercraft. Forms of sea ice include fast ice, pack ice, and icebergs.

1-75. Fast ice forms and remains fast or attached along the coast. It may attach to the shore, to an ice wall, to an ice front, between shoals, or between grounded ice floes. It may form in place from water or by floating ice of any age that freezes to shore. It can extend a few meters or several hundred kilometers from the coast. It may be more than one year old (old, second-year, or multiyear). Vertical fluctuations may be observed during changes in sea level. If higher than 2 meters above sea level, it is called an ice shelf.

1-76. Pack ice, also referred to as icepack or pack, are free-floating bodies of ice on the Arctic Ocean and adjacent seas. Pack ice varies in size and can be large and thick enough to support temporary military activities including austere airfield operations and camps. However, like ice cap regions, pack ice operations require significant sustainment planning to achieve and carry a higher degree of risk. Figure 1-21 shows a skiway insertion on pack ice. Pack ice is affected by weather and can become unstable. Commanders must strongly implement risk mitigation controls on pack ice and limit the duration of operations based on weather conditions.

Figure 1-21. Pack ice operations

1-77. Icebergs are large pieces of ice that break off, or calve, from ice shelves or glaciers and drift into the ocean. Formed from compacted snow, icebergs are composed of freshwater. These floating ice masses pose significant hazards to maritime navigation. While large icebergs can be detected visually or with radar under calm sea conditions and clear visibility, approximately 90 percent of an iceberg's mass is submerged below the waterline, making detection challenging. Smaller icebergs, known as 'bergy bits' or 'growlers,' are particularly difficult to detect and avoid due to their size. Icebergs are common in some areas of the Arctic, such as the waters around Greenland and parts of the Canadian Arctic Archipelago but are generally absent from areas like the arctic coast of Alaska.

Coasts

1-78. In maritime and coastal areas, the air is predominantly wet-cold. Long snow-covered seasons allow increased reflected radiation from the land surface surrounding a cold coastline. This loss of radiation produces temperatures that are cooler in the cold coastal regions. Winter winds cause extremely rough seas that create dangerous windchill and hide obstructions in whitewash and radar noise.

1-79. Coastal tundra regions are susceptible to fog and cold onshore air. Vegetation consists of grasses, sedges, lichens, and willow shrubs. The coastal plains of the tundra have numerous lakes formed by melting groundwater. The coastal areas that are part of and surround the boreal forest climate are wet-cold, extremely stormy, and dangerous.

1-80. Some coastal areas have beaches, while others do not. In the fjords of Scandinavia and Canada, the coastal regions have cliffs rather than beaches. Areas available for amphibious operations are very few since the cliffs go straight into the water. Ascending these cliffs requires specially trained mountaineers.

Freshwater

1-81. Freshwater sources such as rivers, streams, lakes, and canals are abundant in the Arctic. These sources can serve as an asset or obstacle depending on the season and training of a unit. Frozen rivers, for instance, can serve as fast avenues of advance through boreal forests and are considered key terrain. However, units that use ice rivers as an avenue of approach must also plan to travel significant additional distance to account for the meandering path rivers take.

1-82. During warm seasons, rivers and lakes become obstacles in the form of wet-gap crossings or hazards in the form of thin ice. However, if waterways are deep enough and units are well-trained and equipped for riverine operations, then rivers can become LOCs and avenues of approach for watercraft. Many streams are glacier-fed and carry great volumes of water in the summer. Careful reconnaissance is required as the location of their main channel often changes from year to year. Figure 1-22 shows images of rivers during winter and summer to display the distinct difference the seasons have on arctic inland waterways.

Figure 1-22. Ice covered versus thawed river

1-83. During the winter, ice surfaces can often be extremely valuable as aircraft landing areas or as smooth, obstruction-free surfaces for ground transportation. In some instances, drift snow may make ice surfaces uneven and require additional engineer support to facilitate aircraft. Additionally, ice covered water can be broken up by explosives to create an obstacle and delay troop movement. (For more information on ice cover and ice thickness considerations, see Appendix C.)

NAVIGATION

1-84. Navigation in the Arctic is difficult because of unique space and cyberspace domain considerations. Solar weather, limited satellite coverage, or enemy actions can frequently disable navigation technology in the Arctic. Because of this, Soldiers/Marines must be well versed in the fundamentals of navigation with compass, maps, pace count, and odometer readings.

1-85. Compass navigation challenges troops in the Arctic. The declination of true north and magnetic north is significantly increased, making the margin of error much higher. Above 84°N, Soldiers and Marines must use universal polar stereograph maps instead of universal transverse Mercator maps. Magnetic storms can affect compass readings. Significant ferrous metal deposits can also skew compass readings. Pace count changes at different depths of snow or muskeg and can lead to miscalculations. The combined effect of these challenges can lead units far off their intended destination. This is especially true in the tundra, where few distinguishable terrain features exist.

1-86. Astronavigation (navigation by the stars) can be used to verify electronic or compass navigation, especially during long periods of darkness. Well-trained personnel can also use astronavigation as a reliable primary means of navigation.

1-87. Occasionally, maps may be unreliable or even nonexistent, especially during spring thaw periods when unexpected rivers and streams may emerge. In these instances, troops can use aerial photography as a source of timely terrain information to supplement maps.

1-88. Another challenge to map reading occurs from maps that view the globe from left to right (known as Mercator maps). These maps place North America in the West and Asia in the East but skew the size and distance of arctic geography and misrepresent proximity. For larger strategic planning, it can be helpful to use arctic maps with a North Pole stereographic (top-down) view of the globe. Figure 1-23 shows the difference between the two types of maps.

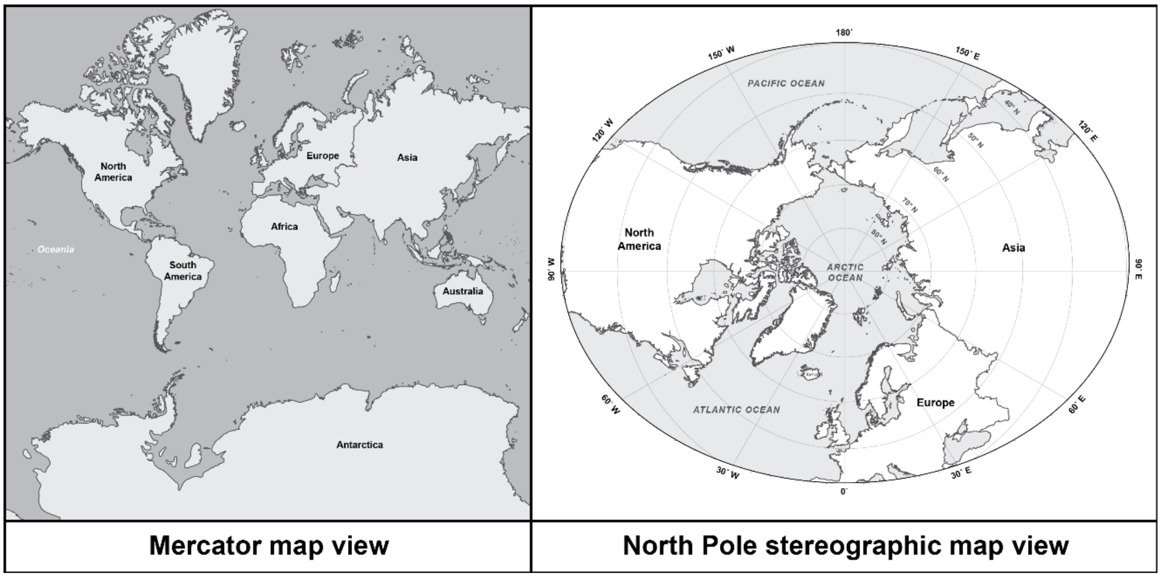

Figure 1-23. Mercator versus North Pole stereographic maps views

WEATHER

1-89. The extremes of arctic weather strongly impact all factors of an OE and shape operations—perhaps more so than any other environment. Arctic storms tend to be fast-moving and violent and can hinder or kill those who are unprepared. Units must be prepared to self-sustain for several days during and after a storm. Additionally, many weather phenomena exist only in the Arctic. Relative advantages for Soldiers and Marines come from integration with the staff weather officer (SWO)/meteorology and oceanography (METOC) officer, who enhances weather interpretation and assigns tactical meaning to it. However, Soldiers and Marines should not solely rely on the SWO/METOC. They must also be familiar with arctic weather patterns in the event they become isolated without reliable communications and cannot receive weather and intelligence updates from analysts.

Note. For all mentions of temperature, see Appendix A for conversions.

TEMPERATURE

1-90. The Arctic is characterized by its extreme cold temperatures, which can average below -50 °F in some regions. In Siberia, the lowest recorded temperature was -90 °F. Preparation for the cold is an absolute necessity. The effects on personnel and equipment can be lethal. Below -40 °F, exposed skin can freeze in under a minute; metal becomes brittle and can break; and fuel and other liquids can freeze, cause contact frostbite, or impair equipment operations. Cold weather will affect electronics and batteries, which are essential for normal operations.

1-91. Even in the height of summer months, units remain prepared for winter-like conditions. This is especially true in damp-muddy regions. These regions suffer the effects of cold water mixed with temperatures at or below 50 °F. Such an event can cause cold-weather injuries such as trench foot.

1-92. An understanding of temperature trends is imperative to planning. As a rule, the higher the latitude, the colder the region is, but this is not always the case. The Scandinavian Peninsula, for example, is greatly affected by warm ocean air and enjoys more moderate subarctic temperatures despite being in the Arctic Circle. Additionally, elevation also greatly affects temperature. The general rule is for every 1,000 feet of elevation gained, the temperature decreases by 3 °F to 5 °F.

Cold Temperature Zones

1-93. There are five zones of cold temperatures. Most zones have an immediate if not secondary effect on visibility, mobility, and survivability. See Table 1-3 for the zones. See Appendix A for temperature conversions.

Table 1-3. Five zones of cold temperatures

Zone	*Description*	*Temperature range*
Temperature zone 1	Wet cold	39 °F to 20 °F
Temperature zone 2	Dry cold	19 °F to -4 °F
Temperature zone 3	Intense cold	-5 °F to -24 °F
Temperature zone 4	Extreme cold	-25 °F to -40 °F
Temperature zone 5	Hazardous cold	Below -40 °F
F Fahrenheit		

Temperature Zone 1

1-94. Wet cold conditions pose greater risks to troops and equipment than dry cold environments. Wet snow and rain create slushy, muddy ground, and perpetually wet clothing and equipment. Water conducts heat 25 times faster than air, leading to core body temperature drops when troops are wet and exposed to wind. Proper equipment, training, and leadership are crucial to prevent weather-related casualties. Wet cold, combined with wind, can cause hypothermia, frostbite, and trench foot (See Appendix D for more information on hypothermia, frostbite, and trench foot). These conditions occur in various environments during seasonal transitions, and planning becomes problematic due to freezing and thawing cycles.

Temperature Zone 2

1-95. Dry cold conditions are easier to endure than wet cold conditions. Proper equipment, training, and leadership remain critical. Windchill is a factor. Low humidity and frozen ground make survival more manageable. Precipitation is primarily dry snow, and the absence of thawing and freezing cycles reduces how dry cold conditions impact personnel and equipment.

Temperature Zone 3

1-96. Intense cold affects both mind and body. Simple tasks become slower and require more effort than in warmer temperatures, leading to decreased work quality and attention to detail. Bulkier clothing reduces dexterity. Commanders consider these factors when planning operations and assigning tasks.

Temperature Zone 4

1-97. Extreme cold presents a paramount survival challenge. Individuals often prioritize physical comfort, withdrawing into themselves. Leaders anticipate and plan for potential failures of weapons, vehicles, and munitions. Leadership, training, and specialized equipment for extreme cold conditions are crucial for successful operations.

Temperature Zone 5

1-98. Engaging in operations below -40 °F carries greater risk, and commanders and planners assume increased responsibility. The ability to conduct operations is diminished significantly. Equipment breakage occurs more frequently. Logistics expenditures are high. Soldiers and Marines are at much higher risk for environmental injuries. Units undergo extensive training before undertaking operations in such extreme temperatures.

Freeze-Thaw Cycles

1-99. Changes in temperature transform the arctic environment and terrain. Temperatures below 32 °F will freeze the landscape and water. Temperatures above 32 °F will thaw landscape, snow, and ice. Leaders must be especially aware of temperatures around 32 °F, which create transitional periods where tactical considerations shift with the changing landscape. For instance, freezing and thawing of off-road surfaces can impede mobility, creating ice-covered and muddy surfaces. Freeze-thaw periods also cause material to expand and contract. This places great stress on susceptible equipment components. Leaders plan for increased potential of maintenance issues during these times.

1-100. During freeze-thaw periods around 32 °F, equipment is at risk of being frozen to the ground as it sinks into mud during the day and then freezes in the evening. This includes tents, vehicles, and even aircraft. Units need to place equipment on some form of barrier, such as pallets or tree branches that provide insulation and prevent freezing. If soil or snow has thawed during the day, it usually freezes at night making movement easier but noisier than by day. During the spring thaw, daytime thawing usually restricts the use of roads to night hours.

Temperature Inversion

1-101. Temperature inversions are very prevalent in the polar regions. These occur when cold air settles towards low ground and a layer of warm air rests on top of it. This causes temperatures to warm with altitude, versus normally cooling with altitude. In mountainous areas, the general rule is for every 1,000 feet of elevation gained, the temperature decreases by 3° F to 5° F. Inversions typically form with calm winds and clear skies. They intensify during winter months under areas of arctic high pressure that can last for days. Expect inversions to occur in larger river valleys and bigger lakes. They can be several hundred meters high and experience as much as 59 °F temperature differences between layers. It may be advantageous to operate above the inversion level where temperatures are warmer.

1-102. Temperature inversions have visual effects. Troops can see an inversion from a position of height. A valley that is full of what appears to be a cloud or fogbank has an inversion taking place. Temperature inversions can reduce visibility by trapping pollutants and water vapor closer to the surface. They also cause sound and shockwaves to travel much farther near the surface due to refraction, which can also affect targeting and communications systems. However, inversions can be taken advantage of as well. As little as a 1,000-foot elevation gain can put a unit into a warmer area.

1-103. Temperature inversion is important to consider during operations because of the potential for other weather hazards it creates. These include:

- Looming.
- Freezing rain (see paragraph 1-131).
- Icing (see paragraph 1-144).

Looming, also known as Fata Morgana, is an optical illusion that causes objects to appear larger or sometimes float over ice or cold water (see Figure 1-24 for looming). It is caused by light rays passing through warm and cool portions of temperature inversions at different speeds, thus warping the image received by the human eye. Soldiers and Marines must be cautious of looming effects. Even small visual looming can cause miscalculations in distance and targeting.

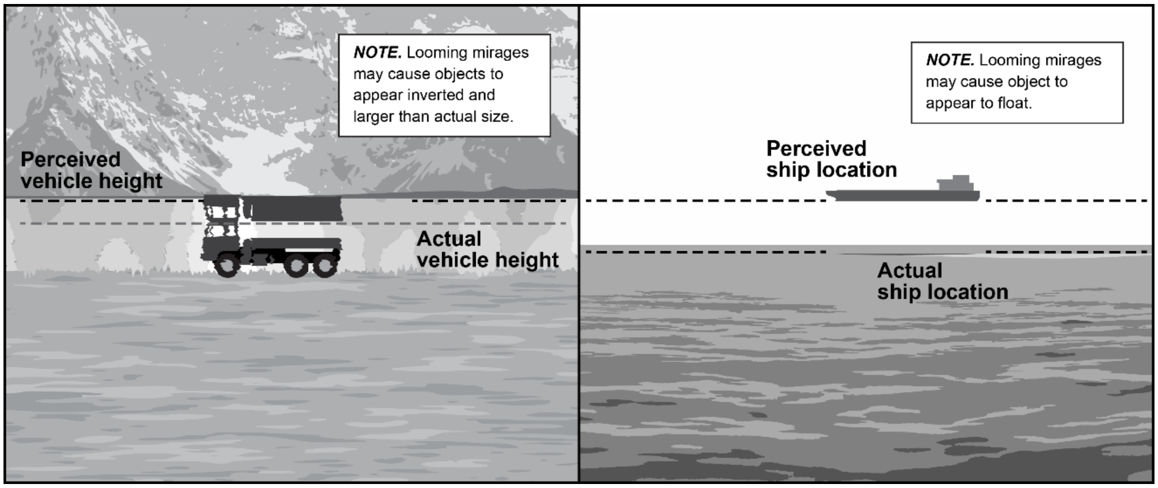

Figure 1-24. Looming

WIND

1-104. In many parts of the Arctic and subarctic, surface winds may normally be fairly low. However, in areas near seacoasts and mountains, strong winds may be quite common and wind speeds can attain hurricane velocities. For example, winter wind gusts of 130 miles per hour have been reported in Kotzebue, Alaska. See Appendix A for distance conversions.

1-105. In the summer months, the area immediately adjacent to a glacier or large snowfield can experience colder temperatures due to the flow of cold dense air downslope (katabatic winds).

1-106. Leaders must consider high wind areas when selecting sites for operations and understand that—

- In high mountains, the ridges and passes are generally windy and seldom calm.
- Normally, wind velocity increases with altitude and is intensified by mountainous terrain.
- Wind speed increases when winds are forced over ridges and peaks (orographic uplift) or when they funnel through narrowing mountain valleys, passes, and canyons (Venturi effect).
- Wind blows with greatest force on an exposed mountainside, the military crest of a ridge on the windward side and summits.
- Protected valleys rarely have strong wind.
- Valley outlets carry higher tendencies for strong winds. Winds in the morning tend to blow upslope due to warming (valley breeze), while winds in the evening tend to blow downslope due to cooling (mountain breeze).
- Persistent wind over tundra sinters and hardens snow and provides a more solid base to maneuver for wheeled vehicles.

1-107. Wind has a variety of tactical implications. It can amplify effects of the cold, carry sound, cover tracks, affect visibility, and slow movement. The Arctic has the following weather conditions produced by wind:

- Windchill.
- Ground blizzard.
- White out.
- Chinook winds.
- Sound-refraction.
- Snow drift (see paragraph 1-43).

Windchill

1-108. Windchill dramatically amplifies the effects of cold temperatures. In addition, movement in a vehicle, momentum from free-fall parachutists, and operations in and around helicopters also create wind. Any wind can exponentially increase windchill. Commanders must consider windchill and its effect on Soldier/Marine safety and operations (see Table 1-4). See Table 1-5 for potential frostbite considerations.

Table 1-4. Windchill chart

		Air temperature in degrees Fahrenheit																	
Wind speed in miles per hour		40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-40	-45	-50
	5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
	10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
	15	32	25	19	13	6	6	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
	20	30	24	17	11	4	4	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
	25	29	23	16	9	3	3	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
	30	28	22	15	8	1	1	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
	35	28	21	14	7	0	0	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
	40	27	20	13	6	-1	-1	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
	45	26	19	12	5	-2	-2	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
	50	26	19	12	4	-3	-3	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
Frostbite Danger Level				Slight Danger					Increased Danger				Great Danger						
Minutes until potential frostbite in dry, exposed skin				Greater than 120					Less than 45				Less than 5						

Note. Frostbite does not occur when ambient air is above freezing. Trench foot and immersion foot may occur at any point on the chart.

Table 1-5. Time to occurrence of cheek frostbite in minutes

		Air temperature in degrees Fahrenheit											
Wind speed in miles per hour		10	5	0	-5	-10	-15	-20	-25	-30	-40	-45	-50
	5	>120	>120	>120	>120	31	22	17	14	12	11	9	8
	10	>120	>120	>120	28	19	15	12	10	9	7	7	6
	15	>120	>120	33	20	15	12	9	8	7	6	5	4
	20	>120	>120	23	16	12	9	8	8	6	5	4	4
	25	>120	42	19	13	10	8	7	6	5	4	4	3
	30	>120	28	16	12	9	7	6	5	4	4	3	3
	35	>120	23	14	10	8	6	5	4	4	3	3	2
	40	>120	20	13	9	7	6	5	4	3	3	2	2
	45	>120	18	12	8	7	5	4	4	3	3	2	2
	50	>120	16	11	8	6	5	4	3	3	2	2	2

Note. Data is based on dry cheek skin of the most susceptible five percent of personnel. Wet skin or exposed extremities, such as fingers, could significantly decrease the time for frostbite to occur.

Ground Blizzard

1-109. A ground blizzard creates blizzard-like conditions without any precipitation. Strong winds move unpacked snow forcefully throughout the air and severely limit visibility. This hazard is common in the Arctic, can last for days, and can lead to white out conditions. An attacker or defender with the wind at their back during a ground blizzard has a notable advantage.

White Out

1-110. White out conditions are caused by several occurrences. Typically, blowing snow causes white out. Other weather conditions, such as low clouds, snowfall, or fog can also cause white out. White out conditions can also be self-induced by high winds from helicopter take-offs or landings.

1-111. White out greatly reduces visibility. White out occurs when a person becomes engulfed in a uniformly white glow with little to no visual references. During white out, a person loses a sense of depth perception and orientation. Objects do not cast shadows, the horizon is not discernible, and light-colored objects are difficult to see. (Figure 1-25 illustrates white out conditions and its effect on depth perception.) White out can restrict or halt operation of both air and ground vehicles. Travel under white out conditions is difficult and dangerous. Weapon optics are significantly degraded in white out conditions.

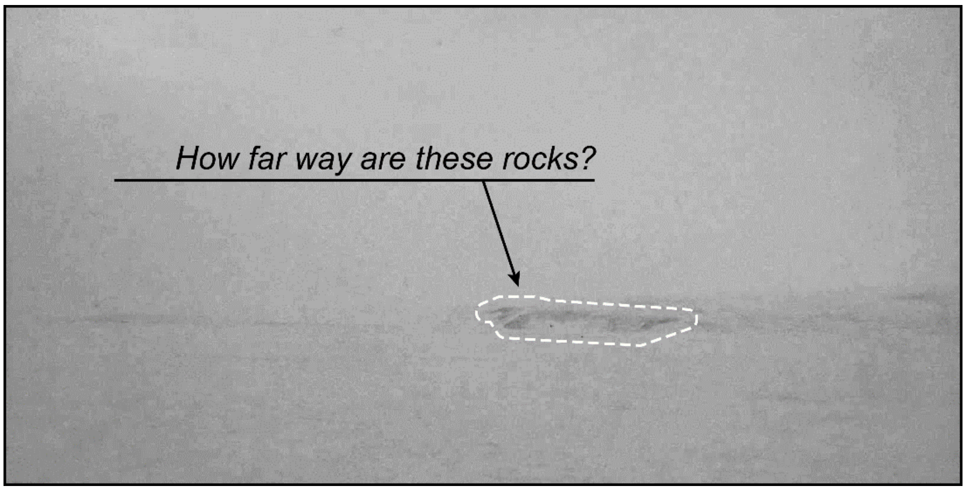

Figure 1-25 White out conditions

Chinook Winds

1-112. Chinook winds are warm dry winds that occur in the lee of high mountain ranges. In a few short hours, these winds produce complete thaws in cold regions that typically do not thaw until the spring or summer months. The conditions mimic the spring-thaw period typical of cold regions. Mud and flooding on roads and trails make them impassable. Frozen rivers and lakes partially thaw, making them unreliable as transportation routes. This is usually a temporary condition. When colder temperatures return, the previous thaw will turn into substantial amounts of ice.

Sound Refraction

1-113. High winds affect sound wavelengths and can either amplify or muffle sounds. Under clear, cold, and calm conditions, sound is significantly amplified and travels much farther. Under such conditions, all troops must realize the need for and practice silence. Otherwise, surprise is impossible to achieve and security is difficult to maintain. Light wind will carry sounds downwind, while screeching winds will muffle sounds in any direction.

LIGHT

1-114. Light is a major consideration in the Arctic. Sunrise and sunset times swing dramatically with prolonged periods of light or darkness as seasons shift. The further north a unit operates, the more pronounced the effect. Above the Arctic Circle during the winter solstice, the sun never rises and there is a period of 24-hours of night with only limited periods of twilight during sunrise and sunset timeframes.

1-115. During the summer, days become longer and the ability to conduct nighttime operations is extremely limited. During the summer solstice, the sun never sets, and there are 24 hours of daylight (commonly referred to as the midnight sun). Commanders need to account for the lack of night during operations and enforce rest cycles to avoid fatigue.

1-116. During the winter, days become shorter and long periods of darkness make night operations the norm. On clear, cold, windless, moonlit nights, personnel can see exceptionally well over open snow-covered terrain. However, in the absence of moonlight, pitch darkness can cause trips, falls, and vehicle accidents. On moonlit nights, the moon's reflection off the snow increases ambient light and improves night vision effectiveness. On moonless nights, infrared sights are preferred.

1-117. Planning for efficient use of daylight requires diligence. Twilight provides some visibility even though the sun has set. However, in a snow-covered forest, it becomes extremely dark. Leaders plan and use limited light hours to the greatest extent. Sunrise, sunset, and the amount of usable light available for operations become relative to where Soldiers/Marines are located and the time of year. Soldiers/Marines use the information contained in Figure 1-26 to approximate the number of daylight hours available for a given part of the year.

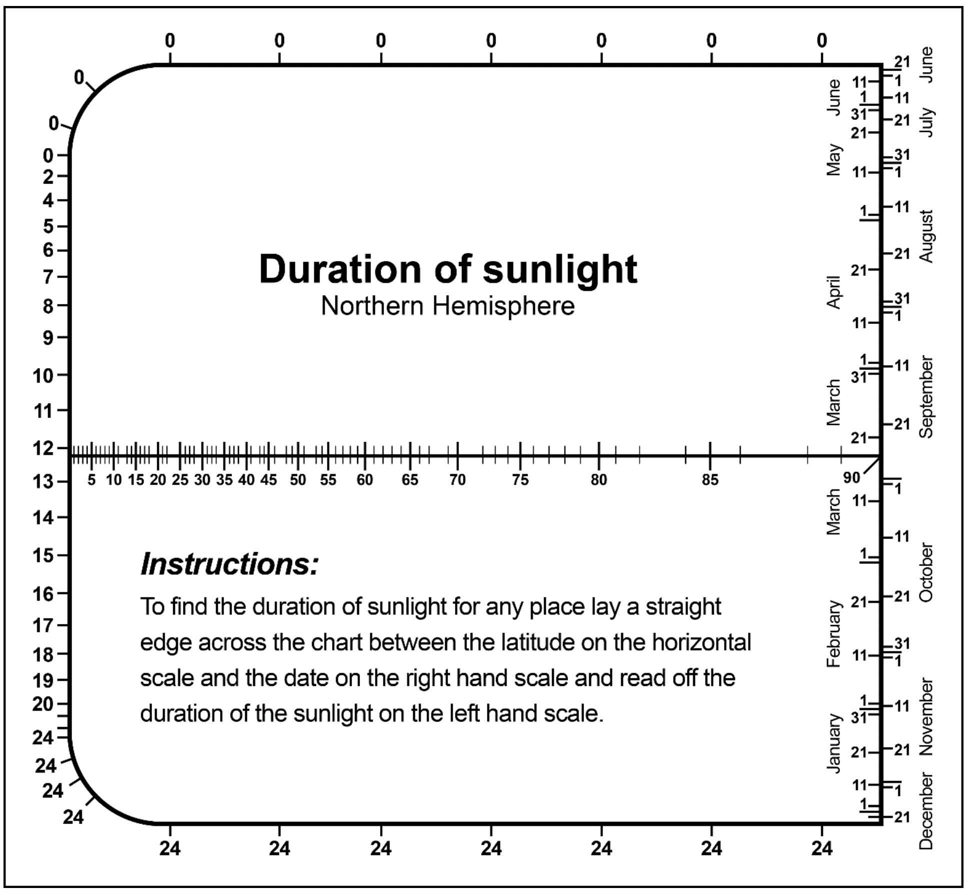

Figure 1-26. Light chart

1-118. Light also presents the following hazards:

- Flat light.
- Snow blindness and sunburn.

Flat Light

1-119. Flat light is a condition where the horizon becomes indistinguishable from the terrain (as illustrated in Figure 1-27). This height-depth illusion occurs when the sun reflects on snow through an overcast sky. Individuals experience a loss of depth perception and an inability to distinguish irregularities in terrain. Flat light can rapidly lead to a white out environment (see paragraph 1-110). Both white out and flat light conditions are treacherous. They occur quickly as visual references slowly begin to disappear.

1-120. Vehicle operation under flat light conditions is hazardous, especially for aviation assets. However, with good judgment and proper training and planning, drivers and pilots can safely maneuver in flat light conditions. Ground commanders limit air support during flat light conditions. Additionally, individuals experiencing flat light can begin to feel very nauseous and dizzy due to a lack of a discernable horizon. This may be severely debilitating.

Figure 1-27. Flat light

Snow Blindness and Sunburn

1-121. Sunshine reflection from snow will cause severe sunburn on all exposed skin and damage to retinas. This is most prevalent in the spring months of March through May. Units must issue full ultraviolet protective eyewear to prevent snow blindness in troops. Units select eyewear from the authorized protective eyewear list. Snow blindness will happen with inadequate eye protection and is very debilitating. It can occur in a matter of a couple of hours in very bright conditions.

1-122. To prevent sunburn, Soldiers and Marines should cover all skin with clothing. A piece of old bed sheet can be used to cover the face and neck. Units should issue sunhats for additional protection but should avoid using lotion-based sunscreen as it can contribute to cold weather injury (CWI).

PRECIPITATION

1-123. Despite widespread snow and ice cover, the Arctic receives very little precipitation, much of it falling as snow. However, certain parts of the subarctic under the influence of maritime storm paths receive considerably heavier precipitation. Arctic tundra regions receive an average of 8.8 inches of precipitation per year. Subarctic boreal regions receive an average of 16.9 inches per year. (See Appendix A for length conversions.)

1-124. There is a prevalence of low cloud ceilings in the Arctic. Cloud cover occurs most frequently in the summer along arctic coastal areas and in the fall in all other areas. During these seasons, sea ice moves further north, and the exposed water provides more moisture for low cloud condensation. Low cloud ceilings can affect operations such as aviation, search and rescue, intelligence, surveillance, and reconnaissance. Winter months experience fewer clouds. Overcast skies can create flat light or white out conditions and can potentially limit aviation operations.

Snowfall

1-125. Snowfall limits visibility, masks sound, and weakens electromagnetic signals (for example, optical and infrared sights). Snowfall also masks troop movement and covers tracks made on snow-cover. Therefore, it generally favors the offense and is disadvantageous to the defense.

1-126. Accumulated snow also affects the performance of electromagnetic sensors and additionally imposes a structural load on buildings, shelters, vehicles, and other equipment. Snow accumulation on the ground affects vehicle mobility. These effects can be made more severe when the snow is windblown or when the temperature of the snow is close to freezing. For military purposes, snow is categorized as light, moderate, or heavy. Each classification affects visibility and ground movement due to accumulation, as seen in Table 1-6.

Table 1-6. Snow categories

Category	*Visibility*	*Depth*
Light	Visibility is equal to or greater than 5/8 mile (or 1,000 meters) in falling snow.	A trace to one inch (2.5 centimeters) per hour accumulates.
Moderate	Visibility is 5/16 mile to half a statute mile (or 500 to 900 meters) in falling snow.	One to three inches (2.5 to 7.6 centimeters) per hour accumulates.
Heavy	Visibility is cut to less than 1/4 statute miles (or 400 meters) in falling snow.	Three or more inches per hour accumulates.

Blizzards

1-127. A blizzard consists of the following conditions for three or more hours:

- Sustained winds or frequent gusts to 35 miles (56 kilometers) per hour or greater.
- Considerable falling and/or blowing.
- Reduced visibility to a quarter of a mile or less.

1-128. Blizzards impact all aspects of operations. As with ground blizzards, attackers or defenders with the wind at their back during a blizzard have a notable advantage. Combat operations are sometimes assisted by high winds and snowstorms, which cover sounds and obscure movement. Close reconnaissance and attack are possible under the concealment afforded by such conditions. The associated high windchill and the lack of visibility demand a high degree of training for all troops. If units conduct combat operations during snowstorms or high wind, then leaders need to keep compact formations, simple plans, detailed instructions, limited objectives, and a positive means of identification.

1-129. Accurate timing is required so that troops do not remain exposed for prolonged periods. If the windchill factor is high, the unit attacks from downwind, if possible, forcing the enemy to face into it. If Soldiers and Marines have little or no experience operating in cold environments, then leaders avoid offensive operations during inclement weather. If a mission needs to be undertaken, then commanders use compact formations to maximize command and control.

1-130. In the defense, leaders take precautions against surprise during blizzard conditions. Leaders should increase the number of listening patrols and implement continual checks to ensure that guards maintain vigilant watch, particularly on the windward and most dangerous flank.

Freezing Rain

1-131. When raindrops fall through a cold layer of air (colder than 32 °F) and become super-cooled, then freezing rain occurs. The drops may freeze on impact with the ground to form a very slippery and dangerous "glazed" ice that is difficult to see because it is almost transparent.

1-132. Freezing rain is common during temperature inversions and can create a severe icing hazard for aircraft and UAS operations. It can also collapse camouflage netting systems and tentage, obscure various sensor arrays, collapse radio antennas, encase vehicles and other objects, and hinder paved surfaces. Paved surfaces become almost impassable requiring tire chains for vehicles and traction devices. When freezing rain occurs, Soldiers and Marines must be proactive to avoid these effects from paralyzing their unit.

1-133. In maritime environments, troops must remove ice created by freezing rain from small boats to prevent fouling of rigging or even capsizing.

HUMIDITY

1-134. Low rates of evaporation make the climate humid with a low dew point. Any water vapor introduced to the arctic cold air causes ice fog as well as condensation, which results in sweating and icing.

Fog

1-135. Fog is created by the presence of minute water droplets in the atmosphere at or near the Earth's surface. It forms when the air cools to a point where water vapor begins to condense into droplets of water that are sufficiently small to remain suspended in the air. Fog typically occurs in coastal areas in mid-north latitude areas or in mountain valleys in the winter. Fog is an obscurant that reduces the transmission of electromagnetic signals, affecting visibility, mobility, communications systems, and sensors. Reduced visibility can severely restrict the operation of both air and ground vehicles. Fog also degrades laser range-finding and target-acquisition systems.

Ice Fog

1-136. Ice fog is comprised of ice crystals suspended in the air. It occurs naturally at temperatures at −20 °F and below when a vapor source is introduced to extremely cold still air causing it to crystalize into small ice particles. It occurs frequently from vehicle exhaust, combustion, explosives, or steam. Ice fog can be extremely dense and persistent. It can restrict visibility across a whole valley to less than 10 feet and can linger for hours to multiple days. It also impacts electromagnetic signal transmission. (See Appendix A for temperature conversions.)

1-137. In addition to vehicles, living areas, and working areas, weapon firing can produce ice fog that obscures the vision of the operator and provides the enemy with an easy-to-spot location signature. Artillery fire will also cause ice fog and sudden drops in visibility. Figure 1-28 displays ice fog created by an AH-64 Apache Helicopter firing a hellfire missile and the effects it can have on gunners' visibility.

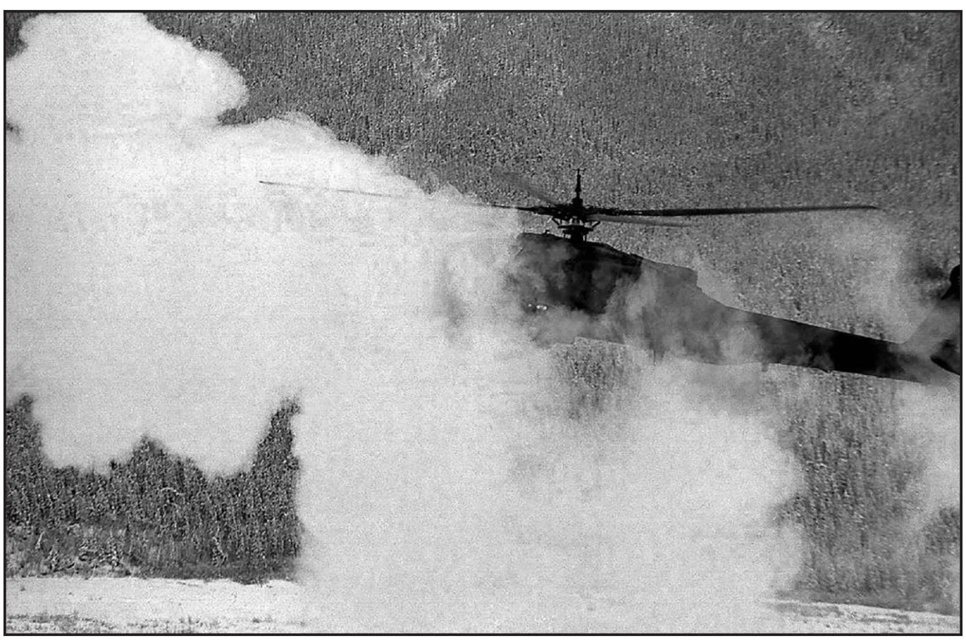

Figure 1-28. Ice fog caused by weapon fire

1-138. Ice fog also provides a signature of human activity and is greatly increased in populated areas due to the increased amount of water vapor being introduced into the atmosphere. On airfields, ice fog created by fixed-wing aircraft may cover an entire runway. Visibility can be reduced so that other aircraft cannot take off or land if the wind is calm. Besides reducing visibility, the ice fog draws attention to the airfield location.

1-139. Units can mitigate ice fog by—

- Dispersing logistics areas.
- Using available tree lines to hide signatures.
- Not allowing vehicles to idle for long periods. (Use engine compartment heaters instead.)
- Sandbagging larger generator sets.

1-140. Combat operations can at times be assisted by reduced ground visibility created by fog and ice fog. These conditions can conceal troop movement, close reconnaissance, or an attack. Movement under dense fog conditions is extremely difficult and slow.

1-141. Combat under ice fog conditions requires additional fire-position planning and preparation. Ice fog resulting from weapon fire can obscure the gunner's vision and may pinpoint the location of weapons, vehicles, and troops for miles with a lasting signature. Leaders establish alternate firing positions for both target acquisition as well as cover and concealment.

1-142. Launching missiles such as the tube-launched, optically tracked, wire-guided (known as TOW) missile in very cold air can create ice fog. As a missile moves to the target, the exhaust blast exits into the air where it condenses and creates ice fog. If the wind is calm, this fog follows the trajectory of the missile and reduces launch point visibility to such an extent that the operator loses sight of the target. Also, threat forces can then identify the launch point from the condensation trail of the missile.

1-143. Movement and maneuver during periods of intense ice fog require greater command and control, generally smaller formations, decreased spacing, prescribed direct and indirect fire control measures, and trust in subordinates. In the defense, units must take precautions against surprise during fog and ice fog conditions. Additional listening patrols are necessary.

Icing

1-144. Icing is any deposit or coating of ice on an object. Icing can occur in areas that experience temperatures below freezing, where sufficient water vapor or freezing precipitation events occur. Ice accumulation on structures and equipment can cause damage and interfere with communication, visibility, and mobility.

1-145. In the Arctic, icing can occur rapidly. Icing freezes and seizes critical components of vehicles, weapons, and equipment thereby rendering them inoperable. Icing is especially dangerous for aircraft. Even a little ice on lifting surfaces affects the aerodynamics of aircraft and can degrade performance or cause a crash.

Space Weather

1-146. In the Arctic, solar weather causes spacecraft charging and electromagnetic interference with satellites and cyberspace capabilities. This interference results from higher levels of energetic charged particles during geomagnetic and ionospheric storms. Units operating in the Arctic must be prepared and create contingencies to account for frequent disruptions in communication, tracking, navigation, and surveillance.

1-147. The aurora borealis is caused by charged particles produced by a solar storm. The charged particles are trapped by the magnetosphere, diverted into the ionosphere, and drawn towards the poles along magnetic field lines. These charged particles create a light show in the sky and are most visible on cold clear nights (as seen in Figure 1-29). The aurora borealis occurs throughout the year. The aurora borealis signals the presence of a solar storm that can seriously degrade radio communications, satellite communications (SATCOM), and Global Positioning System (GPS) signals. Solar storms disrupt amplitude modulation communications but enhances frequency modulation communications.

Figure 1-29. Aurora borealis

SEASONS

1-148. Seasons in the Arctic influence all aspects of the physical environment and have the potential to reshape an entire OE rapidly. Seasonal transitions should be a critical planning factor in operations (see discussion beginning on paragraph 2-85).

1-149. Winter dominates most of the year. Summers are short. Fall and spring transitional periods are even shorter. Arctic fall and spring do not resemble those of more temperate climates. Planners can think of fall as a freezing season and spring as a thawing season.

1-150. Spring is also commonly referred to as "break up" in northern regions. During this period, snowpacks are often impassable until they refreeze at night. Climax avalanches occur during this season as the winter snowpack becomes saturated with water. River ice thins unevenly and makes riverine travel on the ice impossible for several weeks every year. Table 1-7 shows significant characteristics associated with each season.

Table 1-7. Season chart

Season	*Light*	*Temperature Zone*	*Precipitation*	*Ground Condition*	*Ice Condition*
Winter	24-hours of darkness during December 21	Dry-cold or colder	Snow falling mostly near October	Frozen or snow covered	Lakes and rivers frozen
Spring (Thaw or Break Up)	Days begin to trend towards light	Wet-cold trending towards above freezing	Highest rate of monthly precipitation; mostly as light rain	Muddy or light snow cover	Rivers begin to break up; Mountainous areas begin cataclysmic avalanching
Summer	24 hours of daylight during June 21	Above freezing	Light rain	Muddy with muskeg	Rivers and lakes melted
Fall (Freeze)	Darkness occurs most of the day	Wet-cold	Occasional rain or snow	Muddy trending towards frozen	Ponds and streams frozen; Rivers begin freezing

1-151. The time of year, length, and characteristics of these seasons vary slightly from region to region. Depending on the climate, colder regions have longer (at times enduring) harsher winters, and milder climates have extended summer periods.

1-152. Figure 1-30 depicts the average date that freezing periods start in different regions. Figure 1-31 depicts the average date that thaw periods start in different regions. The freezing season varies geographically and can be expected as early as September in the northern latitudes. Similarly, the thawing season can begin as late as June in the Far North.

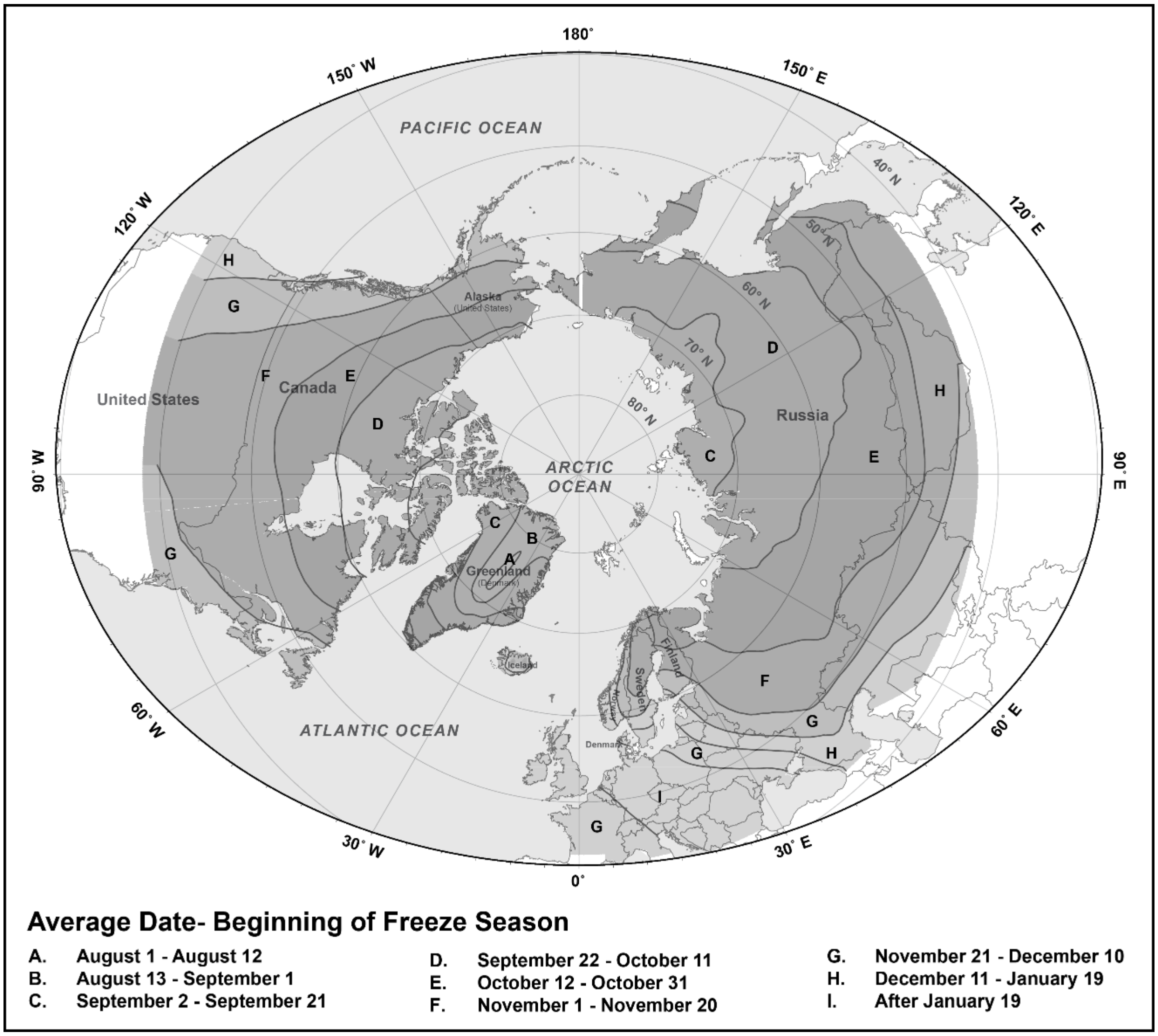

Figure 1-30. Mean date of the beginning of the freezing season

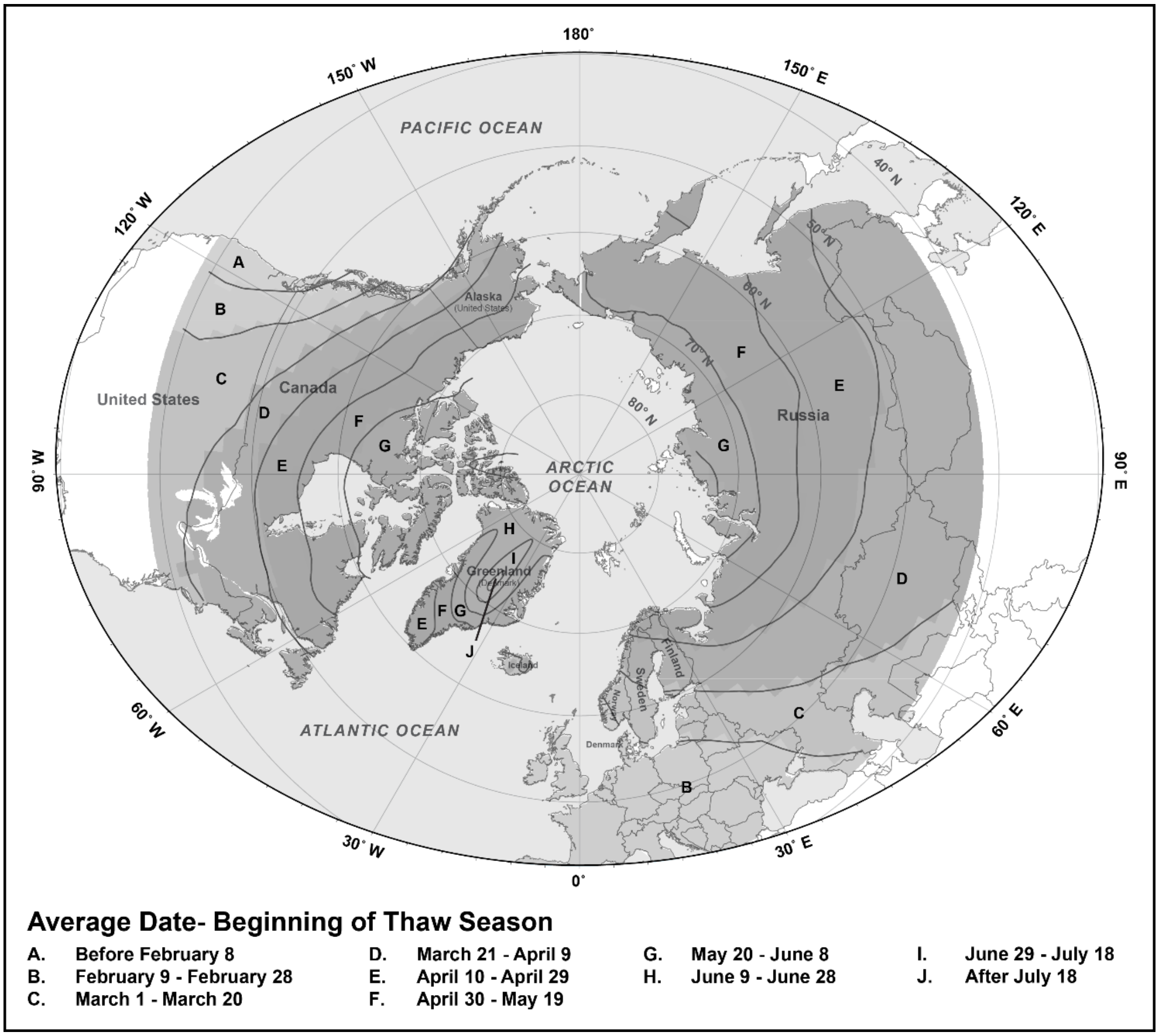

Figure 1-31. Mean date of the beginning of the thawing season

Note. The frost and thaw isolines in Figure 1-30 and Figure 1-31 were generated using global temperature data from the World Index Database by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory.

WILDLIFE

1-153. Significantly, less wildlife exists in the Arctic than in more temperate climates. However, those that do live there have adapted particularly well to the environment and could pose a hindrance or threat to operations, especially predators. Animal migration also can impact operations and signal the movement of human herder populations. Commanders and planners consider potential risks associated with local wildlife.

LAND WILDLIFE

1-154. Land wildlife in the Arctic can consist of both dangerous predators and prey. The relationship between the two is complex. Soldiers and Marines must be attuned to the ecoregions in which they operate because the species of animals will differ. In the tundra, predator wildlife includes the arctic fox, brown bear, gray wolf, and polar bear. The tundra also has caribou. Towards the boreal region, the variety of species increases with the more hospitable ecosystem. Populations of black, brown, and grizzly bears are common. Other dangerous predators include the gray wolf, lynx, and wolverine. Throughout this region, beaver, caribou, marten, mink, and moose are found as well. As terrain shifts from forestry meadows to more mountainous, species like the mountain goat and dall sheep grow increasingly common.

1-155. The extreme northern reaches of the world have very few snakes. The only venomous snake is the European adder. It is found up to the latitudinal tree line (roughly 68°N) in Europe and Russia. Alaska and Greenland are free of venomous snakes, and Canada only has them in the southern third of the country.

MARINE WILDLIFE

1-156. Along the coast and in rivers and bodies of fresh water in the interior, numerous fish species are found. Marine life to consider in the polar ecoregions include the bearded, ringed, spotted, and ribbon seals. In addition, the Pacific walrus is a keystone species in the Arctic. Off the western and northern coasts fin, humpbacks, gray, and beluga whales are extremely common. Salmon sharks are commonly found in the Gulf of Alaska, the Pacific Ocean, and the Bering Sea.

INSECTS AND PESTS

1-157. Mosquitoes and biting flies are prevalent in the summer months and are considerably irritating and distracting. Insects and pests pose a hazard because of their propensity to spread disease. The insects and pests to consider are flies, mosquitoes, midges, stinging insects, leeches, parasites, and spiders. There are numerous different species of these insects and pests. Large swarms of relentless mosquitoes can affect morale. As temperatures rise in the region, more biting insects are found. Units issue head nets and sleeping area netting for protection. These items are more effective and healthier than chemical pesticides such as DEET.

Arctic Mosquito

1-158. Mosquitoes are plentiful in the tundra and spruce-fir forests. Numerous meltwater ponds are breeding areas for mosquitoes during their short existence. In the Spring, they breed actively in small pools formed on the surface that remain wet throughout the warm season. Arctic mosquitoes will bite so frequently as to make life miserable for troops, but they are not known to be transmitters of malaria or yellow fever. Mosquito hoards seek leeward surfaces in slight winds. In these protected locations, and after twilight hours, the mosquitoes are active almost all the time. In temperatures below approximately 45 °F (7 °C), their activity is greatly reduced.

Sand Fly

1-159. Sand flies are tiny blood-sucking insects. They bite chiefly in the early morning, late evening, and on cloudy days. They can crawl under head nets, through small holes in clothes, and under or between garments. Repetitive bites become very irritating and distracting.

1-160. Sand flies are found at scattered locations during the summer. They breed in decaying vegetation and are found in wet places near streams, ponds, and in both fresh and saltwater marshes. They seek shade and leeward locations in slight winds. During daylight hours, the size of their swarms are limited.

Black Flies

1-161. The small hump-backed black flies concentrate in scattered areas, breed in large numbers in swiftly flowing streams, and are more numerous in forested areas than in the tundra. Their greatest activity is in the dry and sunny days of June and July. They hover about overhead and crawl rapidly about the body looking for openings in clothing. If successful, they cluster near tight underclothing and give a vicious bite which stays open and bleeds for a short time, later swelling to an itch. At night these flies are troublesome.

Deer Fly

1-162. Several kinds of flies generally referred to as “bulldog” are found in the tundra and forested areas of the Far North. They are larger than the common house fly, with brown, prominently banded wings, and are fast fliers. Cool evenings send them to cover. Their active season is somewhat longer than the mosquito. Deer flies are irritating because of their constant circling and buzzing. They frequently strike the face and occasionally land to bite. Their bite is vicious and draws blood, causing skin swelling and itching that can lead to infection.

SECTION III – ENVIRONMENTAL HAZARDS

1-163. The ninth imperative of multidomain operations is to understand and manage the effects of operations on units and Soldiers (see FM 3-0 for more on multidomain operations). In the Arctic, the risks posed by the enemy threat are compounded by environmental challenges to personnel, equipment, and operations. Often, environmental hazards can be more dangerous than the enemy. Commanders may have to expend more resources on survival than on combat.

ENVIRONMENTAL HAZARDS TO PERSONNEL

1-164. Environmental effects on personnel cannot be underestimated. Severe arctic conditions can rapidly affect unprepared troops physically, mentally, and medically. While leaders can mitigate some of the effects in the moment, the best prevention is preparation. Leaders who properly train their troops for operations in the Arctic hold a distinct relative advantage over enemies who have not. (For detailed training information, see Chapter 10. For a full list of effects on personnel, see TC 21-3. For more information on medical effects, refer to TC 4-02.1.)

PHYSICAL EFFECTS

1-165. Soldiers and Marines are subject to the harsh effects of the environment and when cold, are generally less efficient. Without shelter, they lose sleep, are less alert, and weaken. With heavy clothing, they become slower and less precise. However, without the required personal protective clothing, they become numb, mishandle weapons, or worse.

1-166. Leaders must ensure troops have the proper equipment to endure the elements. Engaged commanders ensure leaders check on Soldiers and Marines frequently and make sure they are hydrating. In a cold dry environment, people quickly lose hydration and moisture even though they do not feel sweaty. Planners account for degraded efficiencies and slower timelines in their operation plans.

MENTAL EFFECTS

1-167. Soldiers and Marines exposed to prolonged periods of cold and darkness are prone to cocooning and depression, especially those untrained in cold environments. Cocooning (withdrawn behavior resulting from inexperience to the cold) occurs when Soldiers or Marines are unaccustomed to the discomfort associated with being cold. They become withdrawn and indifferent. They become negligent of their duties and focus on warming themselves in tents, vehicles, or sleeping bags. In severe cases, they can even become disobedient and irrational. At its most severe, entire units can enter a cocooned state. This is known as group hibernation and can render a unit combat ineffective.

1-168. Engaged leadership, the use of the buddy system, maintaining morale, and instilling a positive attitude can mitigate these effects. Overall, it takes mental determination and a will to succeed at all levels to overcome the fear of the cold. This sense of tenacity in the face of extreme cold is called arctic determination, which is defined and described in paragraph 2-113.

1-169. Maintaining morale can also dramatically improve performance in a harsh environment, especially for inexperienced Soldiers and Marines. Welfare is more than providing mail and clean clothing. Troops must be kept healthy and physically fit. They must have adequate, palatable food, and periods of rest and sleep. However, training remains the best prevention for the mental effects of the cold.

MEDICAL EFFECTS

1-170. Nonbattle injuries can threaten life and limb just as quickly as the enemy. These injuries can include hypothermia (cooling of the body's internal temperature below 95 °F), frostbite (freezing of the skin), trench foot (swollen painful feet caused by prolonged cold and wet exposure), and carbon monoxide poisoning. All these injuries have the potential to produce more casualties than battle. See Appendix D for more information on CWI identification and prevention.

1-171. Leaders at the lowest level ensure their troops are properly equipped, monitored, and evacuated if necessary. Leaders enforce frequent CWI checks to prevent injury. CWI checks include inspecting Soldiers'/Marines' general condition, face, ears, neck, hands, and feet for signs of CWI onset. (See Appendix D for a CWI checklist and preventive measures.) Commanders at the highest level ensure sustainment and casualty care is well planned.

1-172. Heat injuries can occur even in extreme cold temperatures. Overheating typically occurs when troops are overdressed for strenuous physical activity such as foot marches. Layered clothing traps excess heat and can induce heat exhaustion or heat stroke. Leaders and troops train, practice, and understand cold weather layer management to prevent both heat and cold injuries.

ENVIRONMENTAL HAZARDS TO EQUIPMENT

1-173. Extreme temperatures of the Arctic continuously threaten equipment capability and effectiveness. At -20 °F, metal becomes half as strong and can break, rubber stiffens and tires can form flat spots, and plastics become brittle and can shatter. At times, the environment has a greater capability to destroy equipment than the enemy.

1-174. The role of leaders begins with ensuring that weapons, vehicles, and any other equipment are fully winterized to accommodate the cold, as prescribed by TM 4-33.31. However, even these preparations cannot mitigate all issues. Three general categories of issues account for most of the environmental hazards to equipment in the Arctic:

- Degraded components.
- Degraded petroleum.
- Frozen condensation.

DEGRADED COMPONENTS

1-175. Operators use caution when using severely cold equipment that has been inactive for a long time. Metals and plastics, which constitute the majority of Department of Defense (DoD) equipment and components, are greatly impacted by low temperatures. Since metals contract at lower temperatures and expand at higher temperatures, improper clearances may result in either binding or excessive looseness. Many items become brittle in the cold and could break if forced. Severe cold has a different effect on different materials, with which mechanics and operators must be familiar.

1-176. Cold weather can affect batteries adversely. Their capacity to provide power is less at low temperatures. Cold temperatures increase the vehicle's power demands on the battery. Leaders ensure batteries are fully charged. Batteries can freeze when partially or completely discharged. Frozen vehicle batteries can burn or explode if an operator attempts to jump-start a vehicle. A fully charged battery can withstand -70 °F (-56 °C) to about -77 °F (-60 °C) without freezing.

DEGRADED PETROLEUM, OIL, AND LUBRICANTS

1-177. Under severely cold conditions, the physical properties of petroleum, oils, and lubricants (POL) can vary from what is required to meet performance requirements. Impeded physical properties reduce or restrict flow in the various mechanical components, which can lead to failure.

FROZEN CONDENSATION

1-178. Soldiers and Marines use great care when bringing weapons and equipment (such as communications devices and optics) from cold environments into heated shelters. This temperature change causes condensation to form on items. When returned to the cold, the condensation freezes and can render this equipment nonmission capable. For this reason, troops store weapons outside under guard in extreme cold temperatures to prevent malfunction. Communications equipment can also be very susceptible to electrical short circuits because of condensation.

ENVIRONMENTAL HAZARDS TO OPERATIONS

1-179. In the Arctic, basic operational principles still apply. However, success requires significant adjustments for the extreme environment. Adjustments are made—

- Across all domains (land, sea, air, space, and cyberspace).
- Through all dimensions (physical, information, and human).
- In every warfighting function (information, command and control, movement and maneuver/maneuver, intelligence, fires, sustainment/logistics, and protection/force protection).

Operations in the Arctic are simply more difficult. The remainder of this manual discusses the full depth of effects the arctic environment has on operations.

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Chapter 2

Operational Considerations for the Arctic

From now on the arctic region is accessible to man in both war and peace. The events of the wars in the Far North proved that even large numbers of men are able to live, work, and fight in the desolate regions north of the Arctic Circle.

DA PAM 20-292, *Warfare in the Far North* (1951)

This chapter describes the framework for commanders to develop an operational approach to arctic operations. Section I – Operational Considerations describes the many complex aspects of the operating environment. Section II – The Competition Continuum in the Arctic explains the unique aspects of the Arctic OE when considering the competition continuum. Section III –Principles of Arctic Operations describes the overarching principles that must be applied for arctic operations.

SECTION I – OPERATIONAL CONSIDERATIONS

2-1. This section describes the arctic OE in terms of political, military, economic, social, information, infrastructure, physical environment, and time considerations. These considerations help leaders analyze where, how, and why operations are conducted in the Arctic.

POLITICAL CONSIDERATIONS

2-2. Understanding the political variable is critical to understanding the territories of significance in the Arctic. Given the Arctic's vast cold desert landscape, operations are not likely to encompass the entire region. Rather, operations focus on areas driven by political motivations. Commanders must understand the political variable to forecast areas of operations.

POLITICAL ENTITIES

2-3. Eight countries have territory in the Arctic: Canada, Denmark (including Greenland), Finland, Iceland, Norway, Russia, Sweden, and the United States. Five countries have an Arctic Ocean coastline: Canada, Denmark (Greenland), Norway, Russia, and the United States. Russia has the most expansive arctic territory of any of these countries. See Figure 2-2 on page 50 for boundaries of the eight arctic nations.

INTERGOVERNMENTAL ORGANIZATIONS

2-4. Two major intergovernmental organizations exist in the Arctic. These organizations promote peaceful dialogue among issues and disputes:

- The Arctic Council.
- The Arctic Five.

The Arctic Council

2-5. The Arctic Council is the principal intergovernmental forum. It consists of the eight countries with arctic territory and six Indigenous people's organizations. This council focuses on conservation, safety, and development. It establishes accords such as the Agreement on Enhancing International Arctic Scientific Cooperation. By mandate, it is not a forum for security issues or territorial disputes.

The Arctic Five

2-6. The arctic coastal nations make up an ad hoc association called the Arctic Five. This association addresses emerging disputes in the region. Regional conflicts at times may make negotiations difficult.

Indigenous Peoples' Organizations

2-7. Hundreds of Indigenous tribes live in the Arctic represented by numerous Indigenous peoples' organizations. The Department of Defense has an obligation to consult with the sovereign tribal governments of federally recognized tribes under certain conditions as described in DoDI 4710.02. At the international level, the following organizations promote Indigenous rights and interests and represent their people's issues and concerns as permanent participants in the Arctic Council:

- **Aleut International Association:** Represents a combined population of approximately 15,000 in the Alaskan United States and Eastern Russia.
- **Arctic Athabaskan Council:** Represents an approximate 45,000 population in the Alaskan United States and Northwest Territories of Canada.
- **Gwich'in Council International:** Represents a small population of approximately 9,000 that live in the Alaskan United States and Northwest Territories of Canada.
- **Inuit Circumpolar Council:** Represents an approximate 180,000 population in the Alaskan United States, Canada, Greenland, and Chukotka.
- **Russian Association of Indigenous Peoples of the North (known as RAIPON):** RAIPON represents more than 40 Indigenous tribes across Russia, which number more than 250,000 people.
- **Saami Council:** Represents approximately 100,000 Saami across Norway, Sweden, Finland, and Russia.

POLITICAL DISPUTES

2-8. International disputes in the Arctic are associated with economic rights and maritime territory. Multiple countries assert expanded rights to the Arctic based on surveys of the continental shelf (see Figure 2-1 that illustrates these zones). Russia has claimed law enforcement authority over international waters in the Northern Sea Route, and Canada has claimed that the Northwest Passage constitutes internal waters, despite protests from other countries. China disputes arctic nations' exclusivity to the region and has asserted itself as a "near-arctic state" to try to legitimize future claims.

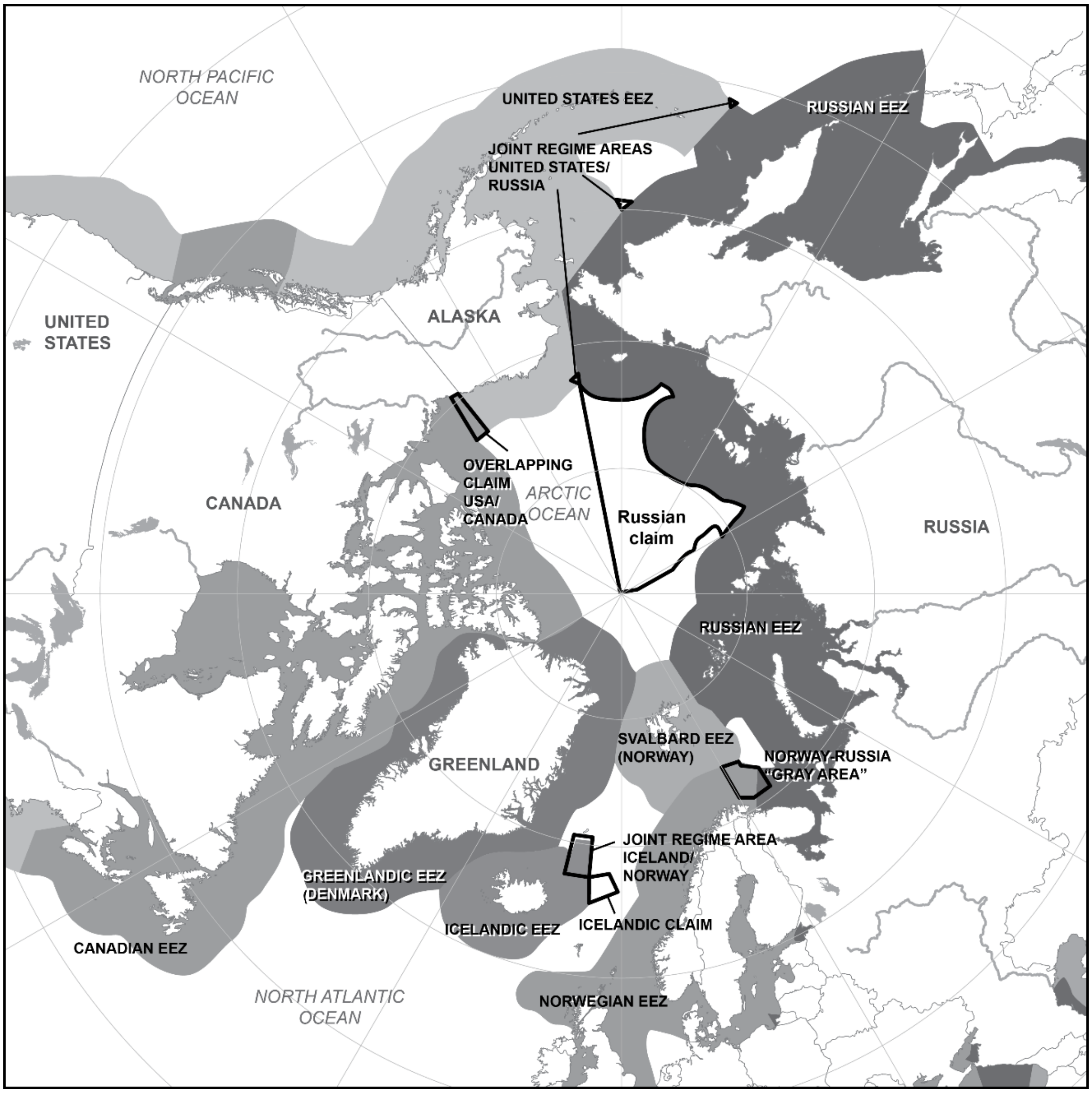


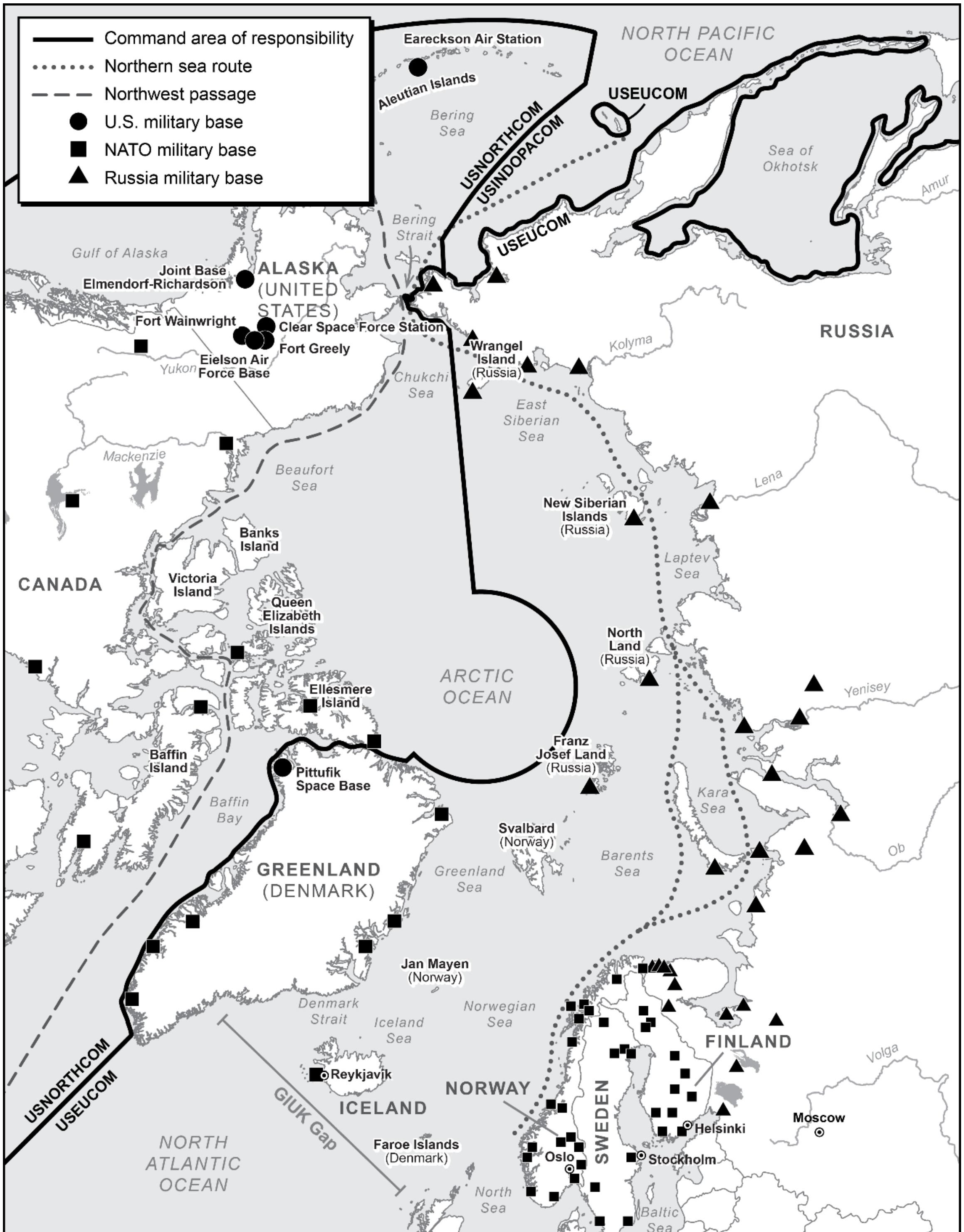
Figure 2-1. Arctic territorial claims as demonstrated through exclusive economic zones

Note. Figure 2-1 depicts exclusive economic zone claims as of 2020.

MILITARY CONSIDERATIONS

2-9. In the Arctic, dozens of military facilities from each arctic nation spread across U.S. Northern Command and U.S. European Command. Certain U.S. military organizations stationed in Alaska also have responsibilities to the U.S. Indo-Pacific Command. Since multiple combatant commands have responsibilities in the Arctic, commanders emphasize the importance of well-understood command relationships in arctic operations. Figure 2-2 shows the location of arctic military facilities by country.

2-10. Russia maintains the largest military presence in the arctic environment. Among U.S. allies, Canada and Norway have the most robust arctic military forces. Some nonarctic countries, including the United Kingdom, France, and China, have an intermittent arctic military presence.



GIUK	Greenland, Iceland, and United Kingdom	USEUCOM	United States European Command
NATO	North Atlantic Treaty Organization	USNORTHCOM	United States Northern Command
U.S.	United States	USINDOPACOM	United States Indo-Pacific Command

Figure 2-2. Arctic military facilities and shipping routes

2-11. Most military activity in the region is concerned with exercising sovereignty, search and rescue operations, environmental protection, or support to civilian authorities. Russia and NATO also maintain deterrent force postures in the Arctic. Global competition is a predominant context in the Arctic and occurs primarily between Russia and NATO members.

INTERNATIONAL MILITARY ORGANIZATIONS

2-12. Two major international military organizations exist in the Arctic:

- NATO.
- Arctic Security Forces Roundtable.

North Atlantic Treaty Organization

2-13. NATO is the only military alliance in the Arctic. Canada, Denmark, Finland, Iceland, Norway, Sweden, and the United States are NATO allies. Russia is the only arctic nation not associated with NATO.

Arctic Security Forces Roundtable

2-14. The Arctic Security Forces Roundtable is a multinational forum to improve communications and maritime domain awareness. Canada, Denmark, Finland, France, Germany, Iceland, the Netherlands, Norway, Russia, Sweden, the United Kingdom, and the United States are members. Russia, a founding member, was disinvited following the annexation of Crimea in 2014.

ECONOMIC CONSIDERATIONS

2-15. The economic variable is a significant influence on political disputes in the region. Commanders must understand economic drivers in the Arctic to identify areas of key terrain during competition, crisis, and conflict. Economic drivers include resource extraction (including oil and natural gas, iron, nickel and copper ore, and rare earth elements), shipping and transportation, fishing and aquaculture, renewable energy development, and tourism.

2-16. The arctic economy is small compared to other regions of the world because of low population and historic inaccessibility caused by the extremes of the physical environment. Commanders consider the impact that operations can have and avoid disrupting local economies, especially during competition and stability operations.

2-17. Climate change increases the importance of the arctic economy. Although the Arctic will remain a challenging environment for the foreseeable future, decreases in annual sea ice, along with advances in extraction technology, make fossil fuel basins and other resources more accessible and lucrative. Decreasing sea ice extends opportunities for global shipping, in turn increasing the geostrategic importance of the region. Russia has been capitalizing on this opportunity by investing in an icebreaker fleet that vastly outnumbers those of all other arctic nations combined. Although the Arctic will not surpass warmer shipping routes in traffic volume, arctic sea routes provide significant transportation cost savings resulting in a growing number of ships transiting between Asia and Europe.

2-18. Increased accessibility due to climate change is prompting nonarctic nations to assert themselves in the region. China has the largest embassy in Iceland, seeks to increase its presence in Greenland, and has maintained a permanent scientific presence in Norway since 1925. In addition, China, Japan, and South Korea have developed ice-breaking capabilities to enable arctic transport, research, and resource exploitation.

SOCIAL CONSIDERATIONS

2-19. Populations in the Arctic are typically smaller, more dispersed, and isolated compared to other geographical regions. However, their access to internet and resources makes most arctic cities, towns, and cultures similar to any other. Populations are typically fiercely independent and self-sufficient. They also have valuable knowledge of regional patterns and seasonal weather shifts and effects. Commanders consider these characteristics when interacting with local populations.

2-20. Given the isolated nature of the Arctic, commanders must understand the importance of a population center as a hub for operations and a foothold to project into more desolate regions. Units prepare for urban operations while considering the potentially disruptive impact on local populations.

2-21. Although the population is small compared to other regions, as of 2019, the Arctic Circle alone had more than four million people and seven major urban areas with populations greater than 50,000 people. Five were in Russia: Murmansk (292,465), Norilsk (180,976), Vorkuta (54,223), Apatity (55,201), and Severomorsk (52,597). Two were in Norway: Tromsø (76,649) and Bodø (52,024). Russia had the largest arctic population, but Norway had the largest percentage (10 percent) of its population north of the Arctic Circle. When including populations above the 60° latitude, the Arctic and subarctic had more than 13 million people and numerous cities. These numbers will continue to grow as economic opportunities continue to attract business.

2-22. Often population size is an indicator of available infrastructure. Large populations likely have more robust infrastructure networks. Conversely, a lack of infrastructure networks is a good indicator of minimal population density.

2-23. Indigenous people constitute approximately 10 percent of the population throughout the Arctic and are experiencing faster population growth than any other arctic demographic. Climate change and economic development impact the lifestyles of Indigenous circumpolar peoples in all arctic countries, which have traditionally revolved around subsistence hunting and fishing. Indigenous populations may be cross-border communities or at least have close ethnic, familial, and cultural ties in multiple countries.

2-24. Alaskan and Canadian Indigenous populations are represented by sovereign tribal governments. There is a renewed push to revive language, which affects everything from casual conversation to street signs in the villages. Arctic villages tend to be very closed to the outside world and some may be unwelcome towards outside visitors. These populations perceive the impact visitors may cause to a village's limited resources or have experienced historical trauma caused by previous contact.

2-25. Commanders must be aware of local Indigenous cultures and practices. Disruptions to these populations may directly affect their survivability. Additionally, language experts in circumpolar languages may not be available and interpreters will likely have to translate using locals' second language.

2-26. Labor migration in the mining industry can cause seasonal shifts in population. Additionally, some Indigenous hunting and animal herding communities migrate with wildlife and are not static to one region. Commanders should be cautious of population movements during migration seasons and the potential impact of operations on subsistence hunting activities. For local populations, loss of access to subsistence resources in a season can cause food shortages for an entire year.

ARCTIC POPULATION CENTERS

2-27. Population centers vary greatly in the Arctic and are divided into four subregions:

- North American.
- Asian.
- European.
- Island.

These regions vary by distribution, size variability, government support, infrastructure, Indigenous autonomy, and technological advancement. Figure 2-3 shows population centers by size and gives a graphical representation of dispersion.

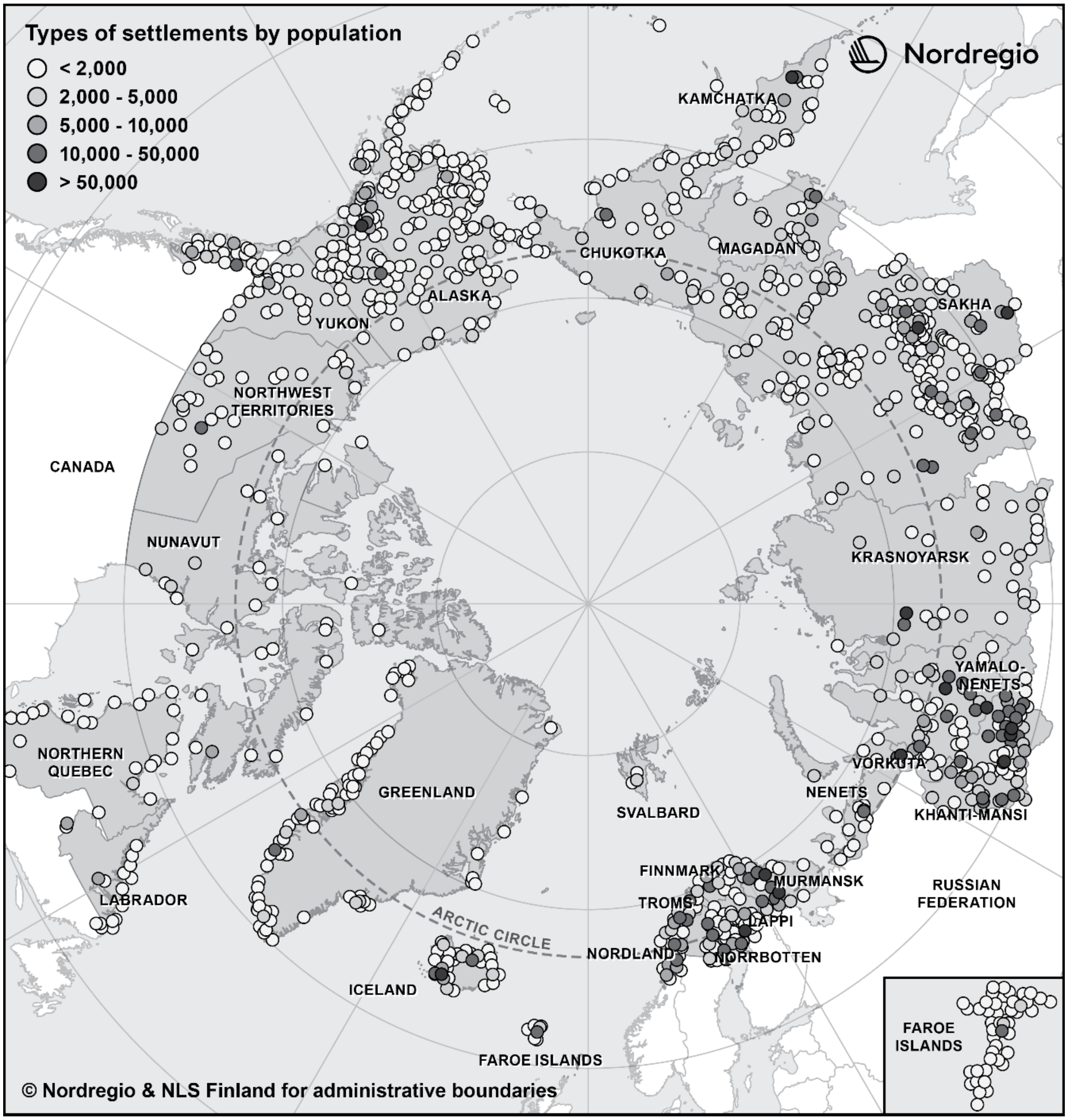


Figure 2-3. Arctic population centers

Note. Data source: 2017 Nordregio's estimates based on data from National Statistical Institutes, Alaska: Alaska Department of Labor and Workforce Department. Regions Include: United States (Alaska); Canada (Northwest Territories, Nunavut, Labrador, Northern Quebec); Greenland; Iceland; Faroe Islands; Norway (Norland, Troms, Finnmark, Svalbard); Sweden (Norrbotten); Finland (Lappi); and Russia (Murmansk, Vorkuta, Nenets, Khanty-Mansi, Yamalo-Nenets, Krasnoyarsk, Sakha, Kamchatka, Magadan, Chukotka).

North American Arctic Population Centers

2-28. North American population centers are those that reside in the United States and Canada. North American population centers are characterized by sparse but evenly distributed population centers. There is less variety in arctic population centers; population size is generally smaller with a few larger cities. Urban culture and dynamics strongly resemble southern Canadian and U.S. trends, and the region is supported by economically strong and technologically advanced governments. Indigenous populations have recognized autonomy and have a voice in political, social, environmental, and economic matters.

Asian Arctic Population Centers

2-29. Asian population centers are composed solely of the wide Russian landscape in the Arctic and subarctic. Asian population centers vary in distribution, with very sparse and small population centers in and near the Arctic Circle and denser city and town placement in the lower latitudes. Asian arctic populations have lower average educational levels. These populations experience higher levels of social and health problems than in southern Asian communities.

2-30. Differences in culture between cosmopolitan and rural cultures are significant. The Asian arctic region is generally less supported by an authoritarian government. Russian law dictates certain restrictions so Indigenous populations can maintain their political status of indigeneity. For instance, Indigenous populations must keep their population below 50,000 people, live only in regions of their ancestors, and maintain a traditional Indigenous way of life. Additionally, Indigenous peoples have very little voice in government.

European Arctic Population Centers

2-31. European population centers include the countries of Norway, Sweden, and Finland. European arctic population centers have a higher density than other arctic population regions due to their milder climates. They are strongly supported by technologically advanced governments and enjoy greater availability of cyber connectivity and improved road networks. Indigenous populations are well represented and integrated into the population.

Island Arctic Population Centers

2-32. Island population centers are those situated on islands such as Greenland, Iceland, Faroes, Svalbard, and Canadian islands. Dense but small population centers exist along coastal regions. Central regions of islands are largely uninhabited due to difficult terrain and climate. Populations on Canadian islands share cultural ties with North America. Populations in Greenland, Iceland, Faroes, and Svalbard cultural and political ties are primarily European.

INFORMATION CONSIDERATIONS

2-33. Vast distances and extreme conditions make tactical information flow in the Arctic challenging and unreliable. Because of these challenges, communications primary, alternate, contingency, and emergency (known as PACE) plans are critical in the Arctic.

2-34. Extreme cold weather can have numerous negative effects on information systems equipment. Cold temperature degrades electronic equipment performance and reduces battery life. Icing on antennas can cause signal interference. Dense snow cover and ice can inhibit equipment grounding and cause wave attenuation when transmitting which can inhibit signals. Condensation can build up in electronics moved from warm inside areas to cold outside environments and cause power shorts. Keys, buttons, and touch screens often freeze and will not work at all until warmed up. They can also be difficult to operate with heavy winter gloves. However, removing gloves in subzero temperatures can cause frostbite in minutes or even seconds. Effective Soldiers and Marines understand the effects of cold weather on information systems equipment to mitigate its effects to the greatest extent possible. As temperatures lower, commanders plan for delays in communications and information processing. They must create contingencies such as analog products and use of aerial platforms to carry orders.

2-35. Communications systems are greatly affected by solar weather and electromagnetic disturbances. Due to its proximity to the Magnetic North Pole, geomagnetic storms (which cause the aurora borealis) are more common. Such storms cause electromagnetic interference that can inhibit radio, satellite, and GPS equipment.

2-36. Civilian information availability varies with infrastructure, population centers, and political systems. European population centers, with their denser populations and milder climate, have the highest information availability, especially compared to the more isolated North American Arctic and the strictly controlled Asian

Arctic. In Scandinavia, even the most rural communities are connected to global networks. North American Arctic areas have access to all media, but connectivity is slower and more expensive. Russia conversely exerts significant influence over all Russian information outlets and limits all media access.

INFRASTRUCTURE CONSIDERATIONS

2-37. The remote, extreme environment shapes arctic infrastructure, resulting in significant regional variations. Infrastructure follows population clusters and economic activity as in any other region. However, it is more difficult and expensive to build and maintain in the Arctic.

2-38. Infrastructure is composed of the basic facilities, services, and installations needed for the functioning of a community or society. Given their limited availability and their importance to sustainment, all forms of infrastructure qualify as key terrain.

2-39. Key arctic infrastructure includes—

- Utilities.
- Ground transportation networks.
- Ports of embarkation and debarkation.

UTILITIES

2-40. Electrical, sanitation, and water utilities are generally more expensive due to limited accessibility, especially in rural communities. Units should consider the resource capacity of local populations in their planning factors. This is a strong indicator of larger theater-level difficulties with supply and resupply. Several pipelines run through the Arctic and are considered key terrain due to their economic and sustainment value.

2-41. Cellular and satellite services in the Arctic are significantly more limited than in areas closer to the equator. Cellular service towers and signals are generally limited to cities and villages. All other communications require SATCOM. Geosynchronous Earth orbit satellites that remain over the equator have a low look angle at high latitudes and can often be obstructed by mountains and other land features (see Figure 2-4 for a graphical representation of Geosynchronous Earth orbit satellite coverage). Mountain ranges in the northern hemisphere have the potential to block satellite transmissions and create blackout regions on their northern side. This condition is often called mountain shadow. Northernmost regions often rely on polar orbiting satellites. Because they are moving, they are more difficult to acquire connection. The higher the latitude, the more difficulties occur. Low earth orbit satellites also provide an alternative and reliable connection.

2-42. Soldiers and Marines must be constantly aware of limitations on cellular and satellite services and their effects on imagery, GPS, and communications in the Arctic. GPS positioning can experience degraded accuracy, and SATCOM can become intermittent. Units also maintain analog products for extended periods in the event of communications issues. Analog products are nondigital items such as printed maps, paper, and white boards.

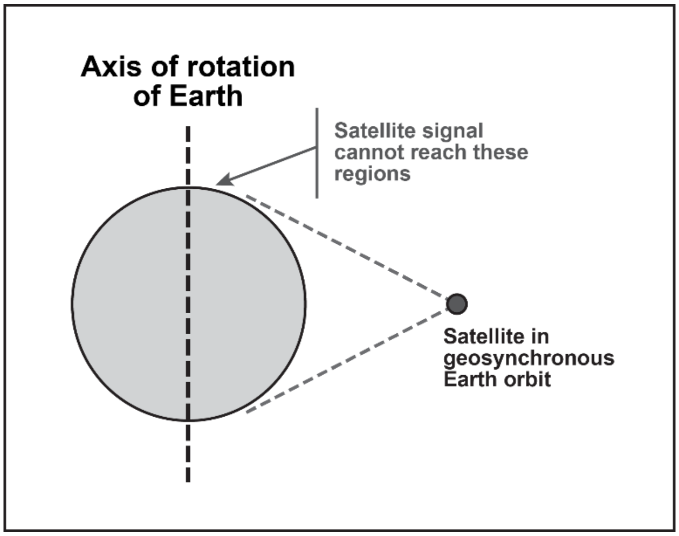


Figure 2-4. Geosynchronous Earth orbit satellite coverage

GROUND TRANSPORTATION NETWORKS

2-43. Ground transportation networks are among the most critical assets for land forces to control. Transportation networks vary widely in the Arctic ranging from highways to natural-made trails to frozen rivers.

Roads and Railroads

2-44. Roads and railroads may be limited and those that do exist are usually vulnerable to enemy action. In addition, climatic conditions may greatly affect their use. Figure 2-5 shows the relative availability of arctic roadways.

2-45. Engineers and scouts heavily scrutinize roadway capacity estimates. Engineers study structural integrity for potential failure due to melting permafrost, snow and ice cover, and freezing and thawing. Roadways experience extreme freeze-thaw cycles. In winter, poorly built roads may experience severe frost heaves, increasing the roughness and reducing throughput. In the spring, many roadways will not be able to support tactical vehicles due to the ground softening as it thaws. To avoid destroying roads during springtime, leaders may need to reduce axle limits on the roads by upwards of 50 percent. Some unsurfaced roads are impassible during spring thaw. This is a major planning consideration for commanders.

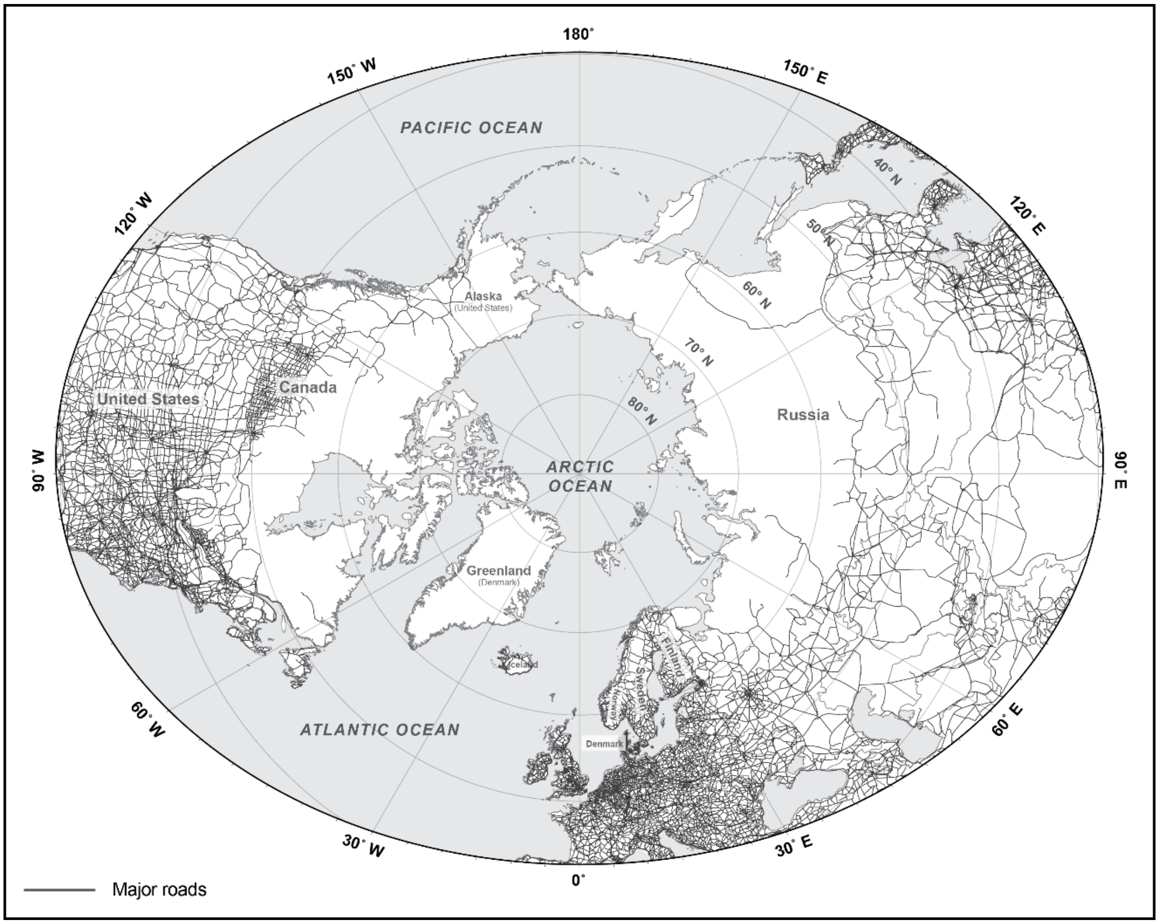


Figure 2-5. Roadway accessibility

Note. Figure 2-5 was generated using data from the World Index Database by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory.

Natural Roadways

2-46. Natural roadways are common in the Arctic and are often the only route to otherwise inaccessible regions of wilderness. Although not manmade, they substitute for major transit networks in more remote regions. They include frozen rivers and trails. In areas dominated by boreal forests, small informal trails are common outside population centers and usually do not show up on topographic maps. Leaders need current aerial imagery and local knowledge to identify these natural road networks.

PORTS OF EMBARKATION AND DEBARKATION

2-47. Airports and seaports always hold substantial strategic and tactical value. In the Arctic, where challenging sustainment and limited mobility are significant, control over these assets becomes essential. In some instances, large enough areas with ice cover can be transformed into natural runways for aircraft. (See Appendix C for ice thickness considerations for aircraft.) Seaport access can be limited due to sea ice, and only ice-class ships can safely navigate to them, which limits land-based support by sea. Thus, ice-free seaports in arctic regions are critical assets for both military and commercial purposes.

PHYSICAL ENVIRONMENT CONSIDERATIONS

2-48. The physical environment is the dominant operational consideration of the Arctic and strongly shapes all considerations. Maritime and land areas have conditions not present in other regions of the world. The climate is extreme. The electromagnetic and space domains have accentuated effects. Informed commanders with trained formations can leverage the environment to their advantage. Conversely, uninformed commanders with under-prepared formations are forced to fight the environment in addition to the enemy. The arctic climate is changing more rapidly than other regions (nearly four times faster than the global average), with permafrost and sea ice receding in all regions. Effective commanders know and consider environmental concerns and mitigate operational impacts on the environment. (For a detailed description of the physical environment, see Chapter 1.)

TIME CONSIDERATIONS

2-49. Time perception in the Arctic is unique and challenging because of two factors:

- Time zones.
- Daylight.

TIME ZONES

2-50. Time zones have a more exaggerated impact on operations in the Arctic. As latitudes and time zones converge at the North Pole, they grow closer together resulting in narrow regions with multiple time zones (see Figure 2-6 for time zones). Russia alone spans seven time zones. Greenland and Canada's arctic regions span four time zones. Leaders must be prepared to synchronize battle rhythms across multiple time zones. Orders, directives, or any form of communication based on time must also account for differences in time zones to avoid miscommunication or confusion.

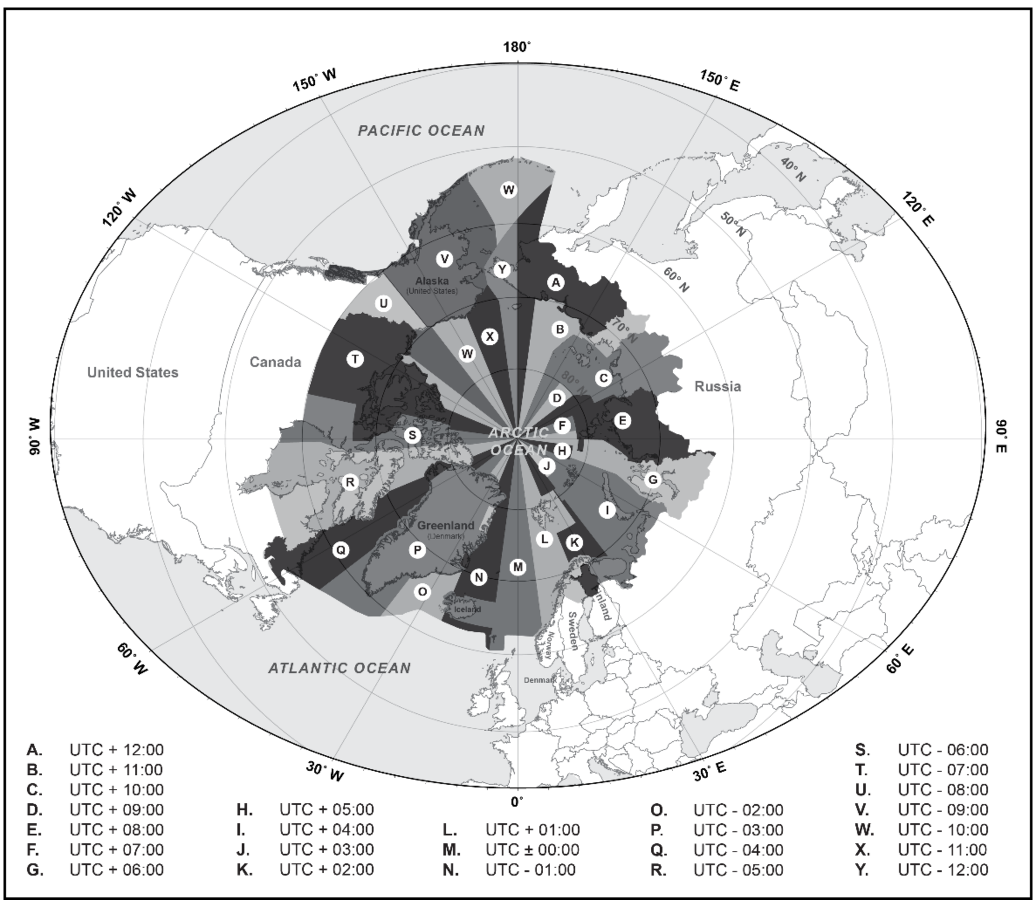


Figure 2-6. Time zone chart

DAYLIGHT

2-51. Arctic daylight hours are exaggerated with long periods of daylight in the summer and darkness in the winter. This phenomenon can skew the passage of time, making hours and days bleed together during prolonged periods of light or darkness. In the summer, when the sun does not completely set near the summer solstice, Soldiers and Marines can experience sleep cycle disruptions and become fatigued. In the winter, when the sun does not rise at all near the winter solstice, Soldiers and Marines can experience degraded performance physically and psychologically. (For more information on the effects of light phenomena, see paragraph 1-114.)

SECTION II – THE COMPETITION CONTINUUM IN THE ARCTIC

2-52. Army doctrine describes the competition continuum through three strategic contexts in which Army forces conduct operations. The contexts are the broad categories of strategic relationships between the United States and another strategic actor relative to a specific set of policy aims. The three strategic contexts are—

- Competition below armed conflict (simply called competition in the rest of this manual).
- Crisis.
- Armed conflict.

Activities throughout the competition continuum as outlined in FM 3-0 remain the same in the Arctic but have special considerations. This section describes those arctic-specific aspects.

COMPETITION IN THE ARCTIC

2-53. U.S. objectives for the Arctic during competition include maintaining security and developing capabilities necessary to expand arctic activity (such as defense, commercial, and scientific) and international cooperation. The Army and Marine Corps can support national objectives in the Arctic by preparing and maintaining a capable and credible force trained and equipped for arctic operations. These forces prepare for large-scale combat operations in arctic conditions by—

- Training and developing leaders for operations in arctic conditions.
- Building allied and partner capabilities and capacity as well as improving joint and multinational interoperability.
- Preparing to transition and execute operation plans.
- Setting the theater.
- Protecting forward-stationed forces.

2-54. These forces prepare for large-scale combat operations in arctic conditions by training and developing leaders for operations. A capable and credible arctic force depends on leaders and troops experienced in cold weather conditions and extreme environments. Units based in arctic regions develop unique capabilities, such as skiing, snowshoeing, and other extreme cold weather skills. Non-arctic units foster cold weather fundamentals, which are considered basic Soldier/Marine skills. Such training and experience depend on specialized equipment. Therefore, during competition, forces develop and improve equipment optimized for the arctic and continually increase over-snow, soft-ground, and rough terrain mobility.

2-55. Another method to prepare forces for large-scale combat operations involves building allied and partner capabilities and capacity as well as improving joint and multinational interoperability. Joint and multinational exercises are essential activities during competition. They demonstrate combat and combined arms capabilities, promote deterrence, and enhance interoperability. Such exercises are fundamentally important for arctic operations and emerging capabilities since they—

- Familiarize units with challenges of the Arctic.
- Refine planning factors necessary in crisis and armed conflict, such as mobilization and deployment timelines.
- Reduce planning uncertainties and assumptions.

2-56. Preparing to transition and execute operation plans is another way forces prepare for large-scale combat operations in arctic conditions. Given the unique skill set and equipment required for arctic operations, units need significant force tailoring analysis during competition. Leaders determine the right mix of forces, unit training objectives, mission tasks, and materiel acquisition strategies prior to crisis or armed conflict. Without preparation, units can rarely train and equip rapidly for arctic operations in response to crisis or armed conflict.

2-57. These forces prepare for large-scale combat operations in arctic conditions by setting the theater. Units set the theater by using military engagements, security cooperation, and other activities to assess and understand the current conditions within the theater. These same units then execute specific theater setting activities to support joint forces and other unified action partners.

2-58. Lastly, forces prepare for large-scale combat operations in arctic conditions by protecting forward-stationed forces. The protection of forward forces is essential. U.S. forces implement procedures and conduct necessary activities to ensure they, and the joint or partner forces they protect, can endure an initial attack with little early warning. Forward forces enable a mission to succeed.

2-59. Russian goals in the Arctic during competition relate to border security and economic interests. Melting arctic sea ice exposes and makes Russia's northern borders vulnerable. Russian military activities focus on developing defense infrastructure along the entire Arctic Ocean coast as a buffer zone (see Figure 2-2 on page 50 for locations of Russian arctic military infrastructure). The Kola Peninsula is the traditional location for Russian force projection into the Arctic Ocean and North Atlantic including the Bear Gap, Barents Sea, North Sea, Norwegian Sea, and the Greenland, Iceland, and United Kingdom gap (See Figure 2-9 on page 64 for a notional example of Russian force projection from the Kola Peninsula). Defenses consist mainly of naval, infantry, and air defense capabilities with several arctic-specialized brigades. Coastal defense capabilities from the Kola Peninsula to the Bering Strait include fixed or mobile missiles and fixed or mobile artillery. From an economic perspective, Russia seeks to control the Northern Sea Route, expand its extended continental shelf claims, and expand its access to arctic natural resources.

2-60. During competition, China aims to increase political and economic influence in the Arctic region. It seeks increased access to resources and shipping routes and increased influence in governance. China has particular interest in establishing a "Polar Silk Road," a shortened shipping route from China to Europe (see Figure 2-7 for Chinese shipping routes). China has declared itself a "near-arctic state" as an effort to legitimize its actions in the region. Additionally, China has used economic investment with Russia as a means to gain access to the Arctic.

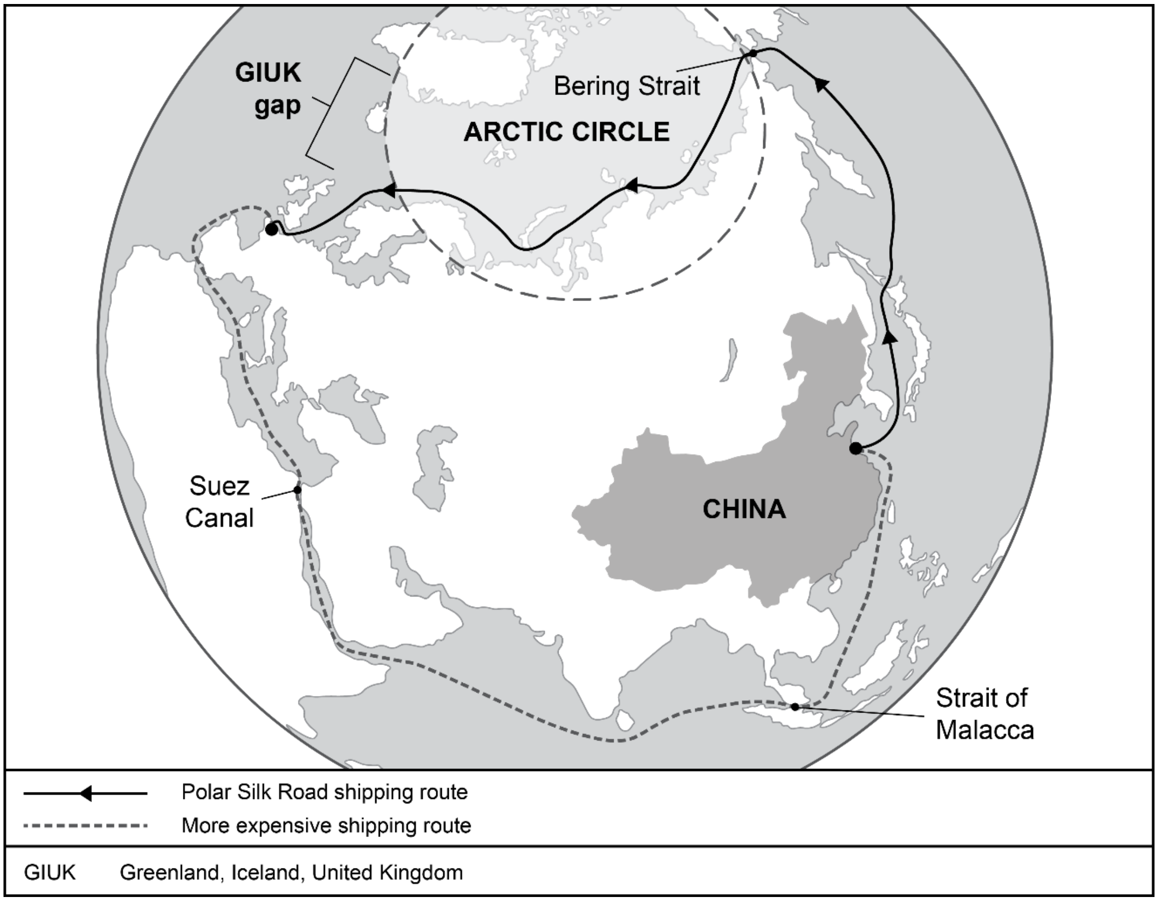


Figure 2-7. Chinese polar silk road shipping route

CRISIS IN THE ARCTIC

2-61. Army and Marine Corps forces deploy during a crisis to deter an adversary from escalating a crisis to armed conflict. Should deterrence fail, these forces are positioned and prepared to defeat enemy forces. (See FM 3-0 for information on preparation for crisis.) The Arctic creates force projection challenges for U.S. forces responding to a crisis. Key challenges during crisis in the Arctic are opening the theater; reception, staging, onward movement, and integration (RSOI); and sustainment. Planners expect few ports of debarkation in an arctic theater. Sustainment and RSOI activities experience extended timelines due to limitations common to the Arctic. Limitations include reduced infrastructure, supply chain issues, difficult transit, and increased consumption rates. Sea ice also limits access for bulk shipments by water. In some regions, supply by water is limited to July, August, and September. Seasonal limitations require units to deploy with redundant equipment and supplies and increased analog products over multiple seasons.

2-62. Crisis contingency planning needs to consider the training, equipping, acclimatization, and degraded efficiency of units untrained in arctic operations. During a crisis, there are limits to the number of arctic-trained, deployable forces. Units specifically trained and equipped for arctic operations may have responsibilities in other nonarctic theaters of operations during a crisis. Arctic-specialized units often require additional support from other units. Therefore, headquarters may require units untrained in arctic operations and from any home duty station to support an arctic region. Such units would require additional cold-weather training and equipment, preferably prior to deployment. If training and equipping cannot be provided in advance, leaders deliberately plan it into RSOI. Units schedule additional time into RSOI for acclimatization. Many pieces of equipment require winterization and modification kits for extreme cold temperatures. Such maintenance significantly increases resources and time required for action. If deploying during a cold season, units winterize equipment before deployment. If equipment must be winterized in theater during RSOI, then planners expect for substantial delays common with cold-weather maintenance. Units can reduce risks to mission and personnel by conducting routine training on cold-weather fundamentals before a crisis occurs. Fundamental training includes clothing layer management, cold-weather bivouacking, and equipment maintenance. Such skills can be trained in any cold environment. Developing basic cold weather skills reduces the time it takes a unit to adapt to the arctic and drastically reduces risk of CWIs.

ARMED CONFLICT IN THE ARCTIC

2-63. It is less likely that armed conflict would occur strictly because of tensions in the Arctic. More likely, the Arctic would serve as a secondary, yet vital, theater of a larger conflict where tensions spill into the Arctic. The Arctic is a region of homeland defense and force projection since it has a short access of advance between the East and West. It also has several critical resources, ports, air and sea LOCs, and bases of strategic value during times of war.

2-64. Despite the challenges posed by arctic conditions, Soldiers/Marines must be able to conduct offensive and defensive operations to close with and destroy enemy forces. Soldiers/Marines support the joint force and other Services through multiple actions, to include but not limited to establishing command and control on land and conducting large-scale combat operations. (See FM 3-0 for information on Army forces operating as part of the joint force.)

FRIENDLY ARCTIC OPERATIONS

2-65. Scenarios for ground forces involvement during armed conflict in the Arctic include NATO defense operations in Europe and homeland defense in North America. Potential areas of contention are areas relevant to naval choke points. Such choke points include the Greenland, Iceland, and United Kingdom gap towards the Atlantic and the Bering Strait towards the Pacific. U.S. ground forces prepare for contingencies to reinforce allies in the European Arctic and to protect important infrastructure for air and sea LOCs from the United States to Europe. U.S. ground forces prepare for homeland defense missions with allies and partners. Key tasks include to secure and retain key terrain, deny enemy access, and if necessary, interdict and isolate enemy forces.

2-66. Ground forces always conduct Arctic operations as part of a joint force, and usually as part of a multinational coalition during large-scale combat operations. A foreign NATO commander with extensive arctic experience and large, specially trained forces would likely assume command of an allied joint force in the Arctic. As such, Soldiers/Marines need to understand allied tactics in arctic operations and promote interoperability.

Historic Objectives in European Arctic Combat

A historical look at arctic warfare provides a foundation for considering potential future conflict. During World War I and World War II, the Arctic Ocean was a critical supply line for Russia, which received hundreds of thousands of tons in war-critical minerals and general cargo in the port of Murmansk. Supplies were shipped from the United States, United Kingdom, and France. During World War II, Germany invaded Norway in April 1940 to control ports used to export substantial quantities of ore from Sweden and to provide basing for potential air strikes on the United Kingdom. The Nazis invaded using amphibious assaults and airborne drops. By June 10, 1940, the Norwegians surrendered, and German forces occupied the country. In 1941, the Germans allied with Finland and planned to seize the Russian port of Murmansk and the railway from Murmansk. If the advance succeeded, it would have severed an important supply source for Russia. However, the Nazis were unprepared for arctic operations, which prevented them from making any significant advances toward Murmansk beyond the Finnish border. Figure 2-8 depicts German objectives in the Arctic during World War II.

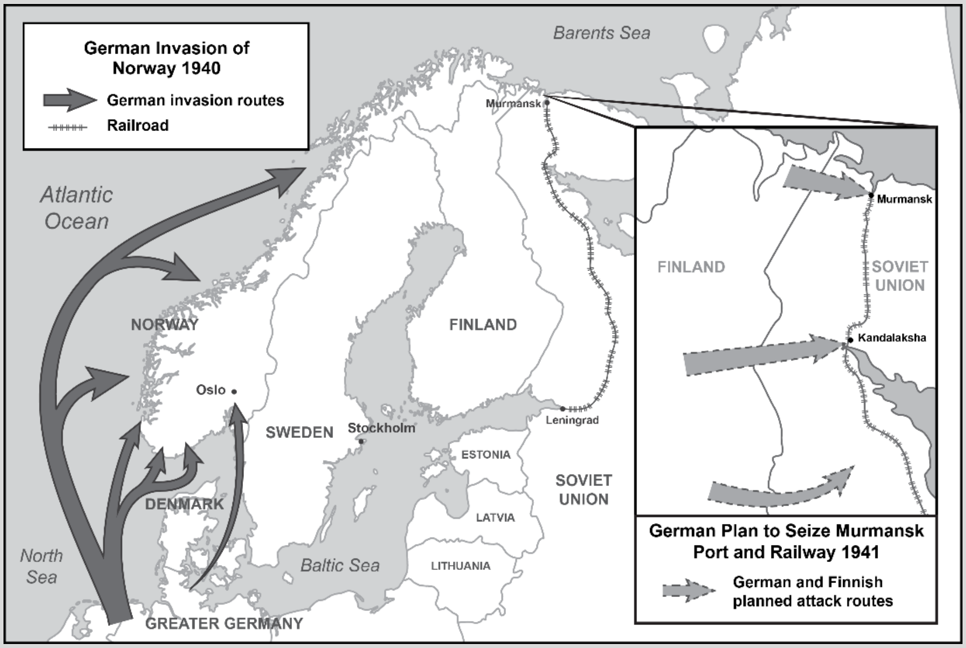


Figure 2-8. German arctic objectives during World War II

ARCTIC ENEMIES

2-67. Potential enemy ground force objectives in the Arctic would likely be to seize European ports and railways. This seizure would allow maritime forces to have freedom of maneuver to project from the Arctic Ocean into the northern Atlantic Ocean, to control sea and air LOCs to North America, and to maintain waters and air space above Northern Europe. Large-scale invasions of North America from the Arctic Ocean would be difficult to sustain but would not be completely infeasible. If attempted, maneuver forces would likely include significant airborne forces aimed at capturing key terrain and establishing footholds for airpower. Smaller elements could attempt infiltration and sabotage. Objectives in Asia would likely involve retaining forward bases, nuclear capabilities, and anti-air capabilities to prevent envelopment and aerial advances over the North Pole. Figure 2-9 depicts a notional example of one of numerous potential adversary objectives and depicts actions from a northern bastion defense.

2-68. Potential enemies in the Arctic could possess peer capabilities able to conduct protracted large-scale combat operations over multiple seasons and in the coldest regions on Earth. Such a force would likely be well acclimatized to subzero temperatures with specialized units, equipment, and personnel in both conventional and special forces. Specialized units train year-round in arctic and subarctic climates, with nonarctic units rotating for arctic training events. The most likely unit compositions are—

- Mechanized infantry outfitted with over-snow vehicles supplemented by dogsled and reindeer-sled capabilities.
- Mechanized infantry outfitted with subzero capable all-terrain vehicles.

Historically, military forces operating in arctic conditions involve smaller maneuver formations than in other areas, but these formations require larger sustainment packages than in other environments.

Figure 2-9. Notional example of potential adversary objectives during armed conflict

> ***Note.*** Figure 2-9 represents a notional example of one of numerous potential adversary objectives. The depicted unclassified scenario was provided by the NATO Cold Weather Centre of Excellence – Cold Weather Operations. Leaders base actual assessments on timely, relevant, accurate, and predictive intelligence.

2-69. The most dangerous enemy forces task-organize for combined arms. They would include subzero capable cavalry, armor, artillery, rotary-wing, antiair, and amphibious assets specialized for severely restrictive terrain. Arctic enemies would likely employ similar operational principles as allied forces and would take advantage of their experience with the polar climate. Arctic enemies are a challenge, but they do have weaknesses. The goal of operational planning is to find and exploit enemy weaknesses to gain relative physical, information, and human advantages toward victory. (See discussion beginning with paragraph 2-98 for more information on relative advantages. See Appendix E for examples of potential enemy equipment.)

SECTION III – PRINCIPLES OF ARCTIC OPERATIONS

2-70. The principles of arctic operations are—

- Campaign mentality.
- Cold weather capability.

- Isolated endurance.
- Arctic task organizing.

Leaders apply these principles in preparation and anticipation for arctic operations, which takes significant dedication and command emphasis. If caught unprepared, a unit rarely can rapidly adapt and implement these principles to their highest potential.

CAMPAIGN MENTALITY

2-71. The first and fundamental principle of arctic operations is to consider all operations as part of a campaign that may extend significantly longer than expected. No matter how overwhelmingly favorable the odds, commanders cannot assume that an engagement will conclude swiftly and decisively. Everything in the Arctic is time consuming and units must be prepared for a long, protracted conflict over multiple seasons. Even at the lowest tactical level, leaders prepare for operations to take hours, days, or weeks longer than anticipated. At the operational and strategic levels, leaders plan for operations to take months or even years longer than expected.

2-72. Just as commanders use the environment as an obstacle and a weapon, they should expect the enemy to do the same to prolong operations. Often the enemy is not bound by one position; the isolated nature of the Arctic means that very few pieces of terrain hold significant value except in relation to the enemy and the ability to affect their LOCs.

Short-Sighted Military Campaigns

History holds many examples of short-sighted units that underestimated how long arctic and extreme cold weather operations take. These units therefore were left unprepared for protracted conflict in the cold against an enemy capable of leveraging the environment:

- In 1939, the Soviet Union invaded Finland, expecting a rapid victory in just two short weeks. Instead, Soviet forces were drastically unprepared for the difficulties of the Arctic and the fighting spirit of the Finns. The resulting Russo-Finnish War lasted over three months ending in a peace agreement but caused the deaths of more than 200,000 Soviet soldiers, many by cold and starvation.
- In 1941, Nazi Germany invaded the Soviet Union, which included operations through Finland. Early German estimates predicted operations would only take three months, but the Continuation War lasted longer than three years before the Germans were eventually expelled from Finland. The German effort suffered from short-sighted logistics plans and a failure to plan for the cold. The Nazi invasion was extended for so long that Germans eventually established training courses conducted by the Finns to rotate troops out of combat to properly train them how to conduct combat in snow and muskeg.

These examples show that arctic operations are a subtle chess match where the contest is not won in a single decisive blow. Instead, the goal is to outsmart and outmaneuver one's opponent until they are incapable of continuing. Commanders seek to cut off opponents' ability to sustain their operations, envelop opponents completely, or overextend an attacker.

2-73. With a campaign mentality, sustainment is planned in-depth and for endurance. Planners forecast required resources and materials long in advance to ensure that fighters can continue uninterrupted. Key terrain in the arctic environment may be infrastructure to enable sustainment. Even small fighting forces require deliberate planning and resources exponentially higher in arctic operations than other operations.

2-74. Having a campaign mentality is more than just planning for a long duration. It also includes preparing for transitions. The sixth imperative of multidomain operations is to anticipate, plan, and execute transitions. (Refer to FM 3-0 for multidomain operations.) Leaders must think six months ahead for transitions since resources in the Arctic are not easy to reallocate or transport. Important transitions in arctic operations are—

- Terrain.
- Seasons.
- Weather.
- Personnel.

TERRAIN TRANSITIONS

2-75. Arctic terrain changes rapidly and directly impacts operational and tactical approaches. These transitions include—

- Tundra and boreal transitions.
- Mountain transitions.
- Maritime transitions.

Tundra and Boreal Transitions

2-76. The tree line sharply segments the boreal region from the tundra and marks a distinct change in tactical approach. Commanders must plan for this tactical shift. When transitioning from boreal terrain to tundra, commanders ensure units decisively control transportation routes to allow large cross-country equipment to move freely. A strong defense at the tree line gives good cover, concealment, and stand-off to provide adequate time for the transition and passage of lines. Planners keep engineer assets ready to prepare combat trails through snow or muskeg.

2-77. When transitioning from tundra terrain to boreal forests, commanders anticipate heavy defensive resistance. Commanders consider the type of mixed forces required to close with the enemy over open terrain against the defense versus those forces required to finish and follow through with the attack in a forested region. Larger vehicles lose mobility in the trees, while light forces are more vulnerable across open terrain. Units avoid using major road networks as the initial avenue of approach until they can secure the surrounding forests. The enemy often seeks to lure and canalize forces onto restrictive roadways to set up an ambush.

Mountain Transitions

2-78. There are many mountainous regions throughout the Arctic. Transitions to this type of terrain often require specialized training and equipment such as climbing gear. (Refer to TC 3-97.61 for specialized training for mountain operations.) The term “high latitude” refers to the arctic region whereas “high altitude” refers to the mountain region. While both can share characteristics of extreme cold weather, units require distinctly different skill sets to operate in each region.

2-79. Commanders should not assume that troops trained in arctic operations have all the necessary capabilities to operate effectively in mountain operations (and vice versa). These two types of operations share many similarities such as cold weather, degraded mobility, difficult communication, and challenging sustainment. The cause of their difficulties and the approach taken to overcome them differ in many ways. The Arctic experiences these difficulties because it is near the top of the world. Its location drastically changes many fundamental properties of nature in counterintuitive ways, such as aurora borealis, the midnight sun, and permafrost. Mountains experience their difficulties because they are closer to the edge of the atmosphere and because of the general shape of mountain terrain, which alters conditions in more predictable, albeit challenging, ways.

2-80. Even though arctic and mountain operations differ, the baseline skill sets required of each of them significantly overlap, such as operating in the cold and planning sustainment in depth. Therefore, troops strictly trained in one or the other, still have a much shallower learning curve and are more prepared when transitioning. The key is to understand the subtle, yet important, differences between the two and to plan and adapt accordingly. (For more information on mountain operations, refer to ATP 3-90.97.)

Maritime Transitions

2-81. The unique characteristic of the arctic maritime domain is that, in many areas, it transforms into the land domain with the change of the seasons. During the winter, lakes, rivers, and even large areas of the Arctic Ocean can freeze and become giant land bridges that units can cross by foot. During the summer, these same areas once again become navigable by watercraft. Commanders anticipate these transitions and the effect it has on—

- Defense.
- Sustainment.
- Equipment.

Defense in Maritime Transitions

2-82. When considering defense, commanders adjust defensive positions well in advance before the terrain transitions. During the summer, waterways create natural obstacles. However, once frozen, if these waterways are left inadequately defended, they become avenues of approach for the enemy. For example, in 1658 during the Dano-Swedish War, Sweden marched its army across several poorly defended frozen straits connecting the Danish Islands. The maneuver took Denmark by surprise and forced its immediate surrender.

Sustainment in Maritime Transitions

2-83. When considering sustainment, commanders acknowledge that access by sea will often be halted during the winter. Logisticians plan six months to a year in advance of any transport by sea in arctic waters. To complicate matters, even during periods of freeze, units still need to defend seaports since they remain as key terrain. Logisticians need to plan for alternate means of sustainment other than by sea to support these defenses, likely by air.

Equipment in Maritime Transitions

2-84. When dealing with inland waterways, maritime transitions require the movement of specialized boating equipment. Appropriate timing is required to ensure boats can enter theater as soon as possible and can also be evacuated from the area before waterways freeze. Logisticians assess means of transportation (water, land, and air) and create multiple contingencies for delivery and evacuation.

SEASONAL TRANSITIONS

2-85. Tactics, equipment, and asset availability dramatically change as seasons transition. Commanders take special precautions to plan for seasonal shifts. Commanders avoid overextending units in the summer, so as to make winter sustainment untenable. In the winter, commanders avoid trapping themselves by water features that will thaw in the summer and potentially become impassible. (For additional tactical considerations for arctic seasons, see discussion beginning with paragraph 3-24.)

2-86. As seasons shift, commanders ensure planners forecast proper equipment. As summer turns to winter, units prepare by supplying equipment such as skis, snowshoes, over-snow vehicles, protective clothing, and other specialized cold-weather equipment. As winter turns to summer, units transition to using equipment such as boats, mosquito repellant, and other assets more available in warmer months.

2-87. Ultimately, troops need to be prepared for all seasons and plan with a campaign mentality. Arctic operations rarely have a short duration, and units must have all seasonal equipment accessible in some capacity from the moment of deployment. Units cannot expect fulfillment of last-minute emergency resupply requests in a timely manner. Figure 2-10 depicts a sample chart of seasonal considerations.

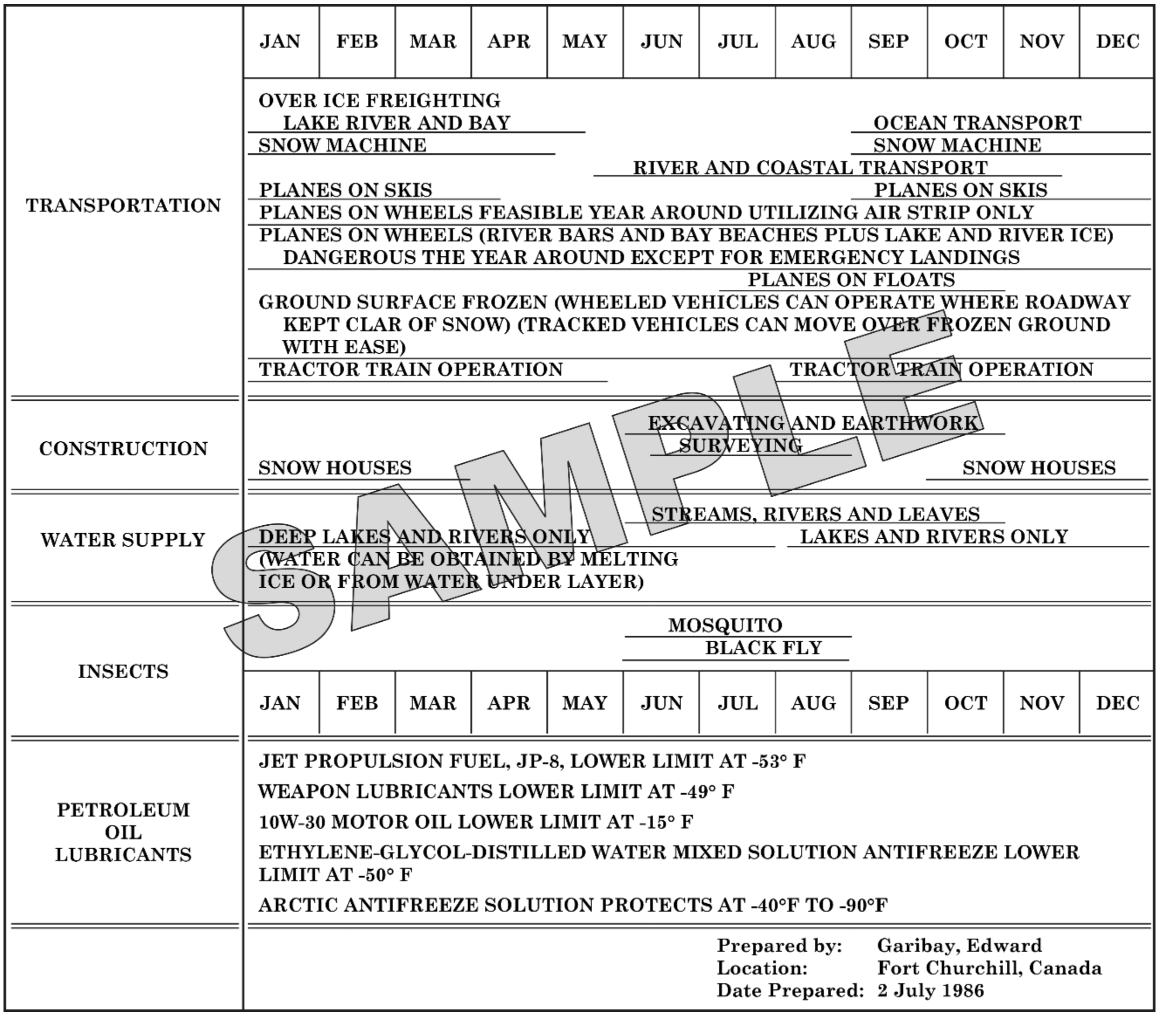


Figure 2-10. Sample work feasibility chart

Note. Sample historical data collected from Fort Churchill, Canada.

WEATHER TRANSITIONS

2-88. Weather shifts are swift and violent. However, units often can plan for these transitions with increased attention to staff weather operations. Short-term weather forecasts should include the next 1 to 2 weeks at a minimum. Weather planning horizons should include weeks and months with historical trends from previous years. Figure 2-11 depicts a sample long-term weather forecast for an arctic region. (For a detailed list of weather conditions, see discussion beginning with paragraph 1-89.)

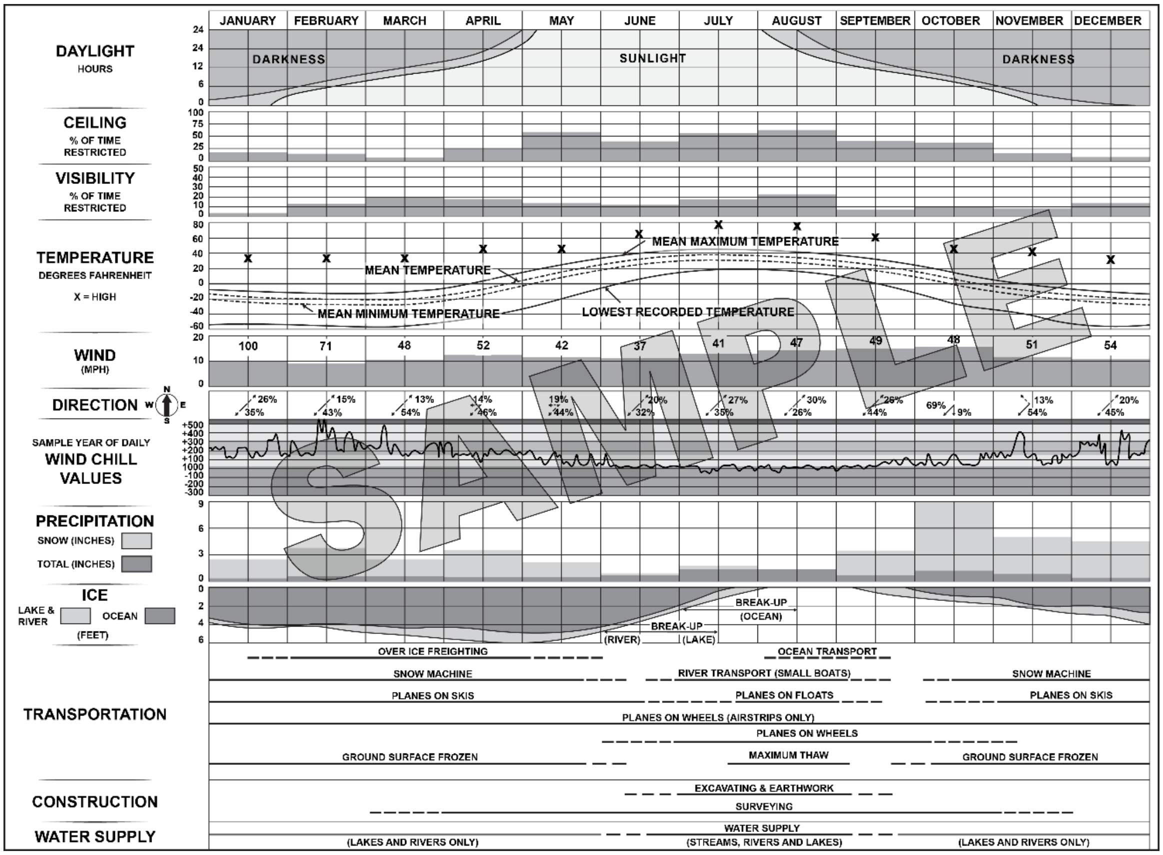


Figure 2-11. Sample long-term weather forecast

Note. Sample historical data collected from Point Barrow, Alaska.

PERSONNEL TRANSITION

2-89. Arctic operations are incredibly strenuous on a unit and its personnel. Commanders understand this strain and continuously plan to transition units from the main effort through passage of lines or relief in place. This transition is critical to maintaining not only high morale, but also endurance and readiness. Tactical patience is of the utmost importance. Commanders must have a deep understanding of their unit's pace and endurance. In an arctic environment, units cannot continuously exert maximum effort. Commanders and staff carefully consider when to hold back and when to exploit windows of opportunity.

2-90. Warmth plays a considerable factor in a unit's ability to fight. After two weeks of constant exposure, units begin experiencing degraded readiness. For this reason, successful commanders at all levels deliberately plan personnel transitions and cycle troops rearward to receive increased access to warmth and hot rations. Even if this transition is only from the front line to a heated area for a few hours, the positive impact can be substantial.

The Sausage War

The importance of personnel transitions was displayed during the Battle of Varolampi Pond in December 1939 in the Winter War. During the battle, two Soviet infantry battalions infiltrated the Finnish rear area. After an intense 5-day march in the blistering cold with poorly suited clothing and equipment, the Soviets launched an immediate raid. The surprise attack caused a swift retreat by the Finnish sustainment unit. Instead of capitalizing on the attack with an immediate pursuit, the Soviet forces were instead distracted by the smell of hot sausage soup left behind by the Finns. The Soviets abandoned their offense in favor of a warm meal. This gave the Finnish troops time to regain their wits and muster together a small group of cooks and supply clerks to launch a counterattack. Exhausted from the elements and distracted by the food, the Soviets were forcefully repelled and suffered five times the casualties as the Finns. As a result of the dramatic impact warm food had on the engagement, the battle was dubbed "the Sausage War."

COLD WEATHER CAPABILITY

2-91. The most imposing and hazardous factor of the Arctic is the cold. While many other unique characteristics hinder and degrade capabilities in the Arctic, the cold stands out as the most debilitating to all operations. To overcome it, in addition to the enemy, a unit must develop its cold weather capability.

2-92. ***Cold weather capability* is the ability to survive and operate in cold environments without being significantly degraded by the elements.** Survival skills are not enough—a unit must be able to conduct their mission effectively even in the harshest cold. Units that can survive but are severely impaired in cold conditions are not cold weather capable.

2-93. Building cold weather capability is essential to gaining relative advantages over the enemy. There are three training thresholds for building cold weather capability:

- **Survive**: Survival in cold weather is the ability to withstand the cold environment without injury or death. Equipping and training troops to survive is the foundation of cold weather capability. Basic survival training is relatively straightforward to teach, and protective clothing and equipment (if used properly) work very well.
- **Operate:** Operating in cold weather is the ability to accomplish required missions and tasks at low temperatures without significant degradation. Those who can both survive and operate are cold weather capable. Reaching the operate threshold takes substantial time, resources, and dedication.
- **Master:** Mastery in cold weather is the ability to use the environment as an advantage against a less prepared and less informed enemy. The fifth imperative of multidomain operations is to impose multiple dilemmas on the enemy (as noted in FM 3-0). Once friendly forces reach the mastery threshold, cold region weather and terrain present ample opportunities to impose additional dilemmas. Units achieve mastery by developing considerable relative advantages over the enemy through diligent training, preparation, and acquisition of specialized purpose-built equipment.

2-94. Those who are *below* the survival threshold risk significant nonbattle injuries and ineffectiveness. Those who are *at* the survival threshold (but cannot yet operate in the cold) experience less cold weather injuries but are still severely degraded. They spend most of their time in self-preservation and are significantly limited in their warfighting capacity. Commanders must weigh the risk versus the necessity of sending non-cold-weather-capable units to cold regions. Non-cold-weather-capable units must plan significant contingencies to account for nonbattle injuries, equipment failure, increased timelines, and an overall higher likelihood of mission failure. Cold weather capable units (those that can survive and operate) can employ their warfighting capabilities freely. They mitigate cold weather injuries and are well-trained and equipped to implement specialized techniques. Commanders who employ cold weather capable troops observe more predictable results and can plan more reliably.

2-95. Figure 2-12 represents the investment of time and resources necessary to develop cold weather capability. Note that the survival threshold only requires a minimal investment. The time and resources required significantly increase to reach the operate threshold. Survival training only teaches individuals how to take care of themselves. The true challenge begins when they must learn how to effectively conduct their mission (especially in a tactical environment). Commanders prioritize cold weather capability and block out specific time to train for the cold weather. Without command support, cold weather training will not receive the necessary emphasis.

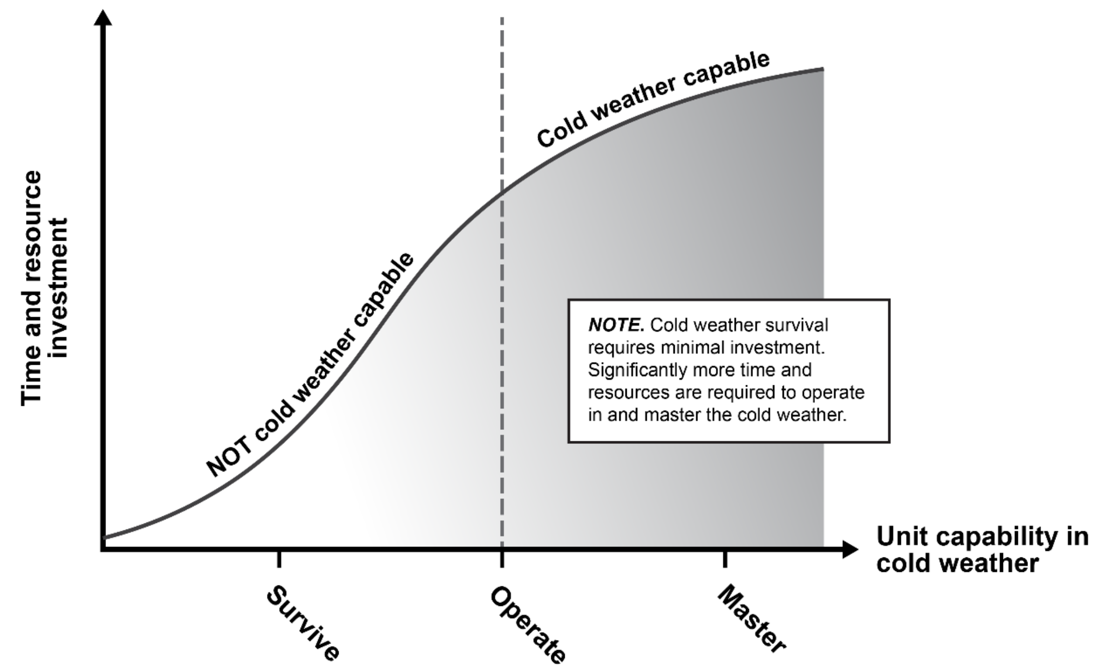


Figure 2-12. Time and resources required to attain cold weather capability

Note. As a general rule, investment in cold weather capability is 20 percent equipment and 80 percent training.

Sirius Dog Sled Patrol

Not all units will be capable in every cold environment. As temperatures drop, fewer capabilities will be available, maneuver forces will be smaller, and sustainment requirements will be exponentially higher. Units will likely have to modify their force structure and how they employ their capabilities based on the climate. For instance, the Danish Sirius Dog Sled Patrol is a special forces unit that consists of only 12 personnel that patrol the Greenland ice sheet. In 2-person teams, they embark for four to five months at a time by dog sled to conduct patrols in temperatures down to -70 °F. They require thorough personnel screening, extensive training, the best equipment, and incredibly forecasted sustainment that is prepositioned, airlanded, or air dropped.

2-96. When assessing a unit's cold weather capability, commanders consider—

- Methods to tailor their force to overcome the environment.
- Additional equipment, funding, and acquisition time required. Consideration must also be given to the time required to train on new equipment.

- Modifications necessary for unit equipment to operate in extreme cold and the time required to install.
- Unit and individual training required and the time necessary to conduct it.
- Time required for acclimatization.
- The effect on readiness when trained personnel leave the organization and untrained personnel arrive.
- Risk mitigation factors.

2-97. Based on a unit's cold weather capability and the climate a unit is deploying to, planners consider:

- The amount of resources that must be prepositioned.
- Total time required to equip, train, mobilize, and acclimatize units.
- Risk mitigation factors for units deploying to climates beyond their cold weather capability.

DEVELOPING COLD WEATHER CAPABILITY THROUGH RELATIVE ADVANTAGES

2-98. A *relative advantage* is a location or condition, in any domain, relative to an adversary or enemy that provides an opportunity to progress towards or achieve an objective (FM 3-0). Cold weather capability is tied to building relative advantages in the three dimensions: physical, information, and human. In the physical dimension, units need sufficient equipment and technology to withstand the weather. This is a prerequisite to all training and operations. The information dimension connects humans to the physical world. Leaders and planners understand the OE and the limits placed on operations by weather while taking advantage of opportunities. The human dimension is the most important factor in the Arctic. Soldiers and Marines must maintain themselves and their equipment as well as have the discipline to do so without being told. They require skills to operate in the Arctic; more so, they require confidence in their skills and the skills of their fellow Soldiers and Marines.

2-99. Cold weather capability is built through rigorous preparation of one's unit to thrive in the cold better than the enemy. Commanders must always seek relative advantages in the physical, information, and human dimensions. While some of these advantages are situational (such as positioning and combat ratios), most cold weather advantages cannot be produced in the moment. Units must prepare and develop these advantages long before operations begin.

Physical Advantage

2-100. Physical advantages include tactical positioning, use of terrain, and access to resources, which are gained during operations. Regardless of those advantages, a unit will be at a disadvantage in the Arctic without prior development of physical advantages in equipment and camouflage.

Equipment

2-101. Equipment accounts for only the first 20 percent of cold weather capability but is essential to maximizing other advantages. Soldiers and Marines require appropriate cold weather gear to even begin cold weather training, let alone operate in it. Units with superior cold weather clothing sustain fewer injuries and have higher efficiency. Other equipment includes purpose-built equipment and over-snow equipment.

2-102. Purpose-built equipment provides the highest level of advantages in the Arctic. However, if purpose-built equipment is not available, troops will need to modify unit equipment to be winterized using adapters and modification kits. These modifications provide advantages over nonmodified equipment, but not nearly to the same extent as purpose-built equipment.

2-103. Over-snow equipment consists of skis, snowshoes, and vehicles. This equipment provides a marked advantage in mobility but must be acquired in advance and trained on. Troops will not have the opportunity to learn how to ski, for example, in their spare time before an operation. Vehicles and other machinery require additional expertise. Expertise in cold weather maintenance maintains tempo and readiness. This expertise can include the use of low-temperature capable fluids, knowledge of frequent malfunctions, upkeep procedures, and familiarity with specialized equipment. (For more information on the effects of the environment on equipment, refer to TM 4-33.31.)

Camouflage

2-104. The backdrop of the Arctic makes detection significantly more likely, and units must prepare to operate under constant surveillance. Units acquire arctic camouflage for all seasons and train to conceal their troops from visual, thermal, and electromagnetic detection. Visually, the Arctic has a unique palette of colors. Shades of white and grey are necessary in the winter, and more woodland shades are needed in the summer. Units that can blend and transition between these two seasonal shades hold distinct advantages. Units must acquire necessary camouflage for personnel and equipment to avoid easy detection against a white backdrop. Cold temperatures increase the chances of thermal detection by the enemy. Troops require specialized training to employ thermal shelter techniques to reduce heat signatures. Due to the limited population in the Arctic, the enemy can more easily discern electromagnetic signatures in the wilderness. Units practice dispersion to disguise high priority targets such as command posts to make them less attractive targets for the enemy. (For more information on camouflage, see discussion beginning on paragraph 9-10. For detailed steps on individual camouflage techniques in a cold weather environment, refer to TC 21-3.)

Information Advantage

2-105. An *information advantage* is a condition when a force holds the initiative in terms of situational understanding, decision making, and relevant actor behavior (ADP 3-13). It is the operational benefit derived when friendly forces understand and exploit the informational considerations of the OE to achieve information objectives while denying the threat's ability to do the same.

2-106. In an environment of degraded communications, imagery, and predictability, mastery of information is imperative. Means of gaining relative information advantage in the Arctic are—

- Superior weather and terrain analysis.
- Superior understanding of the OE.
- Mission command.

Superior Weather and Terrain Analysis

2-107. The extreme arctic environment affects operations more so than any other factor. The Arctic will injure and kill anyone dangerously exposed to the environment. Because of this, units that possess a superior understanding of weather and terrain can use it to their advantage. The Arctic has many unique physical properties that are counterintuitive to those from a temperate climate. For this reason, the SWO/METOC is an invaluable subject matter expert, but SWOs/METOCs should not be the only ones capable of understanding the environment. All Soldiers and Marines should be educated on arctic terrain and weather as well as the tactical meaning associated with it (the "so what?"). Leaders at all levels studiously examine the physical characteristics of the Arctic (see Chapter 1) and take every opportunity to incorporate weather and terrain analysis into training. Units hold large-scale and lengthy field training exercises to build an understanding of the physical environment. Whenever possible, units encourage and incentivize Soldiers and Marines to conduct multiple tours of duty in arctic locations to build enduring knowledge and understanding.

Superior Understanding of the Operational Environment

2-108. Soldier and Marine understanding of the OE starts with a deep appreciation of the physical environment including weather and terrain. This appreciation is further enhanced by an understanding of all operational considerations described in the discussion starting with paragraph 2-1. This provides troops with context as to why their training is so important and why they need to continue to adapt to the extreme environment.

2-109. Arctic training is tough. Therefore, troops need to understand the purpose behind it and have confidence that their leaders are safely developing them to meet the challenge. Without shared understanding of the OE, Soldiers and Marines tend to view arctic training as pointless and unnecessarily difficult. However, when leaders and their subordinates better understand the OE in which they will fight, they become more creative, adaptive, and motivated in their preparation and development.

Mission Command

2-110. Given atmospheric interference, satellite challenges, and the potential for enemy electromagnetic warfare, degraded communications often occur in the Arctic. Units that can overcome this challenge and maintain a higher speed of decision making and action hold an important information advantage. Because of this, mission command is the standard in arctic operations. Leaders should empower their subordinates to take action and capitalize on opportunities even when communications are degraded.

2-111. Mission command takes trust between leader and subordinate. Trust that the orders are made in good judgment and trust that the order will be executed within the commander's intent. This trust is not lip service. Soldiers and Marines earn trust through incremental confidence built during habitual training and experience as a unit and team. One method units can use to build trust and confidence involves training only with analog products. This builds the practice of good planning and orders production while also breaking the compulsion to have nonstop updates and tracking through digital mission command systems.

Human Advantage

2-112. Human advantages are the most important aspect of building cold weather capability and the most significant factor in mission success. They are also the most difficult to develop in the Arctic and require the most attention. While many physical and information advantages can be gained rapidly, human adaptation to the cold takes time and commitment, especially to extreme cold. In arctic operations, the most potent human advantages are—

- Arctic determination.
- Cold weather field craft.
- Experienced leaders.

Arctic Determination

2-113. Arctic determination is a special mix of morale, discipline, and physical conditioning. ***Arctic determination*** **is an individual's mental and physical tenacity to accomplish the mission by leveraging confidence in personal skills to overcome extreme cold weather and other arctic challenges.** Soldiers and Marines with arctic determination develop a mental outlook, despite the cold, that they can succeed because they have tested their capabilities during training, know the effectiveness of their gear, and understand what must be done. They acknowledge that conditions will be uncomfortable, but that success is possible nonetheless. They fight the urge to become physically and mentally paralyzed by inaction because of the cold and encourage others to do the same. They understand that the Arctic is challenging, and they are willing to meet those challenges. Ultimately, arctic determination is the will to get the job done despite arctic challenges.

CAUTION:

Arctic determination is based on confidence in one's own skill. It is NOT blind ambition into dangerous situations. Leaders build arctic determination through deliberate training, motivation, and risk mitigation.

2-114. Units manned with troops who have arctic determination can thrive in and dominate the arctic environment, even with degraded materials and communications. Such domination requires leader involvement at all levels. Even the senior member of a battle-buddy team must accept the responsibility to ensure the team accomplishes the mission. Leaders communicate realistic expectations. Communicating expectations is crucial to building arctic determination. Soldiers and Marines who are mentally prepared for challenges they face are well-positioned to meet difficult operations in the extreme cold. They possess the motivation to succeed and the understanding that discomfort is a necessary obstacle to achieve success.

2-115. Self-discipline cannot be over emphasized. Units must complete many additional tasks in extreme cold weather to ensure operations continue. Soldiers and Marines fight the urge to focus only on themselves and ensure they address the necessary tasks to support the unit and the mission. Leaders seek to build discipline through routine supervision and inspections.

2-116. Physical training and acclimatization are a must. Acclimatization is not something that can be accomplished in a few short days. The initial period for troops deploying in the winter from the South to the North is unpleasant, and it is determination to succeed that carries them through. Units can reduce this period of acclimatization by physically training troops in the cold with proper clothing, equipment, and techniques. By increasing their overall fitness and familiarity with the cold, Soldiers and Marines are better conditioned to adapt to the arctic environment both physically and mentally.

Cold Weather Field Craft

2-117. Although the United States has arctic territory, most U.S. forces reside in temperate climates. To train well-adapted troops to the Arctic, leaders forecast the hardships of the environment and take every opportunity to train their formations in the elements to build tolerance, experience, and proficiency.

2-118. Soldiers and Marines who are acclimatized to cold weather and are trained in its field-craft are exponentially more effective in cold weather conditions than those unacclimatized. Leaders build this effectiveness through thoughtful, long-range, extended-exposure cold-weather training. Acclimatization and training cannot be done in the moment; it takes time. Commanders prioritize and dedicate training time, gradually acclimatize new troops, and implement appropriate risk mitigation controls. Units in more temperate climates may use altitude to achieve arctic and subarctic temperatures.

2-119. Leaders know that cold weather gear and equipment only works if troops are properly trained to use them. Repetition and experience are essential to understand ways to adapt equipment for varying situations. Many items are less efficient or even harmful if used improperly. For instance, cold weather clothing is bulky, restricting, and often makes tasks more difficult to complete. Troops that fail to practice in their gear perform even simple tasks less effectively, such as reloading their firearm. Troops that wear their gear incorrectly risk cold weather injuries when static or even overheating when active. (For detailed information on arctic training, see Chapter 10 and refer to TC 21-3.)

Experienced Leaders

2-120. Commanders expose themselves, their subordinate leaders, and staff to the challenges of arctic operations to give them an appreciation of what they ask troops at the front to do. They seek out those within their formation with significant arctic experience and leverage their expertise in planning and decision making. Leaders who do not prepare themselves and do not appreciate the dangers of the environment may potentially create hazards for the Soldiers and Marines they lead.

2-121. Arctic leaders at all levels must be well-experienced in the characteristics, effects, hazards, challenges, and opportunities of the environment. They must be realistic and possess tactical patience, since all things in the Arctic take more time. They must be redundant in their contingencies, for many things can go wrong. They must leverage the environment, for it can be their greatest ally or enemy. Above all, they must mitigate hazards and care for the well-being of their troops, because the environment can cause more casualties than the enemy. (For detailed information on arctic leadership and risk management, see discussions beginning in paragraphs 4-3 and 4-10.)

ISOLATED ENDURANCE

2-122. Isolated endurance is the ability to continue operations when isolated from medical support, communications, or sustainment. Within the Arctic, there is generally a higher likelihood of all three. Long distances often separate forces from supporting arms. Weather phenomena will naturally degrade communications and make it challenging to communicate. Cold weather will degrade electronics or render them inoperable. Difficult terrain and extreme cold weather will complicate sustainment and delay resupply. Units must prepare for these challenges and train to overcome them prior to entering operations.

2-123. Given the large distances and separation of echelons in the Arctic, medical support is generally less responsive. Circumstances such as inclement weather may prevent casualties from immediate evacuation. Rotary-wing support may also be limited due to weather effects or range from hangers. Efficient units treat or stabilize wounded as far forward as possible. Leaders embed medical assets further forward on the battlefield, and all Soldiers and Marines receive routine tactical combat casualty care training. (For more information on health service support in the Arctic, see discussion beginning in paragraph 8-97.)

2-124. Even with the best primary, alternate, contingency, and emergency (known as PACE) plan, communications may still fail in the Arctic. To prepare for degraded communications, units train extensively using analog products and command and control methods. Analog products are printed in advance to prevent a single point of failure if electronics stop working because of the extreme cold. Leaders at all levels must become comfortable without 24/7 communications and data feeds, because they will likely have to operate without them. (For more information on communications, see discussion beginning in paragraph 4-21.)

2-125. Units that become isolated from sustainment in extreme cold weather run a high risk of severe cold weather injuries or even death. Units train a multitude of contingencies to prevent this and ensure both logisticians and maneuver units understand standard operating procedures (SOPs). Even with contingencies, units need to be prepared to self-sustain, sometimes for up to a week, without external sustainment support. At the individual level, all Soldiers and Marines carry a 72-hour sustainment pack in case of an emergency. (For more information on arctic sustainment, see Chapter 8.)

The Chosin Reservoir Breakout

The Battle of the Chosin (Changjin) Reservoir during the Korean War provides a prime example of isolated endurance in extreme cold weather operations. In November 1950, the 1st Marine Division (with attachments from the U.S. Army, the Republic of Korea, and the United Kingdom) advanced to North Korea near the Chinese border. The Chinese army entered the war by surprise and surrounded the 1st Marine Division at the Chosin Reservoir with 12 enemy infantry divisions. The 1st Marine Division was isolated, and a breakout was necessary. Surrounded and outnumbered 30,000 to 120,000, Major General O.P. Smith, commander of the 1st Marine Division, stated that they were not withdrawing, rather, they were “attacking in another direction.”

The battle lasted from the end of November to mid-December. Temperatures ranged between -20 °F and -40 °F with near-constant wind that funneled through valleys from Russian Siberia. Daylight was only for approximately 5.5 hours and snowstorms occurred frequently at night. Survivors of the battle described conditions as so cold that “if you stopped moving, you died.” Despite harsh elements and isolation from friendly forces, the 1st Marine Division was exceptionally better prepared for the elements than the Chinese. The U.S. forces were trained and experienced in cold-weather combat from World War II, they had the best clothing available, and were relatively well fed. They took care of the wounded, had indirect fires on demand, and had close air support when weather permitted. Air assets delivered more than 250 tons of supplies daily and evacuated more than 4,000 casualties.

Conversely, the Chinese were not frequently resupplied. They could not heat rice or make water. Their clothing was not adequate for low temperatures. Cold weather injuries were the norm. Starving troops often stopped attacking to loot overrun positions, and communications issues prevented them from exploiting opportunities.

After weeks of battle, the 1st Marine Division successfully broke out from encirclement and returned to friendly lines. While U.S. forces lost 6,000 Americans in battle, the Chinese toll was significantly higher. Chinese forces lost an estimated 50,000 troops, including the eldest son of the Chinese dictator Mao Zedong. Cold weather injuries for the Chinese were massive and their rear lines were described as one giant hospital. The aftermath of the battle shows the result of the superior fighting spirit of the 1st Marine Division and their isolated endurance in comparison to the Chinese.

ARCTIC TASK ORGANIZING

2-126. To optimize warfighting potential in arctic operations, leaders strike a balance between four competing factors based on the situation:

- Mobility.
- Firepower.
- Protection.
- Sustainment.

These four factors are critical to any operation. In the Arctic, it is very difficult to maximize all four because of the effects of soft snow or muskeg. On arctic terrain, any weight added by firepower, protection, or sustainment directly limits mobility. Therefore, leaders choose which to prioritize based on the mission.

MOBILITY

2-127. Mobility is an often-overlooked challenge in the Arctic because of snow and muskeg. Most leaders quickly recognize the effects of the cold. However, they may not recognize that degraded arctic mobility can have as much, if not greater, impact on mission success. Leaders should therefore maximize mobility to the greatest extent but be aware that it comes at a cost. Leaders balance mobility considerations with mission requirements for firepower, protection, and sustainment.

2-128. With restrictive terrain in the Arctic, enhanced mobility provides a distinct advantage over the enemy, and therefore receives high priority in most situations. Elements of firepower, protection, and sustainment produce additional weight through ammunition, armor, and supplies which limit speed and tempo. To build mobility, units often have to sacrifice at least one of the three elements.

2-129. Alternative means to maximize mobility include—

- Employing engineers to improve paths, compact snow, or remove snow and ice.
- Using specialized over-snow vehicles and equipment.

FIREPOWER

2-130. Firepower is a necessary part of battle and must not be reduced below mission requirements. However, units must avoid holding excessive ordnance on combat platforms. If high levels of ordnance are required, units should use additional logistics and ammunition platforms to lighten combat platforms.

2-131. Light troops usually have limited ordnance. These forces focus on the following:

- Mobility gained through well-trained small units on specialized, fast, and lightly packed over-snow equipment.
- Leveraging poor terrain and weather to strike from unforeseen directions.
- Using guerilla tactics and difficult or inaccessible terrain to deny heavy units.
- Employing lightweight, high-payoff anti-tank or anti-air ordnance.

PROTECTION

2-132. Greater protection comes from armor, Kevlar, steel, and the like. Such protection adds weight, which reduces mobility and must be considered in relation to the required weight for firepower. Firepower can act as a form of protection but can also be counter-productive if it inhibits mobility. Mobility can also be used as a form of protection, especially for light forces operating in difficult terrain, poor weather, and stealth. In some cases, mobility may be more advantageous to protection.

SUSTAINMENT

2-133. Sustainment adds endurance and is an absolute survival necessity in extreme cold temperatures, but it takes up considerable space and adds significant weight. Units and individuals without proper sustainment quickly succumb to the arctic environment. Units must carry additional days of supply in the event of isolation. Additional clothing and tentage are all essential but limit mobility and take space away that is normally designated for firepower or protection. Fuel for heat sources and extra batteries to account for the cold also add considerable weight to combat loads.

2-134. Heavy sustainment loads bog down mechanized travel and exhaust dismounted troops. Dismounted units can minimize the impact of sustainment loads on mobility by dragging them on ahkio sleds. Units can store sustainment loads for short periods nearby to boost unit mobility. For instance, infantrymen on the attack can stow their additional cold-weather clothing at the objective rally point. However, leaders need plans to rapidly bring stowed clothing to the objective to prevent CWIs following the attack.

Chapter 3

Planning and Executing Arctic Operations

[C]old, with its attendant unpleasantness and complicated living conditions, affects military operations but does not prevent them.

FM 31-71, *Northern Operations* (1963)

This chapter describes the planning and execution of arctic operations at the tactical level. Section I – Planning for Arctic Operations outlines the fundamental considerations for planning arctic operations. Section II – Executing Arctic Operations details how to conduct forms of maneuver, offense, defense, enabling operations, stability operations, and defense support of civil authorities in the Arctic. Sections III and IV discuss arctic-specific considerations from operations in the maritime and air domains.

SECTION I – PLANNING FOR ARCTIC OPERATIONS

3-1. The fundamentals of planning operations apply in the Arctic. The most significant differences are considerations to overcome the environment. Arctic operations must be viewed as a series of opportunities and challenges that provide a level battlefield for friendly and enemy forces alike. The long hours of daylight and swarms of insects characterize summer. Winter consists of long nights and bitter cold. Mud and morass occur during transition periods of spring and autumn. Other challenges include the disrupting effects of natural phenomena, the scarcity of roads and railroads, the vast distances and isolation, and the lack of maps. These challenges combine to severely degrade mobility, firepower, and communications. Despite all this, commanders avoid looking at the situation as a problem. Instead, they shape their approach by identifying opportunities and challenges. They look at the opportunities available first. When facing challenges, commanders resist the urge to view any obstacle as insurmountable by either themselves or the adversary. Most challenges can be met with proper equipment, diligent training, positive leadership, and arctic determination. This section details the important characteristics of the Arctic that shape these changes and the necessary planning factors to adjust.

ENVIRONMENTAL CONSIDERATIONS

3-2. Paragraphs 3-3 through 3-7 list some of the most significant environmental factors. Effective commanders consider these factors when developing tactical plans in arctic operations. Social factors consist of population density. Infrastructure factors consist of transportation networks such as roads, railways, waterways, mapping, and navigation. Physical environment factors consist of weather, extreme cold, wetlands, forested areas, and snow cover. Time factors include atmospheric disturbances and limited daylight.

3-3. Low population density characterizes social factors. Settlements, supplies, infrastructure, and LOCs are limited. Therefore, populace and resource control measures become highly important. A unit’s interactions with settlements can significantly bolster or hinder operations in the vicinity based on the unit’s actions and the settlement’s friendly, neutral, or hostile sentiments.

3-4. Infrastructure factors mostly affect transportation. Roads and railroads may be limited. Those that exist usually are vulnerable to enemy action. In addition, weather conditions may greatly affect their use. Lakes, waterways, and swamps are prevalent and may either aid or hinder an operation depending upon the season. During deep winter, units can use rivers, streams and other water features as avenues of approach or airstrips once ice assessment teams deem them safe. In the summer, waterways may either be major obstacles or LOCs. Occasionally, maps may be unreliable or even nonexistent. Therefore, units need timely aerial photographs as a source of terrain information. With proper preplanning, pilots can take aerial photography and supporting geospatial engineers can convert them into a photomap. Unless adequately laid out, annotated, and referenced to known survey points, aerial photographs will lack necessary "map-like" accuracies for navigation and employment of indirect fire weapons. Land navigation is further complicated by a lack of landmarks, large forested areas, periods of reduced visibility, the difficulty of cross-country movement, and large magnetic declinations.

3-5. Weather, extreme cold, wetlands, forested areas, and snow cover make up the physical environment factors. Arctic weather is subject to rapid changes. The commander with SWOs/METOCs who can accurately forecast sudden changes in the weather has a distinct advantage over enemy forces. The importance of local weather forecasting capability cannot be overemphasized. Changes include extreme temperature shifts, snowstorms, strong winds, and dense fog. Changes may be sudden but must be anticipated. Effective units exploit favorable conditions to the maximum, even if they only last for a short period. During winter, the extreme cold affects all operations by making them more difficult and take longer. Operations often take two to four times longer than they would in a temperate environment. Proper clothing and equipment are an absolute necessity and must be acquired and trained on well in advance. Unit and individual acclimatization are a long-term effort.

3-6. Other physical factors include arctic wetlands, forested areas, and snow cover. In summer, arctic wetlands and muskeg are prevalent and severely limit cross-country mobility. Avenues of approach are greatly limited and wheeled vehicles may be restricted to established road networks. Tracked, low-ground-pressure vehicles can navigate muskeg and expanses of marshy terrain enabling off-trail movement of troops and supplies. Vehicles like the cold weather all-terrain vehicle (CATV) enhance year-round mobility. Forested areas offer concealment and present excellent opportunities for ambushes and guerilla tactics. They provide comparatively good protection against wind and snowstorms but present a serious obstacle to cross-country mobility. In the summer, forests burn easily, and fires may become a major hazard. Units in forested areas are vulnerable to blast effects from nuclear weapons. Snow cover enhances the movement of well-equipped and trained troops but reduces the mobility of troops lacking proper equipment and training. For mission planning, the nature of the snow cover is needed to predict or inform ground mobility. Snow depth and density are the most critical parameters, followed closely by strength and layering or stratigraphy. SWOs/METOCs can provide authoritative, trusted surface state weather analyses and forecasts for intelligence and mission planning, including snow cover, snow depth, and liquid water equivalent amounts.

3-7. Time factors consist of atmospheric disturbances as well as daylight and darkness. Extended operating distances and atmospheric disturbances make military communications difficult. Units must be prepared for long periods of night operations. The long daylight of the summer limits low-visibility operations. At night and under other conditions of low visibility, it becomes difficult to distinguish friendly from enemy troops, especially when both are wearing white. Distinctive markings and signals are necessary.

CONSIDERATIONS FOR DEVELOPING A COURSE OF ACTION

3-8. As in other OEs, arctic operations use the following considerations when developing a course of action for operations:

- Mission.
- Enemy.
- Terrain and weather.
- Troops and support available.
- Time available.
- Civil considerations.

The mission variables are commonly remembered with the mnemonic METT-TC (I)—mission, enemy, terrain and weather, troops and support available, time available, civil considerations, and informational considerations. The parenthetical “I” stands for informational considerations; it is an important part of each variable, but not an independent variable itself.

Note. The Marine Corps only uses METT-T (mission, enemy, terrain and weather, troops and support available -time available) for mission variables.

3-9. Because the Arctic so frequently differs from experiences in temperate climates, a commander must have a firm understanding of the OE to properly understand, visualize, describe, direct, lead, and assess operations.

MISSION

3-10. When developing mission objectives and parameters in arctic operations, it is critical to incorporate the following characteristics. While these are valuable characteristics for an operation in any environment, there are specific considerations when applying them to the Arctic:

- Simplicity.
- Key terrain.
- Sustainment.
- Risk mitigation and safety.

Simplicity

3-11. A simple plan of action is paramount in arctic operations. Mission command is preferred to give maximum flexibility to subordinate commanders to exploit local situations and take initiative when the opportunity is presented. Overly complex plans have a limited chance of success against the Arctic's extreme weather, degraded communications, and limited mobility. Extreme weather conditions can delay tasks and prevent command posts from gathering accurate information. Degraded communications often occur and can prevent the timely transmission of situation reports and fragmentary orders. Limited mobility delays task completion and limits the responsiveness of units to react to changing orders. If not accounted for, the combination of these three factors can frustrate both commanders and Soldiers/Marines alike and lead to mission failure.

3-12. All plans must be constructed with contingency, redundancy, and resiliency in mind. This is standard in most mission planning. It is even more significant in arctic operations because the chance for unknown complications significantly increases. In addition, the risk of failure is significantly more costly, often resulting in serious injury or death.

Mission Command and Motti Tactics

A simple plan and mission command provided the flexibility necessary for the Finnish 9th Division to dismantle the Soviet 163rd and 44th Divisions during the Battle of Suomussalmi, December 1939 to January 1940, in the Winter War. The war occurred along the border of Finland and Russia. Soviet forces planned to split Finland in half, seize the rail system, and control a major road junction. Temperatures were between -20 °F and -40 °F, daylight was only present for about four and a half hours, and snow cover was over three feet deep. The Russians advanced in large vehicles but were restricted to narrow roads with mature forests on both sides. The Finns, conversely, were well-trained on skis and moved swiftly and silently across the terrain to surround the Russians. The Finnish Soldiers, camouflaged in all white, ambushed a few vehicles at a time, eventually halting and separating convoys into isolated pockets. Trapped and unable to move off the roads, the Russians either died from the cold or were slowly dismantled through drive-by assaults of swift-moving, snow-camouflaged Finns on skis. The tactic was called "Motti" (the Finnish word that describes chopping down a tree section by section). It was so effective, it earned the Finns the Russian name "Belaya Smert: The White Death."

The aftermath of the battle creates the appearance of a complex, well-synchronized attack (as shown in Figure 3-1). However, the success of the Finns was a result of simple, clear guidance and intent given by the division commander. Competent subordinate commanders acted independently, leveraged their superior mobility, and responded rapidly to opportunities. Conversely, Soviet commanders were afraid to act on any matter, despite having three-to-one numerical superiority. Soviet losses amounted to approximately 27,500 casualties, ten times the casualties of the Finns.

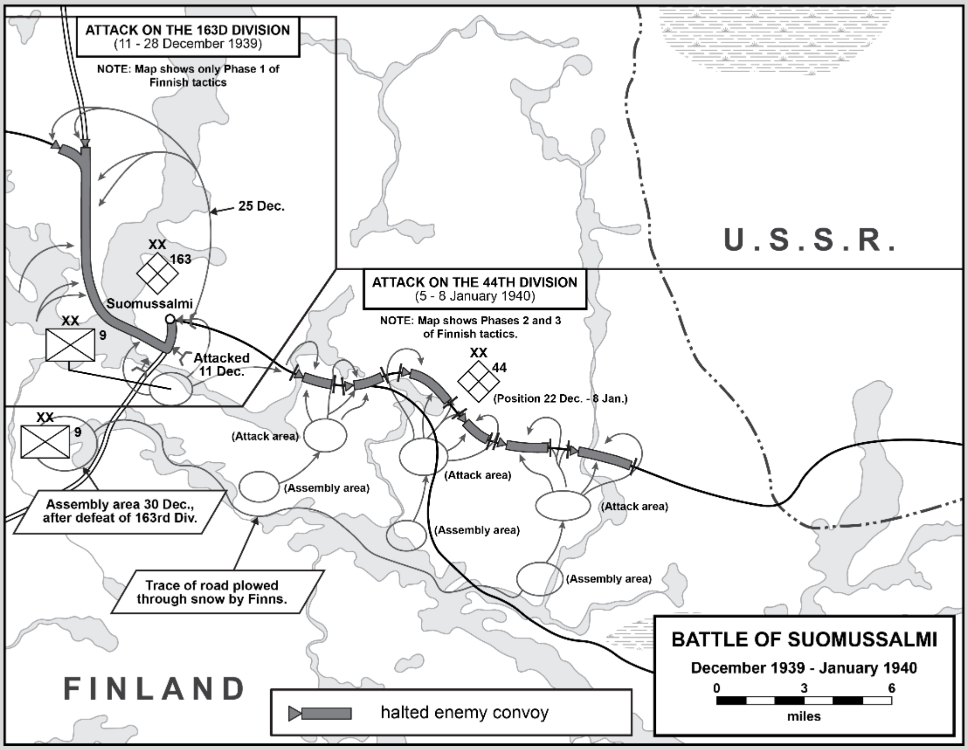


Figure 3-1. Battle of Suomussalmi

Key Terrain

3-13. Key terrain analysis focuses on gaining and maintaining positions of advantage to deny enemy access and reinforce friendly supply lines and maneuver. Key terrain is often related to LOCs, which hold vital significance in arctic operations for even basic survival. Units can defeat an enemy by interrupting its LOCs through destruction or denial. Key terrain related to LOCs include—

- Urban areas, which provide a critical foothold into more austere regions.
- Valuable infrastructure and resources such as pipelines and mineral deposits.
- Transportation networks (roads, rivers, rails, trails, and aerial ports and seaports of debarkation), which are often limited and potentially the only feasible means of wheeled transportation.
- Mobility corridors.

Sustainment

3-14. Sustainment must be among the first considerations when planning at any echelon. Sustainment requirements are drastically higher and more difficult to provide in arctic operations. Units that consider sustainment as an afterthought frequently culminate early, risk failure, and become vulnerable to a counterattack or the elements. Units assess their sustainment capabilities and exercise tactical patience to avoid outrunning their support elements. Doing so is the key to endurance in the Arctic.

3-15. Given the mobility concerns in the Arctic, units can carry only limited supplies to maintain speed of action. Resupply is essential but challenging. Transportation networks are limited, and engineer support can only enhance ground networks so much. Therefore, planners emphasize resupply by air and over-snow vehicles. Given these difficulties, forecasting is essential and must be continually refined by keeping a running log of consumption data. Planners must estimate forecasting for some requirements painstakingly far in advance. For instance, when deploying to an arctic theater, units should deploy with all equipment and supplies needed to accomplish their mission in both cold and warm seasons. As seasons transition, units cannot rely on supply chains to be able to send materials and equipment on demand. (For more information on sustainment in arctic operations, see Chapter 8.)

Risk Mitigation and Safety

3-16. The arctic environment inherently adds risk to operations. Risk mitigation and Soldier/Marine safety must be considered in all operations. (The discussion of risk mitigation begins in paragraph 4-10.) Units must ensure the safety officer is experienced in arctic operations and can provide expert guidance throughout operations, especially regarding hazards of the cold. Units and individuals plan and prepare to be isolated at any time and ensure troops always have a sustainment kit. When making risk determinations, commanders consider—

- Unit acclimatization.
- Unit training levels.
- Equipment suitability.
- Sustainment capability.
- Weather conditions.

ENEMY

3-17. When analyzing the enemy variable, leaders assess the enemy and establish an all-around defense.

Enemy Assessment

3-18. Analyzing the enemy is done with respect to relative advantages. Leaders conduct the assessment in the same manner as elsewhere while strongly weighing the enemy's—

- Cold weather capability.
- Cross-country and over-snow mobility.
- Communications reliability.
- Sustainment capacity.
- Morale.

All-Around Defense

3-19. Given the vast and often isolated nature of the Arctic, enemy attacks can come from any direction at any time. For this reason, an all-around defense is preferred in most circumstances and LOCs are vitally secured. Units account for being under constant surveillance by the enemy and use dispersion and deception. However, units also maximize atmospheric disturbances and weather conditions that disrupt the enemy's ability to communicate and surveil.

TERRAIN AND WEATHER

3-20. The impacts of terrain and weather on operations are covered in detail in discussions beginning in paragraphs 1-20 and 1-89 respectively. Paragraphs 3-21 through 3-29 discuss overarching planning considerations when considering terrain and weather.

Terrain

3-21. As an essential part of any arctic operation, leaders and planners consider the effects of terrain on mobility. True mobility can only be obtained by properly using all aviation support, over-snow equipment, and tracked vehicles. Wheeled vehicles are greatly limited by snow and muskeg and are often constrained to the limited established road network.

3-22. Leaders seek to maximize mobility to gain a relative advantage, but they account for overall degraded tempo in synchronization and make sure faster elements do not outpace slower ones in the overall plan. Rapid movement of small units with adequate firepower, mobility, and communications plays a vital role in the success of arctic operations. Tactical planning must include the use of vertical envelopment and wide flanking attacks to exploit the principle of surprise.

Weather

3-23. In addition to standard weather effects, planning must also account for—

- Seasonal conditions.
- Extreme weather.

Seasonal Conditions

3-24. The most suitable time to conduct operations is from midwinter to early spring before the thaw period. The snow is "settled," giving well-trained troops an excellent opportunity for over-snow mobility. During this period, operations are possible even in a roadless wilderness. Early winter, after the formation of ice, is also favorable; however, it does not afford well-trained troops the same over-snow and cross-country mobility as midwinter. The winter cold requires special cold-weather clothing and equipment and places a premium on fuel for warmth. Tracks in the snow and ice fog, created by a heat source, complicate the camouflage of positions. High winds and the phenomenon of white out can interfere with aviation operations. High winds can also combine with the cold to make moderately cold weather extremely uncomfortable.

3-25. In spring, limited objective operations are feasible, but mobility is limited. Freeze and thaw cycles can change trafficability on an hourly basis. The best time for movement is when there is only a thin layer of mud on deeply frozen ground, and lake and stream ice are still firm. However, a sudden thaw period can interrupt these operations, causing units either to slow down or stop entirely.

3-26. At the end of the thaw season, units can resume operations after the ground has dried sufficiently to allow trafficability. Troops and vehicles regain mobility to some degree. When operating in the low areas, the numerous streams and swamps will require greatly increased engineer efforts and special equipment. Units can often use the many rivers and streams to move troops and supplies.

3-27. In autumn, poor drainage may cause low-lying country to become isolated from the surrounding terrain. Roads may become flooded. Poorly constructed roads disintegrate. Often, the only means of transportation is by aircraft and low-ground-pressure vehicles. Attempts to maintain normal ground mobility can exhaust troops and impair equipment.

Extreme Weather

3-28. Operating in extreme weather, especially the cold, is the prominent challenge of the Arctic. Combat effectiveness is difficult to maintain unless troops are kept warm, fully hydrated, and in condition to fight. A force long exposed to the elements and not accompanied by warming equipment or other essential support is vulnerable to attack or counterattack. Units must ensure troops have the appropriate equipment and clothing to endure the elements. Failure to do so can lead to more casualties by nonbattle injuries than combat.

3-29. Skilled commanders view the environment as another weapon to combine arms, create multiple dilemmas, and achieve convergence. They seek to leverage the cold against the enemy by forcing enemy forces out of shelter or isolating them from LOCs. Within 72 hours of a LOC being cut, extreme cold will significantly degrade even a force the size of a brigade. Extreme weather creates ample opportunities to be audacious through periods of limited visibility, snowstorms, and periods of extreme cold to surprise the enemy.

TROOPS AND SUPPORT AVAILABLE

3-30. When analyzing troops and support available, commanders consider—

- Task organization.
- Reduced personnel and equipment effectiveness.

Task Organization

3-31. Units must task organize to balance mobility, protection, firepower, and sustainment requirements (see discussion beginning in paragraph 2-126). The mission will dictate the appropriate composition, but mobility should be prioritized in most cases. Commanders need always to consider the size of forward-positioned combat forces in relation to the amount of sustainment support available. Generally, the lower the temperature, the smaller the combat force and the larger the sustainment package is to support them.

Reduced Personnel and Equipment Effectiveness

3-32. In addition to quantity, commanders must also look at the quality of forces. Smaller amounts of cold weather capable forces may be more effective than larger amounts of forces below the survival threshold (see discussion beginning in paragraph 2-91). Commanders must also account for the fact that most if not all capabilities will be degraded either by the cold, the terrain, or electromagnetic disturbances. In many cases, units will require more assets to achieve the same effect expected in a temperate environment. For instance, fires have a reduced effect in deep snow and require more munitions to compensate. Additionally, at certain temperatures or weather conditions, some assets may become completely unavailable, such as aviation support.

TIME AVAILABLE

3-33. Two significant factors exist when considering the time variable for arctic operations:

- Time and space.
- Time allotted for preparation.

Time and Space

3-34. The primary consideration when developing a tactical, operational, or even strategic plan in arctic operations is time. Everything in the Arctic takes longer to do, both in cold and warm seasons. Especially in extreme cold, the time required for even the simplest task is frequently underestimated. It is not unusual for operations to take two to four times longer than they would in typical temperate climates. Commanders ensure units have additional time planned into operations to account for these delays. When synchronization is required, leaders set no-earlier-than times for operations to ensure all units have adequate time to overcome arctic-related challenges.

3-35. The challenge of time is further compounded by the sheer size of the Arctic. Distances in the Arctic are enormous, but frequently misjudged. For instance, Alaska alone is nearly half the size of Europe (see Figure 3-2 for size comparison). Not only are these distances great, but they are difficult to traverse due to limited transportation networks and the presence of snow, muskeg, and numerous mountain ranges.

3-36. Planners, especially from more temperate regions, tend to underestimate both time and space. Commanders approach all plans with a campaign mentality—a sense that operations will endure and require in-depth plans for multiple contingencies. In addition, plans must account for the unit's cold weather capability. Less capable units require more time and contingencies to operate successfully. Planning is best conducted when those making estimates have physically endured the hardship of extreme cold weather and muskeg. This gives leaders a stronger sense of what is feasible and helps synchronize tempo. Experienced personnel must convey to decision makers the difficult reality of the Arctic, its vast distances, and the toll it takes on timelines.

Figure 3-2. Surface area of Alaska compared to Europe

Time Allotted for Preparation

3-37. When allotting time, planners consider the many tedious tasks required to prepare for arctic operations. Every opportunity is taken to issue warning and fragmentary orders as soon as possible. Prompt orders give subordinate troops maximum time to conduct arctic preparations, which take exponentially longer than in more temperate regions.

3-38. Upon receipt of mission, troops adjust their clothing and equipment. This act eliminates unnecessary halts for adjustment of clothing, rucksacks, skis, or sled loads. Leaders ensure that troops do not overdress, which increases the possibility of overheating and exhaustion. The unit leader also verifies that Soldiers/Marines have every piece of necessary clothing and equipment, and they are in serviceable condition. Although this is routine, it is still time-consuming.

3-39. Movement is slowed while operating in low temperatures because troops must transport heated shelters (tents with heaters and fuel). Time is consumed by packing shelters and loading equipment. Similarly, troops need time to prepare campsites, tents, and heaters once at location. During the cold season, shelters stay up until the last possible moment before movement so that troops can have heat and shelter as long as possible. Trail-breaking detachments, which move at a slower rate than the remainder of the unit, depart soon enough to avoid delaying the main body. If a movement includes vehicles in extreme cold temperatures, sufficient time must be planned to allow proper starting and warming procedures as prescribed in TM 4-33.31.

CIVIL CONSIDERATIONS

3-40. The vast and unpredictable arctic region is sparsely populated, with communities scattered across it. However, the civil considerations are no less critical than in more populated environments. Upon receipt of a mission, commanders filter information categorized by the operational variables into relevant information with respect to the mission. They use the mission variables, in combination with the operational variables, to refine their understanding of the situation and to visualize, describe, and direct operations. (For information on civil analysis, see FM 3-57.)

SECTION II – EXECUTING ARCTIC OPERATIONS

3-41. The fundamentals of operations and tactics as outlined in FM 3-0 and FM 3-90 apply to arctic operations and must be understood as a foundation. This section supplements those publications by providing the unique aspects of arctic operations that leaders consider when implementing—

- Forms of maneuver.
- Offensive operations.
- Defensive operations.
- Stability operations.
- Defense support of civil authorities.

FORMS OF MANEUVER

3-42. The forms of maneuver are—

- Frontal attack.
- Penetration.
- Envelopment.
- Turning movement.
- Infiltration.
- Flanking attack.

FRONTAL ATTACK

3-43. Frontal attacks are typically least preferred in arctic operations because the terrain usually substantially limits mobility, thereby aiding the defense. The Army definition of a *frontal attack* is a form of maneuver in which an attacking force seeks to destroy a weaker enemy force or fix a larger enemy force in place over a broad front (FM 3-90). The Marine Corps definition of a *frontal attack* is an offensive maneuver in which the main action is directed against the front of the enemy forces (USMC Dictionary; see also MCWP 3-01). Frontal attacks conducted through deep snow, muskeg, or mountains incur higher casualties and have drastically reduced chances for success. When planning for frontal attacks in these conditions, planners must increase the ratio of relative combat power beyond three-to-one (3:1) to compensate for limited mobility.

3-44. Managing tempo is critical to maintaining constant pressure through combined arms, especially during a frontal attack. Cessation of artillery fires must account for delayed movement speed of ground troops. Planners synchronize movement of armor and infantry and account for specific constraints of each asset. Aviation forces can be used to create opportunities in the enemy's front line and disrupt reinforcements.

PENETRATION

3-45. In open arctic terrain, a penetration can be effective when an enemy has overextended their defense to cover too large an area. A *penetration* is a form of maneuver in which a force attacks on a narrow front (FM 3-90). The Marine Corps definition of *penetration* is a form of maneuver in which an attacking force seeks to rupture enemy defenses on a narrow front to disrupt the defensive system (USMC Dictionary; see also MCWP 3-01). In areas with limited mobility (deep snow, muskeg, or mountains), penetration becomes increasingly problematic due to difficulties in maintaining momentum and maneuvering sufficient combat power to the area of penetration in a timely manner. In these regions, as with frontal attacks, planners must increase the necessary relative combat power ratio beyond three-to-one (3:1) and manage tempo carefully. Successful leaders avoid excessive delays between initial and follow-on forces. Closer spacing can reduce time gaps but will increase risk to force.

ENVELOPMENT

3-46. Envelopments can be especially useful in arctic operations to dislocate enemies from LOCs. The Army definition of an *envelopment* is a form of maneuver in which an attacking force avoids an enemy's principal defense by attacking along an assailable flank (FM 3-90). The Marine Corps definition of an *envelopment* is an offensive maneuver in which the main attacking force passes around or over the enemy's principal defensive positions to secure objectives to the enemy's rear (USMC Dictionary; see also MCWP 3-01). Additionally, envelopments can have devastating effectiveness on enemies fixed to narrow roadways.

3-47. Since envelopments depend strongly on speed, mobility must be prioritized. In particular, the main effort requires sufficient mobility-enhancing capabilities such as snow-clearing equipment. Slowing the enemy's mobility takes precedence starting with hindering communications. Vertical envelopments are particularly effective because they can bypass restrictive terrain. Envelopment and encirclement may become more feasible if the enemy's mobility is severely limited forcing the enemy to sacrifice flank, forward, or rear security in the interest of speed. The enemy also may neglect these security measures if road bound and lacking over-snow mobility for flank security. This may happen as the enemy conducts a movement to contact or during friendly exploitation or pursuit.

3-48. In winter conditions, units that are not cold weather capable have a much higher tendency to fail an envelopment for the following reasons—

- Missed movement.
- Predictable avenues of approach.

Inexperienced units fail to recognize time delays imposed by winter conditions. They are more inefficient than those practiced in the cold, which leads to further delays. This lack of preparedness, efficiency, and reliability leads to frequent missed movements, which desynchronize and jeopardize an envelopment. An envelopment can also fail because inexperienced troops use predictable avenues of approach. Inexperienced troops are both uncomfortable, and at times, incapable of using over-snow techniques to take advantage of terrain. These techniques include snowshoe, ski, or even mechanized forces unaccustomed to snowy terrain. This leads to a lack of momentum, creates synchronization issues, and forces troops onto predictable avenues of approach which eliminates surprise.

TURNING MOVEMENT

3-49. In arctic operations, the key considerations when executing a turning movement are mobility and credibility. A *turning movement* is a form of maneuver in which the attacking force seeks to avoid the enemy's principal defensive positions by attacking to the rear of their current positions forcing them to move or divert forces to meet the threat (FM 3-90).

3-50. The first consideration in a turning movement in the Arctic involves mobility and accessibility. Whether in winter snow or summer muskeg, forces must have suitable terrain for an axis of advance that also lends to stealth, surprise, and the ability to strike at the opponent's side or flank. Commanders consider the state of terrain the enemy will be forced into versus that of their own unit. Relative physical advantages in terrain make a significant difference; even a less-than-ideal axis of advance may still be suitable if the enemy is forced into even more unfavorable terrain.

3-51. In arctic operations, a credible target stems from valuable objectives. Given the vast expanse of the Arctic, key terrain is often determined in relation to the enemy's position, disposition, and LOCs. Many objectives hold little to no value and will not lure the intended response from the enemy. When selecting an objective, commanders must determine a credible target that is valuable enough to force the enemy to assume risk and abandon its position. LOCs and critical sustainment targets that would isolate the enemy make for highly credible objectives.

INFILTRATION

3-52. Arctic operations present ample opportunities for infiltration. The Army definition of an *infiltration* is a form of maneuver in which an attacking force conducts undetected movement through or into an area occupied by enemy forces (FM 3-90). The Marine Corps definition of an *infiltration* is the movement through or into an area or territory occupied by either friendly or enemy troops or organizations. The movement is made, either by small groups or by individuals at extended or irregular intervals. When used in connection with the enemy, it implies that contact is avoided (USMC Dictionary; see also MCWP 3-01).

3-53. During infiltration, leaders exploit vulnerabilities in enemy surveillance. The following arctic conditions contribute to surveillance vulnerabilities:

- Great distances an enemy must defend.

- Long periods of darkness.
- Frequent environmental conditions that affect visibility.
- Challenging terrain.

3-54. Special operations forces (SOF), dismounted infantry, patrols, and stay-behind forces are well suited for these operations. Highly mobile units, such as ski-mobile personnel or units equipped with over-snow vehicles, may be used against deeper objectives while larger, less mobile units attack more immediate key objectives.

3-55. The primary tasks associated with infiltration are raids, ambushes, and reconnaissance missions for special or long-term destruction and intelligence tasks. Forces infiltrate by ground, airdrop, or air-land. When used in conjunction with an attack, infiltration uses wide encircling movements to ambush and harass enemy flanks and LOCs and to report on and obstruct the movement of enemy reserves.

3-56. Raids during cold weather take advantage of the enemy's reduced mobility and may be an economical means of neutralizing key support or command and control facilities. Additional high-payoff targets include sustainment assets that provide warmth to the enemy, such as field kitchens and fuel. In retrograde movements, stay-behind forces may be left to ambush reserves, destroy LOCs, mine chokepoints, and demolish bridges. Stay-behind forces also obtain and transmit information on enemy strength, composition, and activity. However, stay-behind forces require additional sustainment.

3-57. Infiltration elements have no fixed organization. The particular mission determines their strength, organization, composition, and equipment. Infiltration can be carried out in all weather and throughout all seasons if troops are properly trained and equipped. However, more extreme environmental conditions create greater risk for personnel, equipment, and operations. In the winter, skis or snowshoes are used. In summer, movement on foot is possible in most areas. Great distances increase the need for aircraft transport, supply, and the evacuation of patrols, casualties, detainees, or documents.

3-58. Infiltration units must be capable of rapid movement on foot or skis over long distances and must be able to operate without resupply for long periods. To achieve this standard, troops rigorously reduce weight of equipment and rations. They keep weight and number of arms to a minimum and use of lightweight automatic weapons and grenades for firepower. A robust communications primary, alternate, contingency, and emergency (known as PACE) plan is necessary to overcome distance and arctic interference. Infiltration and exfiltration routes should differ, if possible, to avoid detection.

3-59. The effectiveness of infiltrating units fundamentally depends on their speed and ability to live in rigorous conditions. High physical endurance and expertise on skis or snowshoes are essential. In addition, every Soldier or Marine must be proficient in survival techniques. Leaders select personnel from troops with a wide practical experience in the arctic region. At least one person in each group should know the language, the people, and the terrain of the combat theater.

FLANKING ATTACK

3-60. The Marine Corps has a sixth form of maneuver. A *flanking attack* is an offensive maneuver directed at the flank of an enemy (USMC Dictionary; see also MCWP 3-01). A flank is the right or left side of a military formation and is not oriented toward the enemy. The attacker creates a flank by using fires or a successful penetration. It resembles an envelopment except units conduct it on a shallower axis. The same arctic considerations for envelopments apply to flanking attacks.

OFFENSIVE OPERATIONS

3-61. An *offensive operation* is an operation to defeat or destroy enemy forces and gain control of terrain, resources, and population centers (ADP 3-0). The Marine Corps definition of *offensive operations* is operations conducted to take the initiative from the enemy, gain freedom of action, and generate effects to achieve objectives. The four types of offensive operations are movement to contact, attack, exploitation, and pursuit (USMC Dictionary; see also MCWP 3-01).

OFFENSIVE OBJECTIVES

3-62. Offensive objectives against LOCs or terrain that deny the enemy shelter can be equally, if not more effective than objectives against enemy forces. Severe winter weather hastens enemy destruction after supply lines are cut and can severely degrade an entire brigade within 72 hours. Breaches in enemy LOCs should be made near dominating terrain if retaining the area is required. During summer, leaders select objectives where the LOCs cross a river or pass between two existing natural obstacles.

3-63. Due to large operational areas, flanks and rear areas are usually lightly defended and present excellent opportunities for envelopment, or under favorable conditions, for a turning movement. Attacks are usually directed against the flanks or rear areas, while supporting attacks are directed against the enemy front to hold them in position. An additional force may be employed to bypass the enemy position and cut enemy routes of reinforcement or withdrawal. The most mobile troops are used to breach the enemy LOCs.

OFFENSIVE PLANNING CONSIDERATIONS

3-64. When planning offensive operations, commanders consider—

- Task organizing for mobility.
- Enemy considerations.
- Characteristics of the offense.
- Preparation for the offense.

Task Organizing for Mobility

3-65. Arctic terrain severely limits mobility available for offensive operations. This is true throughout all seasons, but especially during the muddy spring thaw. In the winter, terrain is more favorable for an attack, but still poses constraints. For that reason, task organizing should favor mobility but must be carefully considered in relation to the enemy's capabilities. If surprise can be achieved and the enemy has relatively low cold weather capability, then a small force can inflict devastating effects on the enemy. However, if surprise cannot be achieved and the enemy has equal to or even greater cold weather capability, then force concentration will need to be significantly higher than the standard three-to-one (3:1) ratio.

Enemy Considerations During Offensive Operations

3-66. During winter months, the enemy will have increased access to warmth and shelter. Attacks should continuously disrupt the enemy and their sustainment to drive the enemy into heightened security postures, deny them shelter, and expose them to the cold. The enemy will seek to build defenses in conjunction with natural obstacles to reduce avenues of approach. Commanders must deceive the enemy as to the size, approach, and objective of the attack. During summer months, the enemy will be able to use unstable terrain, mud, and wet gaps to maximize obstacles and reinforce defensive positions.

Characteristics of the Offense

3-67. The characteristics of offensive operations are—

- Audacity.
- Surprise.
- Tempo.
- Concentration.

The extreme arctic environment presents unique opportunities and challenges for each characteristic of the offense. To capitalize on opportunities, Soldiers and Marines must master the arctic environment. If a unit is not cold weather capable or cannot move and fight in snow or mud, then it cannot implement the characteristics of the offense effectively.

Audacity

3-68. Audacity is a willingness to take bold risks. Leaders can imaginatively use what appears to be weather obstacles and turn them into major advantages and opportunities for audacity. For example, if commanders decide to attack during blizzards or a blowing snowstorm, the unit should attack downwind or at a slight angle to force the enemy to face the full force of the storm. However, conducting offensive operations during severe weather conditions restricts aviation support, increases reconnaissance problems (such as sensor degradation), and may reduce the length of reconnaissance patrols. Commanders weigh the advantages against the risk of losing command and control of their units. They use detailed plans to mitigate risk.

Surprise

3-69. Commanders surprise enemy forces by attacking at a time or place or in a manner for which enemy forces did not prepare or expect. The basic implementation of surprise does not change in arctic operations. Traditional enablers of surprise such as limited visibility, cold, and weather hazards are prevalent in the Arctic and provide ample opportunities for surprise. Units can achieve surprise through superior mobility over harsh arctic terrain. Superior mobility creates surprise by creating opportunities to strike the enemy from unexpected locations and at unexpected times. For instance, units with high mobility can conduct a much swifter and wider envelopment to strike an unprepared enemy from a lesser defended area.

> **Achieving Surprise Through Mobility**
>
> In the 1985 Cold Winter NATO Exercise, the 1st Battalion, 2nd Marines used superior over-snow mobility to achieve surprise and strike with a force much larger than anticipated. After air assaulting deep behind the enemy's flank, the entire battalion maneuvered swiftly on skis at night and over rough terrain to envelop the opposition's defensive strong point and force a surrender. In this instance, the opposition did not expect the size of the force to be so mobile as to close on them undetected.

3-70. Although tactical surprise opportunities are prevalent, local surprise may be more difficult to achieve when snow is present. The enemy can easily see moving objects on the snow and hear Soldiers and Marines moving because of better sound transmission in cold air. Additionally, the enemy may occupy specific locations so that the only way surprise can be obtained is with limited visibility. If ample over-snow transportation exists, suddenly increasing the tempo of an initially slow attack through the snow may surprise the enemy.

Tempo

3-71. *Tempo* is the relative speed and rhythm of military operations over time with respect to the enemy (ADP 3-0 and USMC Dictionary). To achieve tempo in arctic operations, commanders temper the desire for speed with tactical patience. Planners need additional time for troop leading procedures and preparation for combat. Everything in the Arctic takes longer to accomplish, and leaders must plan ample time-buffers to ensure units can meet conditions and synchronize operations.

3-72. Leaders account for differences in mobility between assets. An attack may lose momentum in between phases if commanders do not account for the increased time it may take units with degraded mobility to reach the objective. When considering differences in speed, commanders recognize that—

- Forward troops and reserve forces require more speed for tactical movement.
- Additional lead time may be required for initiating reconnaissance.
- Additional fires may be required to suppress the enemy (especially in deep snow which dampens the effects of some munitions).
- The sustainment effort may need to preposition forward or use aircraft for resupply to maintain the offensive tempo.
- Additional sustainment may be required to support prolonged engagements (such as rations and fuel). An attack may lose momentum if adequate sustainment is not provided.

3-73. To maintain tempo, commanders use follow-on forces to relieve exhausted units. Arctic operations are typically very strenuous, and units require more time than normal for recovery. Commanders should avoid assigning units back-to-back missions. Exhaustion and time-constraints may slow overtasked units to the point that tempo cannot be maintained, and the entire plan becomes desynchronized.

Concentration

3-74. Concentration is massing the effects of combat power in time and space at the decisive point to achieve a single purpose. Concentration in arctic operations relies strongly on proper task organization, tempo, and especially mobility. It may be helpful to establish "no-earlier-than times" when commencing the attack to ensure adjacent units have adequate time to maneuver into position. Commanders implement fires and coordination to achieve concentration in arctic operations. Fires often have less of an effect in arctic operations and require additional munitions to achieve the same destruction in temperate regions. Leaders account for the additional execution time and sustainment resources for fires to achieve the proper combined arms concentration desired. Coordination is extremely important to synchronizing efforts. Mission command and subordinate initiative are essential to maintain momentum. At times, the distance between two enveloping forces may become so great that messages cannot be sent, and subordinate action is the only means of success. To mitigate loss of communications, the radio relay capability of rotary-wing aircraft permits significant range extension for ground tactical radio equipment.

Preparation for the Offense

3-75. Commanders prepare for the offense. They inform their staff officers and issue an attack order as far in advance as possible. In particular, logistics staff often require additional time to make arrangements in arctic operations. Leaders use mission orders to provide maximum flexibility and subordinate initiative to overcome limited communications and long distances. The communications plan is made in detail and must provide measures for overcoming difficulties common to arctic operations.

3-76. After providing orders, leaders plan for reconnaissance. Reconnaissance is initiated early on a wide front with missions to determine enemy locations and reconnoiter routes and terrain, including terrain in enemy hands. Harassment of the enemy is started simultaneously with reconnaissance and is executed by patrols, limited objective attacks, and interdiction by aircraft and artillery. Engineer reconnaissance troops should be included in infantry reconnaissance patrols. Bridging equipment and materials are moved well forward to be ready for use when needed. Leaders keep supply reserves mobile when possible. It may be necessary to establish distributing points in forward areas.

3-77. Prepared fires of supporting artillery and mortars are closely coordinated. Representatives of supporting artillery are included in infantry reconnaissance patrols and in combat patrols. Preparation of firing positions for supporting weapons begins early as it is likely to be time consuming. In some instances, when absolute surprise is desired, it may be preferable to deliver the assault without artillery preparation fires.

3-78. When reconnaissance is completed and other preliminary measures taken for the attack, units open trails to assembly areas. If the distance is not too great, these trails are not opened until the day before troops plan to move. Periods of high wind may push snowdrift into trails, requiring additional maintenance. A halt is made in the assembly areas only long enough to feed and prepare troops for the attack. Vehicles are dispersed and artillery moved to prepared positions and camouflaged or concealed. Troops remain in the assembly area for the minimum length of time necessary to prepare for the attack. Supporting weapons are moved to selected firing positions.

TYPES OF OFFENSIVE OPERATIONS

3-79. Leaders employ the same basic four types of offensive tasks as they do in more temperate regions with modifications to overcome extreme environmental challenges. The offensive tasks are—

- Movement to contact.
- Attack.
- Exploitation.
- Pursuit.

Movement to Contact

3-80. To gain or reestablish contact with the enemy, units conduct a movement to contact. As mobility decreases, units use a smaller force to establish contact. If mobility conditions vary because of differences in snow depth or mud conditions, commanders can adjust the location for deployment into attack formation. The movement to contact may be conducted by infantry on foot, skis, or snowshoes or transported by tanks or personnel carriers. Techniques of conducting the movement to contact are as in normal operations, except when troops are using skis or snowshoes. (For more information on skis and snowshoes, see Appendix B.)

3-81. Before a meeting engagement occurs, commanders consider their options for subsequent actions. If a unit anticipates a hasty or deliberate attack, it proceeds on multiple avenues or at reduced intervals to facilitate its rapid employment. If a unit anticipates a hasty defense, it pushes supplies immediately (such as construction materials, heaters, and additional ammunition) to the forward troops.

3-82. When troops conduct movement to contact on skis or snowshoes, four or five troops follow the same track as they move over the line of departure. They make every attempt to get as close as possible to the enemy before delivering assault fire. Troops do not disperse or halt to fire until reaching the assault position or enemy fire becomes effective. Final coordination lines are generally closer to the enemy during winter than during summer especially when making the assault on foot through snow. Commanders decide whether troops conduct an assault on skis, snowshoes, or foot based on existing conditions. If Soldiers/Marines remove skis or snowshoes in the attack, then they bring equipment forward during reorganization.

3-83. When movement to contact is anticipated as a transition from the defense to a counterattack, it may be necessary to prepare the terrain for mobility. This may include snow removal or snow packing operations to prepare assembly areas and lanes for the counterattacking force. Rehearsals help confirm movement times and actions on contact.

Attack

3-84. When planning a deliberate attack, commanders assess the enemy's ability to prepare an arctic defense. If the enemy can proficiently prepare an arctic defense, then delays caused by preparing for a deliberate attack may favor the enemy. The enemy's defense may be more concentrated due to requirements for shelter and individual sustainability. This makes concentration simpler, but this advantage may be offset by limitations on mobility and fire support effectiveness. Before, during, and after an attack, units control existing LOCs to hinder the enemy in arctic operations.

3-85. A period of slow movement may occur between the cessation of artillery fire on the enemy forward positions and the arrival of the infantry on the objective. This period of slow movement caused by weather or terrain conditions must be considered when planning fire support for the assault. However, when weather, terrain, and lack of effective enemy resistance permits, mechanized infantry may remain in carriers. In carriers, the infantry can make a mounted assault to capitalize on shock effect and reduce the time lag associated with a dismounted assault through snow and underbrush. To further enhance this capability, tanks lead or accompany during a mounted assault.

3-86. Commanders can implement special equipment in offensive operations. They can integrate fixed- and rotary-wing aviation effectively into offensive operations. Vertical envelopment, diversionary attacks, and rapid displacement of supporting weapons and reserves are within offensive capabilities. In continuing the attack, leaders can direct special efforts toward rapid displacement of close-support weapons using sleds or vehicles. Supply routes are prepared as far forward as possible to facilitate unit distribution.

3-87. After seizing an objective, units give immediate attention to organizing the position for security. The assaulting troops may be fatigued and overheated from the exertion of the attack. Leaders distribute provisions to prevent troops from becoming cold casualties. Commanders must give rapid relief to assault elements and bring them back to warm shelter for continued success. Warming tents, if needed, are moved to the closest available concealment by each unit responsible.

Exploitation

3-88. An *exploitation* is a type of offensive operation following a successful attack to disorganize the enemy in depth (FM 3-90). The Marine Corps definition of *exploitation* is an offensive operation, following a successful attack, designed to disorganize the enemy in depth and extend the initial success of the attack by preventing the enemy from disengaging, withdrawing, and reestablishing an effective defense (USMC Dictionary; see also MCWP 3-01). Units immediately follow successful attacks by exploitation to deny the enemy sufficient time to regain the initiative. The exploiting force is aided by over-snow or cross-country vehicles and tanks. Although the forces leading the attack may continue into the exploitation, it is not recommended since these forces will likely need rest or shelter to counteract exhaustion from exposure and fighting through the arctic terrain. Follow-on forces have a much higher chance of success of exploitation but must be well-rested and sheltered for maximum effectiveness.

Pursuit

3-89. A *pursuit* is a type of offensive operation to catch or cut off a disorganized hostile force attempting to escape, with the aim of destroying it (FM 3-90). The Marine Corps definition of *pursuit* is an offensive operation designed to catch or cut off a hostile force attempting to escape, with the aim of destroying it (USMC Dictionary; see also MCWP 3-01). Transitioning from the attack into the pursuit of a retreating enemy may take place at a point when the attacking forces are nearing the end of their endurance. Commanders temper audacity with good judgment if the cold weather presents a significant risk for injury on a broad scale. Conversely, if friendly forces can sustain a pursuit in cold regions, the combined effects of combat and the environment may annihilate the enemy.

3-90. The pursuit force, which must have high mobility, is mounted on skis, vehicles, or helicopters. Airborne or air assault troops are positioned near chokepoints to block the retreat of the enemy. During summer, waterways may be used by the pursuing force as a means of moving patrols behind the enemy to destroy bridges and erect roadblocks along the enemy lines of retreat. Leaders take care not to over-extend troops beyond the ability to sustain operations, which will leave a force vulnerable and open to counterattack.

DEFENSIVE OPERATIONS

3-91. The Army definition of *defensive operations* are operations to defeat an enemy attack, gain time, economize forces, and develop conditions favorable for offensive or stability operations (ADP 3-0). The Marine Corps definition of *defensive operations* are operations conducted to defeat an enemy attack, gain time, economize forces, and develop conditions favorable to offensive and stability operations (USMC Dictionary; see also MCWP 3-01). The fundamentals of defense apply in arctic operations, but leaders must also account for the extreme environment and attempt to leverage these aspects against the enemy. In general, arctic operations favor the defense. Challenging mobility and difficult sustainment pose significant challenges for an attacker against a well-fortified position.

DEFENSIVE OBJECTIVES

3-92. The primary objectives of the defense in the Arctic are the same as in other operations. The defense attempts to force the enemy to attack under unfavorable conditions, such as in long, narrow passes or through deep snow and obstacles where movement is difficult. Due to the restrictive nature and extended LOCs in arctic operations, commanders may be forced to operate in the defense to restore combat power or allow logistics elements time to resupply combat units.

CONSIDERATIONS OF THE DEFENSE

3-93. When planning an arctic defense, it is important to consider—

- Seasons.
- Preparation.
- Security.
- Employment of the reserve.

Seasonal Considerations in the Defense

3-94. Seasonal changes affect defense positions. The thaw season will usually destroy positions built during the winter. Positions or obstacles built during the summer may be made useless by heavy snowfall. Units should use natural obstacles to the greatest extent possible. They avoid relying on them solely for defense because seasonal transitions can turn natural defenses into vulnerable weak points. For instance, an impassible marsh in the summer can become a high-speed avenue of approach in the winter.

3-95. In most instances, spring thaw, summer, and early fall are the most favorable seasons to conduct the defense, particularly an area defense. Wide-spread muskeg, lakes, streams, and rivers create natural obstacles to fortify defensive positions. Standing guards are also not subject to extreme cold and can maintain higher alertness.

3-96. Winter offers the defense several considerable advantages. Firstly, the same mobility granted to the attacker is also available for the defense in the form of a mobile defense or counterattack. Second, the defense has the advantage of shelter to protect from the elements, while the enemy is usually exposed to the extreme environment on the attack. If the attacking enemy is not cold weather capable, then the added effects of the harsh cold can often cause more casualties to the unacclimatized than bullets and explosives. Even with advantages, defensive actions are still difficult in extreme cold because of the requirement to keep troops warm and in condition to fight. Troops must resist the tendency to remain shelter bound. Strong combat patrols are used to harass the enemy flanks and rear.

Preparation of the Defense

3-97. Preparation of the defense must account for the significant additional time it takes to prepare positions and obstacles. This is especially true in winter when frozen ground makes it difficult to dig fighting positions and emplace obstacles. Leaders direct special attention toward maintaining battle preparedness in winter. While resting in forward positions, troops stay ready for combat. Soldiers/Marines constantly maintain and prepare all weapons for immediate use. They also keep firing positions clear of snow. Leaders rotate and inspect guards constantly. Warm shelter is constructed for reserves.

3-98. Defense positions located in deep snow suffer less from the effects of enemy fire. Dense forests, thickets, fallen timber, cliffs, and other natural obstructions collect snow and create obstacles for the attacker. Rocks and fallen tree trunks may become anti-vehicle obstacles. With planning, units can easily increase the effectiveness of natural terrain obstacles. Engineers can pile snow into large berms to construct fighting positions or limit roadway access. Obstacles emplaced on frozen waterways can deny enemy avenues of approach. (See Appendix C for information on ice demolition.)

3-99. Areas in the defense where there is little snow, or which are easily traversed by the enemy, are reinforced with tactical obstacles. These may consist of one or more of the following: wire, craters, antivehicle ditches, abatis, and minefields. Overwatch of obstacles is essential. Deception techniques are practiced extensively. (For more information on the preparation of obstacles, see countermobility discussed in paragraph 3-122.)

Note. The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines.

Security in the Defense

3-100. All-around defense is essential since attacks may be launched from any direction. During spring, summer, and fall a mobile defense is extremely difficult because of trafficability. Commanders locate strong points in elevated terrain. The value of elevated defense positions increases during winter than under normal conditions as the enemy must attack uphill in snow.

3-101. Proper security in the defense requires the location of living and fighting positions for the security force on the outer perimeter. However, tentage and warming shelters with large heating signatures need to be away from fighting positions to reduce detection. Troops can use unheated shelters and individual equipment to keep warm close to their battle position. Units rotate troops to warming shelters frequently to prevent CWIs. Units establish a warning system from the security force position to the forward defense force position. Units keep all movement on the outer edge of the perimeter and in the vicinity of the living-fighting positions to a minimum to prevent observation or attack by hostile air and ground forces. Units use camouflage netting or other thermal mitigation measures on shelter and fighting positions to reduce detection. Leaders understand that active and passive counter-UAS measures are an integral part of the defense.

Employment of the Reserve

3-102. An aggressive defense requires the formation of a proportionately large reserve with maximum over-snow or cross-country mobility. This mobility comes from individual over-snow equipment, over-snow vehicles, personnel carriers, or helicopters. Dismounted reserves locate closer to defense positions, while mechanized or air assault reserves may be stationed farther away. In selecting a location for the reserve, leaders consider the importance of rest as well as the probable area of employment. Most of the reserve is placed in covered and concealed positions, protected from enemy light artillery fire, while the remainder may be placed closer to the front lines. Units prepare trails and roads to the probable points of action for the reserve troops. Elements of the reserve then keep these trails and roads open during snowstorms. As much as possible, troops camouflage the roads and trails.

3-103. Once units identify avenues of approach, they can then maneuver to provide favorable force ratios. If friendly forces defend a broad front, they need to define the enemy avenues of approach and enemy strengths on each avenue early. Mutual support on a wide front may become problematic due to large distances inherent in arctic operations. If gaps exist, reconnaissance assets (or sensors if there is a lack of personnel) keep the area under surveillance. Commanders develop effective fire plans to cover these gaps.

TYPES OF DEFENSIVE OPERATIONS

3-104. The three types of defensive operations are—

- Area defense.
- Mobile defense.
- Retrograde.

Often a delicate balance exists between maintaining mobile and static defenses. This balance depends on the season and time of year. No matter what type of defense units employ, a battle centers on denying the enemy the ability to maneuver along avenues of approach.

Area Defense

3-105. An area defense varies depending on the season. The Army defines an *area defense* as a type of defensive operation that concentrates on denying enemy forces access to designated terrain for a specific time rather than destroying the enemy outright (ADP 3-90). The Marine Corps defines an *area defense* as a type of defense in which the bulk of the defending force is deployed on selected terrain. Principal reliance is placed on the ability of the defending forces to maintain their positions and to control the terrain between them. The reserve is used to add depth, to block, or restore the battle position by counterattack (USMC Dictionary; see also MCWP 3-01). During the spring thaw, summer, and early fall, conditions favor the area defense because trafficability is poor for the attacker. Letting the enemy attack a robust network of well-prepared positions and then counterattacking may prove the best course of action. During colder months, such a course of action exposes enemy forces to the elements, especially if the enemy lacks warming equipment and other logistics support.

3-106. Commanders carefully consider the terrain, weather, and temperature range before choosing a defense scheme that emphasizes static elements. Area defenses cause problems since they require additional construction time to build fighting positions and obstacles. The need to keep Soldiers and Marines heated in extremely cold temperatures also complicates matters.

Mobile Defense

3-107. The Army defines *mobile defense* as a type of defensive operation that concentrates on the destruction or defeat of the enemy through a decisive attack by a striking force (ADP 3-90). The Marine Corps defines *mobile defense* as defense of an area or position in which maneuver is used with organization of fire and utilization of terrain to seize the initiative from the enemy (USMC Dictionary). Leaders often find that conditions favor a mobile defense during the winter months. Since the ground freezes during this time of year, offensive forces move and maneuver more easily on the battlefield. A mobile defense is hard to maintain in spring, summer, and fall due to the marshy terrain. The size and capabilities of the reserve become the paramount concern for this type of operation.

Retrograde

3-108. When troops must delay or withdraw, the arctic battlefield favors the defender. The Army defines *retrograde* as a type of defensive operation that involves organized movement away from the enemy (ADP 3-90). The Marine Corps defines *retrograde* as any movement or maneuver of a command to the rear, or away from the enemy (USMC Dictionary). Defending forces often know the terrain. Further, they are better prepared to cope with mobility and trafficability problems than the attacking force.

3-109. Retrograde movements are executed as in normal operations. Retrograde is best conducted at night or under conditions of reduced visibility when enemy reactions are slowest. Units break trails rearward from positions before the retrograde commences and may mine trails as the rear guard withdraws. If a daylight retrograde becomes necessary, units may use smoke. Over-snow mobility is exploited to the maximum. During the retrograde, troops destroy all abandoned shelters that the enemy can use. Maximum use is made of mines, traps, and abatis.

> ***Note.*** The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines.

3-110. In the Arctic, suitable conditions often exist for leaving strong combat patrols up to a strength of one or two platoons to harass or ambush the advancing enemy. These troops can launch surprise attacks against columns of vehicles and troops at natural chokepoints. In some cases, it may be desirable to establish hidden caches of food and ammunition prior to withdrawal for the troops left behind to ambush the enemy.

ENABLING

3-111. Enabling operations are required to conduct successful offensive, defensive, and stability operations. An *enabling operation* is an operation that sets the friendly conditions required for mission accomplishment (FM 3-90). Enabling operations can also be described or listed as key tasks during the execution of a mission. Enabling operations are—

- Reconnaissance.
- Security operations.
- Troop movement.
- Relief in place.
- Passage of lines.
- Countermobility.
- Mobility.
- Tactical deception.
- Linkup.

RECONNAISSANCE

3-112. Reconnaissance patrols may operate far behind enemy lines for extended periods. *Reconnaissance* is a mission undertaken to obtain information about the activities and resources of an enemy or adversary, or to secure data concerning the meteorological, hydrographic, geographic or other characteristics of a particular area, by visual observation or other detection methods (JP 2-0). In winter, the over-snow mobility of patrols must be given prime consideration. Ideally, only ski-qualified personnel, equipped largely with individual automatic weapons, should be used. However, snowshoes provide an adequate and reliable means of over-snow movement, and their use allows greater latitude in the selection of personnel. Personnel will also carry necessary communications equipment and minimum-essential equipment to construct improvised shelters. Whenever possible, reconnaissance troops use UAS to increase their range, utility, and effectiveness in the cold. Units can resupply troops with prearranged supply drops in enemy territory.

3-113. The most economical way to move long-range patrols into enemy territory is by aircraft. At times, it may be feasible to pick up patrols from enemy rear areas by aircraft. During winter, escort patrols accompany long-range ground patrols to ensure that the long-range patrols get through enemy lines, to carry additional rations for later use by the long-range patrols, and to make deceptive tracks on both sides of the route of the long-range patrol. The speed, mobility, and firepower of air cavalry make it ideally suited for reconnaissance in arctic operations.

SECURITY OPERATIONS

3-114. The fundamentals of security operations apply to arctic operations. *Security operations* are those operations performed by commanders to provide early and accurate warning of enemy operations, to provide the forces being protected with time and maneuver space within which to react to the enemy, and to develop the situation to allow commanders to effectively use their protected forces (ADP 3-90). Most arctic operations require all-around defense because large areas of operations allow the enemy to attack from any direction. Security forces use elevated terrain for strong points and aerial assets that provide far lines of sight for surveillance.

3-115. Rear area security is critical in arctic operations. Enemy patrols often attack routes of supply; therefore, support personnel must always be capable of defense. In rear installations, leaders make area security and damage control plans and establish a warning system. The enemy can infiltrate rear areas with small, well-equipped ski troops that can use unsuspecting off-road avenues of approach. Special attention is paid to possible infiltration routes and to possible landing areas, such as lakes or rivers. When necessary, combat units provide escorts for supply convoys. (For detailed information on operating a patrol base, refer to TC 21-3.) Rear area security forces are affected by cold and difficult conditions just like front-line forces and require similar considerations for force rotation and sustainment. They also require over-snow mobility equipment such as skis, snowshoes, or snow machines.

TROOP MOVEMENT

3-116. Leaders plan for increased movement times for all forms of movement. Troop movement is frequently underestimated in the Arctic and can desynchronize plans if not properly accounted for. *Troop movement* is the movement of Soldiers and units from one place to another by any available means (FM 3-90). Snow, muskeg, and mountains all slow movements. Individual movement techniques are the most reliable form of transportation in arctic operations. All motorized transportation has limitations. Troop movement in the Arctic frequently requires specialized equipment to maximize mobility and tempo. This includes helicopter skis, wheeled-vehicle snow chains, CATVs or small unit support vehicles (SUSVs), snow machines, skis, snowshoes, and cargo sleds. (See Appendix B for more information on specialized arctic equipment.)

3-117. Even with specialized equipment, leaders consider the exhausting toll that any arctic movement has on troops. Trail breaking through snow or carrying heavy loads significantly increases the workload. If possible, the Soldiers/Marines performing more strenuous movement tasks should not be the same Soldiers/Marines in the main effort. If leaders must use the same individuals, leaders consider the potentially decreased fighting capacity of the troops involved.

3-118. Troops train to properly layer clothing for movement. Bulky clothing and the effects of cold weather limit human performance. During foot marches, an overdressed Soldier or Marine can overheat even in subzero temperatures. At the end of a movement, troops prepare to add additional layers or change from wet clothing to avoid CWIs. Leaders should anticipate and plan for the additional time it takes to change during different phases of the movement.

3-119. During night movement, units may get separated and must take additional time to regain contact and continue movement. In temperate regions, this is usually an annoyance that slows movement. In the cold weather environment, long halts can produce CWIs. For this reason, the route should follow the easiest terrain possible. The route should also be well-marked with guides in appropriate places. Units maximize the use of reconnaissance teams and well-defined travel lanes and checkpoints. Reconnaissance teams may also be tasked to put up heated shelters along longer routes. (For a detailed discussion on mobility and planning movement considerations, see Appendix B and refer to TC 21-3.)

RELIEF IN PLACE

3-120. A relief in place of committed units is executed as under normal conditions. A relief in place is an operation in which, by direction of higher authority, all or part of a unit is replaced in an area by the incoming unit and the responsibilities of the replaced elements for the mission and the assigned zone of operations are transferred to the incoming unit. During winter, leaders need a well-planned relief back to warm shelter to maintain combat effectiveness in troops exposed to the exhausting tolls of the cold.

PASSAGE OF LINES

3-121. In arctic operations, mobility is critical to efficient passage of lines. A *passage of lines* is an operation in which a force moves forward or rearward through another force's combat positions with the intention of moving into or out of contact with the enemy (JP 3-18). Mobility problems often make a passage of lines more difficult to coordinate and control. Commanders must pay extra attention to identification of vehicles, routes of passage, signals, and coordination of movements. To the greatest degree, the passing unit must be equipped with over-snow or cross-country equipment to maintain momentum of an operation. If possible, stationary units prepare passage points in advance by clearing snow and ice.

COUNTERMOBILITY

3-122. In arctic operations, using or blocking avenues of approach is the key to victory. *Countermobility* is a set of combined arms activities that use or enhance the effects of natural and man-made obstacles to prevent the enemy freedom of movement and maneuver (ATP 3-90.8/MCTP 3-34B). Retaining control over limited road and trail networks proves instrumental in allowing friendly forces to advance in a theater of war. Lakes, rivers, swamps, or bogs can be used as obstacles in summer, but often become avenues of approach in the winter. In winter, these areas lengthen the front line of a given area of operations and require more troops and weapons to defend it. Commanders deny the enemy access to these natural routes under winter conditions. (Refer to FM 3-34, MCWP 3-34, and ATP 3-90.8/MCTP 3-34B for more on countermobility.)

Denying Access to Waterways

3-123. Commanders eliminate many planning variables in their defensive scheme by nullifying waterways as an avenue of approach. To create water obstacles during winter conditions, units use explosives to blow gaps in lake and river ice making it impassable to enemy personnel and armor. To properly create a water obstacle in this way, units must first construct a detailed engineer reconnaissance plan. (See Appendix C for more information on emplacing ice charges.) Placing charges in ice has the following advantages:

- Units can cut off long areas of the front line at a critical moment from enemy infantry and armor.
- Units require fewer resources to defend a given area.
- Friendly troops may advance or withdraw at any place over the charges without being restricted to passage lanes.
- Charges laid under thick ice are difficult, and often impossible, to detect by use of mine detectors.
- When holes over the charges have refrozen, the field is difficult for the enemy to breach.
- Charges are not affected by weather or snow conditions.

3-124. Placing charges in ice has the following disadvantages:

- Emplacing explosives requires considerable time even when troops have ice-cutting equipment.
- Charges can be set off when hit by artillery fire.
- Gaps blown in the ice tend to freeze over rapidly in low temperatures.
- Continued exposure of the demolition firing system to weather reduces the reliability of the system.

3-125. Units use ice demolitions for protection from frontal or flanking attacks. Normally, units lay one or more sets of charges close to the friendly shore and others farther out in the direction of the enemy. If desired, units allow the enemy to advance past the first set of charges and then detonate both at the same time. This method maroons an enemy on an ice floe and makes them easier to destroy. Units can use the same trapping method against enemy armor or detonate the charges directly under advancing tanks. Commanders keep ice demolitions under observation and secured by friendly fire.

Constructing Obstacles

3-126. Troops can use obstacles to disrupt, fix, turn, or block the movement of an opposing force, and to impose additional losses in personnel, time, and equipment. Obstacles are classified as natural or man-made. In arctic operations, units can use either obstacle type or a combination of the two to hinder and restrict enemy maneuver. When constructing obstacles, leaders consider outside-of-the-box thinking, such as deliberately icing a road to create a cheap obstacle.

Natural Obstacles

3-127. Two effective natural obstacles are slope and waterways. A steep slope creates an obstacle to troops and vehicles even under normal conditions. When covered by deep snow or ice, it becomes much harder to surmount. The bogging-down action and the loss of traction caused by deep snow frequently creates obstacles out of slopes that personnel might easily overcome otherwise. In the summer, muskeg, kettle ponds, and other waterways act as natural obstacles to limit mobility and slow rates of advance.

3-128. An avalanche makes an excellent obstacle for blocking passes and roads. However, this type of obstacle is only available in hilly or mountainous terrain with few natural avenues of approach. An avalanche can have a far-reaching influence over combat operations. However, avalanches that occur naturally may help the enemy unless their timing and location are just right. Units can predict where an avalanche can and probably will occur. By using artillery fire, bombs, or explosives, units might induce the avalanche to slide at the desired time. This type of avalanche is a man-made obstacle in the technical sense. Generally, it will be of more value than the natural type.

3-129. Windfalls are another natural obstacle that precludes movement and maneuver. These occur when strong winds knock over trees in a wooded area. These obstacles reduce the effectiveness of personnel who wear skis and even snowshoes. Covering windfall with snow enhances the effectiveness of this technique.

Man-Made Obstacles

3-130. Man-made obstacles include abatis, wires, and ice. An abatis is similar to a windfall. Units fell trees with sharpened branches facing the enemy's direction of approach and the stump attached to hamper removal. Along trails, roads, and slopes, an abatis can cause much trouble for skiers and vehicles. Units can also use wire obstacles to great effect. (See TM 3-34.85/MCRP 3-17A for more information on types of wire obstacles.) Another useful obstacle units can make involves pouring water on road grades. The ice that forms will seriously hamper vehicular traffic.

3-131. In winter, snow is well available and can be used to construct a variety of obstacles such as berms, serpentines, and fighting positions. Sand and gravel can be combined with water to form icecrete, which can stop bullets (see paragraph 9-7). (For more information on man-made obstacles, refer to FM 3-34.)

3-132. As of January 1, 2010, U.S. forces are no longer authorized to employ persistent and undetectable land mines (land mines that are not self-destructing or self-deactivating). The United States employs self-destructing and self-deactivating mines (scatterable mines) to provide countermobility for the force. Additionally, newly developed weapon systems (called networked munitions) provide the flexible and adaptive countermobility and survivability capability required by the Army. Networked munitions are remote-controlled, ground-emplaced weapon systems that provide lethal and nonlethal effects; they have the ability to be turned on and off from a distance and can be recovered for multiple employments. The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines. Mines should only be used during arctic or extreme cold weather operations after careful consideration of the operational and mission variables. Risk to non-combatants and post hostility implications must be carefully considered. It is possible for water to enter and freeze inside the device. This may cause the mine to fail to self-detonate.

MOBILITY

3-133. *Mobility* is a quality or capability of military forces which permits them to move from place to place while retaining the ability to fulfill their primary mission (JP 3-36). Mobility is necessary for the conduct of successful offensive arctic operations. *Mobility tasks* are combined arms activities that mitigate the effects of obstacles to enable freedom of movement and maneuver (ATP 3-90.4/MCTP 3-34A). There are six primary mobility tasks:

- Conduct breaching.
- Conduct gap crossing.
- Conduct clearing (areas and routes).
- Construct and maintain combat roads and trails.
- Construct and maintain forward airfield and landing zones (LZs).
- Conduct traffic management and enforcement.

Note. For information on constructing and maintaining forward airfield and loading zones, see discussion starting with paragraph 3-203.

Breaching

3-134. Breaching is a complex task that is further complicated by the reduced mobility inherent in arctic operations. The Army defines a *breach* as a tactical mission task in which a unit breaks through or establishes a passage through an enemy obstacle (FM 3-90). The Marine Corps defines a *breach* as to break through or secure a passage through an obstacle (USMC Dictionary). Units should plan for a higher than normal combat ratio beyond three-to-one (3:1) to ensure success. Surprise of the enemy is critical. Given degraded communications, simple plans have a much higher chance of success.

Gap Crossing

3-135. Gap crossing in arctic or cold environments can prove more challenging than in temperate environments due to several seasonal factors. A *gap crossing* is the projection of combat power across a linear obstacle (wet or dry gap) (ATP 3-90.4/MCTP 3-34A; USMC Dictionary). Units must recognize that dry gaps can quickly become wet gaps during the thaw season because of snow melt or rain and water depth, and velocity can change quickly. Streams, swamps, and lakes require more gap-crossing equipment and effort for installation and maintenance. Entry and exit banks may have snow drifts, snow accumulation, and ice floes that will mask the underlying terrain and require on-site observation for proper planning. If gaps have potential ice (including upstream ice that may break free and create debris), leaders need ice mitigation strategies to avoid risk of possible injury or damage. During wet gap crossings, water temperature even in summertime may be cold enough to cause CWIs or death. Units implement necessary control measures to prevent exposure to cold water. (For information on ice gap crossing, see Appendix C.)

Clearing (Area and Routes)

3-136. *Clearing* is a mobility (focused on movement) task performed by follow-on engineers and explosive ordnance disposal that involves the total elimination or neutralization of an obstacle (ATP 3-90.4/MCTP 3-34A). Clearing or reducing obstacles in arctic operations is more challenging and time-intensive than in temperate regions. Therefore, units must identify any clearing requirement early and plan for extended timelines.

Combat Roads and Trails

3-137. LOCs and terrain affect the ability of a force to advance and carry out its mission. Tracked vehicles do not eliminate the need for roads, nor should lack of roads limit the scope of operations. Roads made by combat troops during winter can only improve so much to support the equipment. Engineers build wide enough to accommodate vehicles but avoid unnecessary clearing. Over-clearing roads may reveal friendly locations to enemy air. On single-lane roads and trails, troops build frequent turnouts to permit two-way traffic. Vehicle operators train to offset their tracks to prevent high spots in the centerline, especially on sharp curves.

3-138. The seasonal weather affects vast roadless areas of the Arctic. Under summer conditions, wet and muddy roads impede overland vehicular movement. During the winter months, the ground and waterways are frozen. Combat troops frequently construct temporary summer roads and bridges along the routes without engineer support.

3-139. Mobility conditions change rapidly in cold regions. When faced with degrading or insufficient terrain trafficability, military units often must quickly build, repair, or improve roadways to proceed. Units can use snow, locally available materials, or portable materials carried on vehicles for this purpose. If a unit must cross a swamp, it is done at the narrowest point requiring the least ground reinforcement. In heavily forested areas, units can widen and use existing game trails, clearings, and lanes through the trees for roads. Information on road construction under summer conditions in the Arctic are contained in the UFC 3-130-1.

Snow Roads

3-140. Units construct and maintain snow roads for wheeled and tracked vehicles. Removing and compacting the snow requires significant resources. One wind event can cover miles of road with brick-hard snow overnight. Normally, snow is removed by snowplows, graders, angledozers, and drags. Commanders consider using local contract or state assets to assist with snow and ice clearing when feasible. The unit scatters removed snow away from road ditches. It levels deep-rutted snow hardened by traffic or freezing with harrows, drags, graders, dozers, or by packing loose snow into ruts. To provide drainage for melted snow, they maintain and clear road surfaces, culverts, bridge channels, and ditches. Troops maintain roads for tracked vehicles by straightening sharp curves, filling holes, building turnouts, and draining surface water.

3-141. Mechanical compaction and grooming of snow improve troop mobility by increasing snow road strength and density. These improvements can range from simply packing snow roads with available vehicles (such as over-snow vehicles like a snowmobile and wheeled vehicles with low-ground pressure "tundra" tires) to building and maintaining semipermanent snow roads capable of supporting heavy vehicles.

3-142. Snow roads can support many vehicle types. To build a durable snow road, units compact snow with grooming equipment and then allow the snow to further strengthen through sintering (age-hardening). Units ideally allow newly compacted snow to sinter for 12 to 24 hours before use. With design and careful construction, units can build snow runways that can support very heavy wheeled aircraft, such as the C17.

3-143. Snow road construction consists of the following steps:

- Survey area for the road.
- Cut, rip, and till the snow to create a homogeneous mix—especially if the snow contains ice crusts or other pronounced layering.
- Compact the snow (with compaction cart or rollers).
- Level and smooth the road surface.
- Plow or blow more snow onto the road and then recompact, level, and smooth the surface.
- Allow each lift or construction event to sinter to create a hard strong surface (sintering even a few hours or overnight can improve strength, especially in cold conditions).

3-144. Different types of groomers can be built and drug behind vehicles to prepare snow roads. Snow grooming and trail breaking are vital. Grooming allows friendly forces to create their own LOCs and create false trails in the defense to turn enemies into their engagement areas. Figure 3-3 illustrates both a welded metal groomer and a wooden pallet groomer.

Figure 3-3. Snow road groomers

Thawing Soils and Muddy Ground

3-145. Trafficability of roadways over muddy or thawing ground improves with traction mats, pallets, slash, gravel, and other materials sourced near the operational need. The effectiveness of improving trafficability and the effort required to construct different types of expedient road surfaces varies by material and construction technique. The choice of technique often depends on available materials and time.

3-146. Gravel and other fill materials (such as tire chips and chunk wood) deploy quickly, require minimal training, and typically provide a high level of trafficability and durability. Alternate fill materials work when gravel or soil fill materials are not available on-site or nearby, when getting the material to the road site takes too long, or when gathering resources creates complex logistics.

3-147. Units can quickly deploy and carry purpose-built expedient roadway materials when available, small enough, and needed for an emergency. Roadway materials consist of traction mats, fascines (linked pipes that unroll onto a roadway), and geotextiles. However, these materials cannot typically be quickly or easily sourced, must be carried along, and are useful only while supplies last.

3-148. Many materials can improve trafficability. Slash (cut trees and branches) readily exists in many areas and can greatly enhance the trafficability of mud, soft soil, and snow terrain. Slash is labor intensive—trees must be cut and placed—and may expose Soldiers/Marines to enemy fire in combat situations. Slash can also get caught in tracks and vehicle undercarriages and immobilize or damage vehicles. Vehicles are more vulnerable before the slash has been trafficked, compressed, and worked into the ground. Pallets, tire mats (mats constructed of old tire sidewalls), and other construction or waste materials can also improve traction.

Ice Routes

3-149. In some areas, the best sites for winter road routes exist along frozen waterways. They are relatively easy to prepare, requiring only snow removal and possible strengthening of the ice in places. The only slopes on such routes are at the entrance and exit to the waterway.

3-150. Leaders select road routes across lakes and streams only after an intensive and detailed reconnaissance of ice conditions. This reconnaissance focuses mainly on the ability of the ice to support the unit’s heaviest load. Ice thickness is only one factor in determining its bearing capacity. Appendix C discusses many other factors. Qualified personnel conduct the reconnaissance for a route over ice, studying ice characteristics to limit risks to troops and equipment. These personnel check the entire route over ice, as ice conditions can differ along a relatively short distance.

Traffic Management and Enforcement

3-151. The Arctic has limited road networks, existing roads for only one-way traffic, and normally hazardous conditions during winter months due to ice and snow cover. Visibility seriously deteriorates with snowfall, snow drifts, frequent ice fog, and long hours of darkness which extend the operation of vehicles under blackout conditions. Military police operating in such areas require a tracked vehicle. Units use reflective signs extensively behind the light line and luminous signs forward of the light line. Traffic control posts and checkpoints requiring continuous operation in winter months may require the doubling of personnel. An effective unit establishes a “buddy” system and provides shelter for traffic control personnel.

3-152. Rotary- and fixed-wing aircraft, if available, provide essential mobility for controlling traffic in areas with limited roads and trails. Aircraft can rapidly recon routes in use. The frequency of route reconnaissance depends upon traffic density, weather, and type of vehicles on the road. Investigative and control personnel need to reach serious accidents, incidents, and other emergencies immediately. This can be accomplished by rotary-wing aircraft.

TACTICAL DECEPTION

3-153. Deception has an important role in arctic operations. *Tactical deception* is a friendly activity that causes enemy commanders to take action or cause inaction detrimental to their objectives (FM 3-90). All deceptive measures must be well planned and carefully executed to give them every appearance of reality. However, leaders must balance deception with the amount of time and resources it takes to construct and maintain deceptive measures.

3-154. Several tactical deception methods work well in the Arctic. First, troops make false ski or snowshoe trails to mislead the enemy as to the size of the force, direction of movement, and scope of activity. Establish rules for track discipline in snow, such as using single file to conceal troop strength where possible and restricting the blazing of new trails. Next, troops drape tarps over trees to resemble tents. Troops can also light slow-burning fuel to create smoke resembling individual heating sources. This can deceive the enemy to the size and location of forces. Third, troops can construct dummy gun positions using logs and branches. Units can use sound and flash simulators in these positions to give them a semblance of reality.

3-155. Electromagnetic deception is another important tactical deception. The enemy can be expected to gain intelligence by monitoring nets, locating positions by direction finding, and employing side-looking airborne radar and infrared devices. Friendly forces use electromagnetic deception to hinder the enemy's detection of friendly location and movement.

LINKUP

3-156. Arctic units conduct linkups in the same manner as in other regions, but arctic troops account for limited visibility and intermittent communications. A *linkup* is a type of enabling operation that involves the meeting of friendly ground forces, which occurs in a variety of circumstances (FM 3-90). The Marine Corps definition of *linkup* is an operation wherein two friendly ground forces join together in a hostile area (USMC Dictionary). Leaders stress positive identification. Positive identification prevents friendly fire because during winter both friendly and enemy forces may wear similar all-white camouflage. As linkup becomes imminent, coordination and control are intensified, and positive restrictions are placed on the forces involved. Units establish radio communications in advance to further mitigate chances of friendly fire. Snow and rain within the arctic region may make short-wave communications at close distances difficult causing delays or miscommunications during linkup procedures.

STABILITY

3-157. When conducting stability operations in arctic operations, certain aspects of restoring and providing essential services differ from those found in warmer regions. A *stability operation* is an operation conducted outside the United States in coordination with other instruments of national power to establish or maintain a secure environment and provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief (ADP 3-0). Units execute the methods in the same manner anywhere, regardless of the environmental conditions. FM 3-07 and MCWP 3-03 outlines activities for stability operations.

3-158. Many of the factors that limit offensive and defensive operations also impact stability operations. Extended LOCs, lack of rail networks and airports, difficult terrain and weather, and limited road networks limit the amount of logistics support the military can deliver in support of civilian populations. In addition to these limitations, units need many transportation assets to maintain the force, especially if forces are engaged in ongoing operations. Wheeled operations in support of stability operations are especially hazardous due to terrain and weather phenomena.

3-159. Soldiers and Marines concentrate on eight key tasks to restore essential services to the population in arctic operations. These tasks are—

- Provide essential civil services.
- Perform tasks related to civilian dislocation.
- Support famine prevention and emergency food relief programs.
- Support nonfood relief programs.
- Support humanitarian demining.
- Support human rights initiatives.
- Support public health programs.
- Support education programs.

These tasks are standard in all stability operations. In addition, arctic operations require units to provide a way to keep individuals warm. Commanders meet this task by providing clothing appropriate for the climate, a heat source such as an approved heater, or ideally, both items. Potentially, this problem is limited since many arctic regions have relatively small populations. Smaller populations, in turn, require far fewer resources than large populations demand.

DEFENSE SUPPORT OF CIVIL AUTHORITIES

3-160. Defense support of civil authorities is support provided to civilians by U.S. Federal military forces, DoD civilians, DoD contract personnel, DoD component assets, and National Guard forces. Typically, this response answers requests for assistance from civil authorities for domestic emergencies, law enforcement support, and other domestic activities, or from qualifying entities for special events. (For more on defense support of civil authorities, refer to DoDD 3025.18.)

3-161. When Army units engage in civil support operations in arctic operations, specially trained units with arctic experience, usually the National Guard, conduct these operations. Examples include cold weather air rescue operations. In extreme circumstances, Regular Army or U.S. Army Reserve forces augment state and local resources. In certain arctic regions, federal agencies, state authorities, and local authorities have developed mutually beneficial relationships. These relationships provide the military with valuable training opportunities. In addition, these relationships foster positive civil-military relationships and can help reduce the cost to state and local government agencies. However, these relationships can be suspended due to operational commitments such as deployments to a contingency operation. Marines can use the Marine Corps assets in many of the same civil support roles if tasked by Headquarters, U.S. Marine Corps. An incident command staff and commander will employ both Army and Marine Corps units. (Refer to DoDD 3025.18, JP 3-28, and ADP 3-28 for detailed discussions of defense support of civil authorities.)

SECTION III – OPERATIONS IN THE MARITIME DOMAIN

3-162. The maritime domain is extremely limited in arctic operations due to limited accessibility caused by sea ice. In the Arctic Ocean, movement possibilities vary widely from year to year depending upon the severity of the preceding winter season. However, most areas of the Arctic Ocean bordering on land masses have about ten weeks each year when the ice permits passage of vessels. These periods usually occur during July, August, and September. The relatively short shipping season constricts accessibility to the region and requires significantly long planning foresight. For instance, large items that need to be shipped may need to be planned for a year in advance; otherwise, they may need to be shipped at great cost by air. As climate change continues to warm the region and thaw ice, these ice-free seasons will increase. Commanders forecast these seasons and plan contingencies during periods of inaccessibility.

3-163. The short summer season is usually long enough to melt most of the ice and snow on the land areas and to break up the southernmost portions of the polar icepack for several weeks. Poor visibility restricts observation, which challenges navigation through drift ice and pack ice. Poor visibility also hampers cargo discharge when vessels must anchor several miles from shore. To guide landing craft discharging cargo, marker buoys are placed along the entire route from the ship to the shore.

3-164. Navigation is restricted by the movement of pack ice, which is governed by winds, tides, and currents. Aerial observation by helicopter is essential for icebreakers because of the rapidly changing ice conditions. When the huge floes and chunks of ice freeze together or are packed solidly by the wind and currents, the most powerful icebreaker cannot force passage. Navigation is further hampered by the prevailing shallowness of the water off Arctic Ocean shores and the numerous, migrating sand bars which prevent vessels from standing in close to shore to avoid heavy ice and to discharge cargo. Some areas lack adequate hydrographic data, creating an additional hazard.

3-165. Some significant maritime activities that affect Army and Marine Corps operations in the Arctic are—

- Amphibious operations.
- Supporting arms.
- Supply by water.
- Riverine operations.

AMPHIBIOUS OPERATIONS

3-166. Extreme weather may severely limit, or completely prevent, an amphibious assault against a defended beach in arctic operations. Planners carefully consider the range of high and low tides and beach gradient present in the Arctic. Once the attack is initiated, speed of landing and logistics support is of great importance. Logistics plans include an alternate plan to supply by air should ice conditions change during a critical part of the operation. Plans should include the use of helicopters in an amphibious assault. Once ashore, the operation will be conducted the same as any other attack at arctic latitudes. (Refer to JP 3-02 for more information on amphibious operations.)

3-167. The prevailing influential factors of amphibious operations are—

- Oceanographic conditions.
- Effect of arctic conditions on personnel and equipment.

OCEANOGRAPHIC CONDITIONS

3-168. Sea ice is one of the strongest factors affecting amphibious techniques and their adaptation to arctic conditions. In any amphibious operation within sea-ice areas, the amphibious task-force commander needs great latitude to determine where and when to attack. Icebreakers usually accompany the force, and progress is slow. Evasive action is limited, and positive air protection must be provided. At times, amphibious operations through sea ice may be deemed impractical because shifting ice may close leads, immobilize ships, restrict landing areas, and, in some cases, form pressure ridges which are impossible, or extremely difficult, to negotiate.

3-169. Unnavigable ice consists of pack ice or landfast ice fields that are either impenetrable or penetrable only by the largest and most powerful icebreaker. Under such ice conditions, units can use an air assault from ships. In this case, the operation will be constrained tactically and logistically by the limitations of the planes and helicopters. Another method involves employing landing craft to move troops to the edge of the icepack for follow-on movement across the ice against an objective. Under these circumstances, the operation will be limited, and only lightly armed, swift-moving, well-trained personnel can be used. Logistics support normally will be by air.

3-170. Marginal ice areas include those areas that are negotiable by light icebreakers and areas free from pack ice but still subject to drifting ice and scattered ice floes. This ice continuously moves because of wind and ocean currents. If a landing is executed within the pack area, the task-force commander must determine when to attack based on ice conditions.

3-171. Within ice-free areas, standard amphibious techniques apply with considerations to arctic weather, temperature, and operating conditions ashore.

EFFECT OF ARCTIC CONDITIONS ON PERSONNEL AND EQUIPMENT

3-172. During a beach assault, troops and crews of landing craft require waterproof suits to protect them from sea spray. Such suits also protect personnel from freezing seawater if a dry ramp landing cannot be made. Even during warmer seasons, water is often still cold enough to cause cold-weather injuries and requires protective equipment.

3-173. Operation of all mechanized equipment, boats, amphibians, and aircraft in subfreezing temperatures is difficult. Units have provisions to free landing-craft ramps should they freeze during the movement ashore. Amphibian wheeled vehicles, such as the lighter, amphibious resupply, cargo (known as LARC), work poorly for landing operations either afloat or ashore due to their fragile hull and the low trafficability of soil ashore. Therefore, units strive to use amphibian tracked vehicles to move both troops and supplies from ship to shore.

3-174. At low temperatures, shore party operations may be slowed to accommodate stations for wet-clothing exchange and warming troops. In shore-to-ship evacuation, troops protect casualties from the cold, sea spray, and seawater. Commanders should consider beaching a landing craft, air cushion (known as LCAC) or similar vessel for the shore party to use as protection from weather.

SUPPORTING ARMS

3-175. Employing supporting arms, such as naval gunfire and air support, in the Arctic depends on ice-free sea conditions vitally needed for access and maneuverability of Navy warships and aircraft-carriers. Their operations are further hampered during periods of low visibility and during the long winter darkness. Troops often rely on electronic means to direct fire support. Naval gunfire can operate with little decrease in efficiency. The temperature of ammunition can be controlled onboard, thereby enabling the ship to fire without encountering difficulties experienced by the artillery. Naval air support has difficulties in the Arctic, which requires the highest degree of coordination between naval air and the supported force. These difficulties include—

- Periodic decreases in visibility.
- Adverse weather in arctic maritime theaters.
- Lack of proper charts and identifiable terrain features.
- Atmospheric disturbances which increase the communications difficulties when coordinating air with amphibious or land operations.
- Longer periods of maintenance and preparation.
- Heavy and cumbersome clothing which reduces efficiency of personnel.

SUPPLY BY WATER

3-176. Supply by water in the Arctic Ocean is generally limited to the months of July through August due to hazardous sea ice. However, favorable shipping seasons continue to lengthen with climate change. Units make alternate contingencies to receive necessary supplies during long seasons of unnavigable waters.

3-177. During ice-free periods, an arctic supply expedition by water is less difficult to execute than other methods of supply transport. Supplies can be delivered on a large scale with comparatively less hazards to personnel and equipment than with other methods.

3-178. Cargo discharge is limited by the lack of sheltered harbors, the absence of wharves and piers, and the distance the vessels must anchor from shore. Consequently, more equipment and manpower are needed than under ordinary circumstances since, in a matter of hours, the pack ice may change so that the exit to clear water is blocked. Timing of operations is another governing factor in overwater supply. Because the period of open water or accessibility of installations varies from year to year, supply expeditions must stand ready to take advantage of the leads and breaks in the icepack as they occur.

RIVERINE OPERATIONS

3-179. Riverine operations are generally limited to short warm seasons when rivers are thawed. Riverine operations capitalize on the Arctic’s vast network of rivers, lakes, and canals which accommodate shallow draft waterway traffic in the summer. In the absence of road and railroad nets, these natural arteries become highly valuable to overland transportation. Some inland waterways of North America and Eurasia are navigable for thousands of miles.

3-180. For operations on inland waterways, the principal equipment consists of towboats and cargo barges which have varying capabilities for transporting personnel, equipment, dry cargo, and liquid petroleum products. However, navigation of inland waterways is restricted by shallow water and with sudden changes in channels due to migrating sand bars and ice action. Some occasional spots may even require portaging.

3-181. Significant planning and forecasting are necessary to position watercraft in required areas of operations. Inland watercraft can self-deploy from open water, be airlanded, or be line hauled depending on accessibility. Commanders must consider the limited timeframe that rivers are unfrozen for infill and exfil of watercraft. Arctic inland waterways tend to shift location and depth frequently. Operators must scrutinize hydrographic data. Divers can recon in advance and prevent damage to watercraft. (For more information on riverine operations, refer to ATP 4-15.)

3-182. The following are advantages of riverine operations in the Arctic:

- In areas with limited road and rail networks, units can use water advantageously as an alternate means of transportation.
- Many areas of the Arctic are inaccessible during the summer months except by air or water.
- Large-scale movements of troops and supplies can occur with a minimum of fatigue to the operating personnel.
- Movement by water is one of the most economical means of transportation. In addition, bulky or heavy items that are difficult to transport by other means may be readily moved by water.

3-183. The following are disadvantages of riverine operations in the Arctic:

- Waterways are subject to freezing and can immobilize all traffic unless ice conditions permit the establishment of winter roads on the ice.

- Waterways are inflexible. Although canals have been dug to link other bodies of water, this is not feasible in military operations. Man-made features such as locks, bridges, cuts, and dams along waterways are vulnerable to destruction and, if destroyed, will create obstacles to movement.
- Flooding may submerge or sweep away landing sites (such as piers and docks). During flood periods, the current may increase to a torrent.
- Low water, which frequently occurs in late summer, may reduce the channel depth below the minimum requirement and reduce or temporarily eliminate the usefulness of the waterway as a means of transportation.
- Units must build and use portage roads, and even small trackways, to avoid obstacles formed by rapids, or to link with other bodies of water. Time permitting, the installation of dams and locks to raise the water level may eliminate or decrease the requirement for portaging.
- Waterway craft are vulnerable to enemy air activity, particularly during long daylight conditions.

SECTION IV – OPERATIONS IN THE AIR DOMAIN

3-184. The air domain is critical to arctic operations. The enormous area of operations with limited accessibility often can only be covered by air. Air operations require cold-weather capability. Except for global strike assets and aircraft with air-to-air refueling capability, aircraft must be sea-based or forward positioned in multiple partner nation territories. These countries have varying abilities and will to sustain air operations. Long periods of darkness in winter months require wide-spread night-vision capability for much of the year. Emplacements for ground-based radar are few and geographically dispersed because of limited infrastructure and the cold. Airports and runways may require deliberate hardening for protection because of their significance.

ROTARY-WING OPERATIONS

3-185. Rotary-wing operations add flexibility and speed to ground operations in the Arctic. Generally, the Arctic is devoid of the vast air, rail, and road networks common in temperate areas. The Arctic is sparsely settled. Small communities often have great distances separating and isolating them from the outside. Access to these communities comes from small aircraft, watercraft or other, often slow and primitive means of transportation. The terrain presents numerous formidable obstacles such as mountains, swift rivers, extensive lake systems, snow, large expanses of swamp, muskeg, and dense stands of timber and brush. Helicopters can bypass these obstacles and move rapidly with ground combat and support forces. Reinforcements can be deployed to the battle area in minimum time. Support can be provided quickly and effectively with proper planning and consideration of adverse weather and the arctic environment. Conventional doctrine applies to arctic operations as it does to more temperate regions of the world. (For more information, refer to FM 3-04, ATP 3-04.1, and TC 3-04.4.) However, units need some modifications to operating procedures and equipment to overcome limitations imposed by environmental conditions. Units also require arctic-specific equipment such as cold-weather-rated refueling hoses, expeditionary warming structures, and snow machines. (For in-depth information on arctic consideration for rotary-wing operations, see discussion beginning in paragraph 5-31.)

FIXED-WING OPERATIONS

3-186. The mobility and flexibility of fixed-wing assets are ideally suited for the diverse arctic environment. Many military operations in the Arctic may be forced to depend on air transport as the principal, or possibly the only, means of transportation for personnel, supplies, material, and casualties. Fixed-wing assets can operate in areas within range of available airfields, landing strips, and aircraft carriers. Units can prepare airfields on either prepared fields on land surfaces or ice surfaces on lakes, streams, and seashore ice which have been smoothed and had the snow removed or compacted. When planning fixed-wing air operations in the Arctic, leaders consider—

- Operational limitations.
- Fixed-wing capabilities.
- Land-based requirements.

OPERATIONAL LIMITATIONS

3-187. Basic principles, procedures, and tactical doctrine of joint air operations remain the same in arctic regions. However, certain environmental factors make joint air operations more difficult, time consuming, and complex. Some significant limitations include—

- Reduced load and range capabilities of standard transport aircraft because of the added weight of winterization, emergency, survival, and rescue equipment needed in arctic regions.
- The effect of weather, low ceiling, poor visibility, icing conditions, and low dense fog.
- Navigational difficulties caused by inadequate maps and charts and inadequacy of air navigational facilities in many areas.
- Lack of adequate marshalling areas with warm shelters and suitable troop carrier bases.
- Few hours of daylight for assault aircraft landing operations in winter.
- A reduction of supplies, equipment, and weapons that can be carried in the aircraft for paradrop.
- Maintenance difficulties, insufficient maintenance shelters, and decreased personnel efficiency.
- Difficult starting and warmup operations of aircraft engines that have become cold-soaked.
- Heavy snow or deep snowdrifts on airfields and landing strips with associated snow removal problems.
- Accumulation of frost, snow, sleet, and ice on parked aircraft.
- Difficulties in constructing airhead landing strips in summer.
- Uncertainty of high-frequency (HF) communications.
- Selection of drop zones (DZs) and LZs affected by the following considerations:
  - Visual or photographic coverage. If possible, information should be confirmed by ground reconnaissance.
  - Swamp and muskeg soil conditions.
  - Availability of ice of sufficient depths for suitable DZ or LZ on lakes and other water surfaces.
  - Depth of snow and presence of snow drifts, and snow removal problems.
- Location of landing fields that avoids cold air drainage from surrounding hills draining onto the airfield to create a temperature inversion. This subjects the field to considerable ice fog and can render it inoperable.
- Difficulties in constructing landing strips in summer.

For more information on joint air operations, refer to JP 3-30.

FIXED-WING CAPABILITIES

3-188. Fixed-wing assets provide a variety of services and capabilities. Three of the most important to land forces in the Arctic are—

- Airland.
- Airdrop.
- Counterland operations.

Airland

3-189. Given ground transportation challenges in the Arctic, airland operations provide rapid and efficient movement of personnel, supplies, equipment, and casualties from airfield to airfield. *Airland* is movement by air and disembarkment, or unloading, on the ground after the aircraft has landed or while an aircraft is hovering (JP 3-36). Even in those areas where limited facilities for land transportation are available, air-transportability can contribute to unit mobility.

3-190. In the absence of established airfields, aircraft can use ice surfaces with sufficient thickness as an austere runway. When landing on austere ice-runways, operational capacity is limited to ski-equipped aircraft. Airland operations with wheeled aircraft are possible on compacted snow with a properly prepared surface. Austere runways will need to be reconned, secured, and prepared prior to aircraft arrival (see paragraph C-23). Planners should account for additional time required to conduct these activities before making air support available.

Airdrop

3-191. *Airdrop* is the unloading of personnel or materiel from aircraft in flight (JP 3-36). Airdrop provides speed and access to regions of the Arctic that are otherwise inaccessible, or excessively difficult to maneuver to by ground. These operations include—

- Personnel airdrop.
- Equipment and supply airdrop.

Personnel Airdrop

3-192. The capability to deliver personnel by parachute is of particular importance in undeveloped areas with limited or nonexistent LOCs. When airborne units parachute in arctic areas, commanders first meet special planning factors. Airborne commanders must familiarize themselves with the arctic portion of TC 3-21.220. Special planning factors include—

- Capacity considerations.
- Marshalling.
- Specialized equipment.
- Operational considerations.
- Sustainment.
- Seasonal considerations.

3-193. Airborne capacity considerations is the first special planning factor. When using arctic rigging, fewer personnel can parachute from a single aircraft because of the bulk of equipment and cold weather clothing. For planning factors, units reduce the total capacity by a third. When computing weight factors, the cold weather-equipped parachutist is estimated to weigh 350 pounds for paratroop door exits. Tailgate drops are those drops during which parachutists exit from the aircraft ramp. The maximum rigged weight of the parachutist conducting over-the-ramp operations is 325 pounds. For over-the-ramp operations, the parachutist's rigged weight must be tailored so that their total weight is below 325 pounds. (See Appendix A for weight conversions.)

3-194. Airborne marshalling is another planning factor. When troops put on their parachutes, they need protective shelters, such as hangars. Protective shelters protect troops without them overheating in heavy clothing prior to exposure to extremely low temperatures. Aircraft should park within 200 meters of the parachute rigging facility. Rigged jumpers can avoid walking through deep snow or over ice during winter months when temperatures are low and the individual parachutist's equipment is the heaviest. During the loading phase, troops ride rapid motor transport between the marshalling area and the departure field. Properly coordinated loading and rapid aircraft takeoff reduces the exposure time of personnel to cold and other elements. Winter-equipped parachutists load by way of the aircraft ramp. To avoid overheating personnel, aircraft cabin temperatures should not exceed 40 °F. To prevent possible accidents, troops ensure the ramp is free of snow, ice, and water. This hazard is magnified when exiting the aircraft. Each aircraft should have equipment aboard to ensure the floor is as dry as possible prior to exiting over the DZ. (See Appendix A for length and temperature conversions.)

3-195. A third special planning factor involves airborne specialized equipment. Individuals check the serviceability of the activating lever on the ejector snap of the hook-pile tape lowering line. This check reduces the risk of the lever malfunctioning due to the heavy loads. Modifications of standard equipment must be made for airborne operations under cold weather conditions. Parachutists do not wear arctic mittens or trigger finger mittens during the jump. Their bulkiness interferes with deployment of the reserve parachute and lowering the equipment. Parachutists tuck the mittens inside the front or back of the extended cold weather clothing system jacket. They are not attached or packed in a container separate from the jumper. Parachutists wear the mittens as soon as they reach the ground. Snowshoes are usually rigged on the parachutist to allow for immediate access. Parachutists can jump with skis using the procedures outlined in TC 3-21.220. When a parachutist jumps with skis or with skis as part of the individual jump load, the jump occurs from a rear platform or ramp.

3-196. Airborne operational considerations are another planning factor. Leaders carefully consider the DZ selection. Most boreal regions are covered with trees, ranging from one to ten meters in height, which make DZ selection difficult. Tundra and ice cap areas with sparse tree growth generally make more suitable DZs.

However, open muskeg areas that look suitable on photographic and map inspection often prove to be covered with frozen tussocks one-half to one meter in height. Additionally, leaders carefully consider using lakes and other water surfaces with sufficient ice depths as prospective DZs. The heavy weight of individual parachutists and their equipment will cause a more rapid descent than in temperate climates. When jumping from a high altitude DZ, thin air further magnifies the speed of descent. DZ assembly procedures and the use of assembly aids are especially critical in arctic operations. Units encounter considerable difficulties when assembling in tree-covered areas, deep snow, or during extended periods of darkness. Troops train to overcome the problems of orientation after landing. If the DZ is snow covered, all parachutists drop with snowshoes or skis immediately accessible in their ruck or jumpable pack. This technique will hasten DZ assembly time and will aid in speedy recovery of heavy drop items. Since linkup operations are restricted, airborne forces are more vulnerable to enemy air and artillery action during the initial stages of an operation.

3-197. Another special planning factor involves airborne sustainment. In arctic airborne operations, leaders must make primary and contingency plans for linkup, resupply, or exfiltration. Airborne forces employed in arctic areas must be capable of self-sustainment for at least 72 hours without resupply. Tent group equipment should accompany airborne units on the initial drop. This equipment should include a 5- or 10-person tent, heater, fuel and rations. Troops pack the tent group equipment on ahkio sleds. These sleds should then be heavy dropped on load-bearing platforms. The number of sleds loaded on one platform depends on the type of aircraft and available types of platforms. Ideally, sleds should not be loaded in less than platoon groups. Commanders must account for additional space requirements for this equipment during winter jumps. Because of the remote nature of airborne operations, resupply within the airhead requires significantly more time and resources. Rotary-wing aviation, when available, can enable distribution.

3-198. Airborne seasonal considerations is the last special planning factor. In winter, extreme cold conditions require more detailed planning for airborne operations. During summer, in most respects, conditions are similar to those in temperate zones. Some significant exceptions include the following:

- Hours of darkness are extremely limited. The number of hours of daylight must be considered for long-range planning.
- Water temperatures are low. In some areas, troops landing in water could become cold casualties.
- Airborne operations in the summer months may call for specialized equipment, training, and techniques. For instance, in mountainous regions, operations may require climbing equipment and climbing techniques. Depending on the altitude, cold weather equipment may also be required.

Equipment and Supply Airdrop

3-199. Troops pack equipment and supplies vulnerable to damage by extreme temperatures and moisture in special bundles. Supply agencies at the marshalling area carefully prepare and modify equipment bundles up until the time final loading is completed. Equipment bundles to be free dropped need special preparation and protection. This may vary with the season.

3-200. Troops take every precaution to reduce recovery difficulties. They make special efforts to expedite and ensure the recovery of equipment delivered by parachute. Daylight drops and the use of colored parachutes, streamers, and smoke grenades are recommended; however, airborne commanders must designate personnel to spot dropped equipment and check for equipment aircraft aborts. The use of pathfinders in this role can prove to be practical. Even with due precaution, there will be a high loss rate of bundles which are dropped in deep snow or in marshy tundra.

Counterland Operations

3-201. Counterland support holds increased importance in arctic operations because of the remoteness of arctic regions, the lack of suitable routes of supply and communications, and the resulting unavailability of normal fire support elements. *Counterland operations* are defined as airpower operations against enemy land force capabilities to create effects that achieve joint force commander objectives (AFDP 3-03). Counterland operations include air interdiction and close air support. *Air interdiction* is defined as air operations to perform interdiction conducted at such distances from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required (JP 3-03). *Close air support* is defined as air action by aircraft against hostile targets that are in close proximity to friendly forces and that require detailed integration of each air mission with the fire and movement of those forces (JP 3-09.3).

3-202. Units may use counterland operations to supplement fire support normally obtained from organic support. In extremely mountainous terrain or in glacier operations, air strikes may be the only means of fire support available other than carried mortars or recoilless weapons. Movement of a certified and qualified joint terminal attack controller to points where they can control air strikes poses challenges in arctic operations. Army rotary-wing aircraft are useful for placing the joint terminal attack controller in a position to see the target and direct the fighter aircraft. Ground transportation, even tracked, may be inadequate as it cannot move rapidly from the area of one air strike to the area of another.

Airfields and Landing Sites

3-203. Fixed-wing assets may require the use of land forces to secure airfields or recon landing sites before aircraft support can be made available. Once established, fixed-wing organizations can provide site security for airfield protection but may require additional protection assets to provide defense in depth.

3-204. Fixed-wing organizations typically use a ski landing area control officer (known as SLACO) and polar camp or skiway team to prepare skiways for aircraft. A ski landing area control officer recons the site first for appropriate ice thickness and runway conditions. Ski landing area control officer elements can be airdropped or airlanded by light aircraft but may need the assistance of rotary-wing assets or even ground transportation. Once the ski landing area control officer verifies the site is favorable for skiway construction, the polar camp or skiway team arrives, builds a camp, and then builds out the skiway. This whole process can take roughly 48 to 96 hours from start to finish, depending on conditions.

3-205. Engineer assets can be used to assist and expedite skiway preparation. The amount of effort exerted toward improving landing sites depends on their intended use. The procedures discussed here are primarily for sites in forward areas that are used infrequently or possibly for only one emergency mission. In deep snow, units smooth and pack the surface with engineer equipment or by driving vehicles over it. With a small amount of preparation work, hard wind-packed areas can be made usable for aircraft equipped with skis. Deep soft snow presents difficulties for the landing and takeoff of airplanes, even when those equipped with skis. The deeper a ski sinks into the snow, the longer the ground run required for takeoff.

3-206. For security reasons, the airfields and landing sites should remain snow covered as long as possible. When left uncleared or filled, the enemy cannot easily detect its position. Units avoid unnecessary digging since it creates a dust hazard. Also, units rarely prepare a wooded area by burning because of the created smoke. Units remove or lower all communications wires strung between trees or across valleys in the vicinity of landing sites to the ground. If units use wires and cannot string them on the ground, they must mark wires. This can be done with strips of cloth of highly contrasting colors hung across them at intervals to make them clearly visible to the pilot during takeoff and landing.

3-207. Units can use frozen lakes as LZs. Pathfinders check ice thickness before attempting landings. Using lakes as LZs offers many desirable characteristics:

- Unobstructed approaches to and from the LZ.
- Lower snow depth than in sheltered areas.
- Ready concealment in trees and vegetation around the lake.
- A ready-made landing strip for ski-equipped fixed-wing aircraft.

3-208. Aircraft have several options for landing zones with correct reconnaissance and preparation. During the winter, muskeg and tundra afford suitable landing sites to ski-equipped aircraft, with some engineer effort. Units conduct a ground reconnaissance to detect the presence of clumps of vegetation, rocks, and other hazards to landing. Movement of aircraft and ground handling of equipment is extremely difficult in these areas. Snow covered glaciers make suitable landing fields for ski-equipped aircraft. Troops conduct a ground reconnaissance prior to landing. Crevasses, often hidden by snow, constitute a threat to any movement on glaciated terrain. Aircraft equipped with floats can use lakes and streams for landing areas during summer months. Preparation of even temporary forward landing areas requires extensive engineer effort.

3-209. Troops clear parking ramps of snow and paths provided for movement of heaters and auxiliary power units if extended usage is anticipated. Troops conduct a ground reconnaissance to ensure uniform ice thickness and the absence of obstructions. (See Appendix C for more information on ice reconnaissance.)

UNMANNED AIRCRAFT SYSTEMS

3-210. UAS are susceptible extreme weather conditions and icing on their wings. Launching and recovery can be difficult in deep snow and may require modifications to launch vehicles. Aerial photos of snow-covered terrain will not disclose as much terrain detail as without snow. However, trails and tracks in snow show up in detail on aerial photographs and are excellent sources of information. Infrared sensors are enhanced in cold climates and allow for better target location. Ground moving target indication and synthetic aperture radars typically perform well in cold conditions. Leaders consider the time of day imagery was taken and the angle of the camera and sun. All these things combine to produce shadows that can hide significant objects.

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Chapter 4

Command, Control, and Information

[I]n temperate and cold climates the more prepared side will deliberately select the winter for the decisive battle.

On Winter Warfare (1993)

This chapter describes the important aspects of the command and control warfighting function and the Marine Corps information warfighting function in arctic operations. Section I – Command and Control describes leadership, mission command, risk mitigation, unit organization, and headquarters layout in arctic operations. Section II – Information details the many challenges and solutions associated with information in the Arctic.

SECTION I – COMMAND AND CONTROL

4-1. Command and control in arctic operations is characterized by unreliable communications and dispersed forces. Combined, poor communications and dispersed forces challenge troops' abilities to maintain a common operational picture, develop shared understanding, and meet commander's intent. Leaders at all levels must be capable of conducting command and control with analog products. Because of these challenges, mission command is the rule. Commanders need to capitalize on any advantage generated by the enemy, terrain, or weather. Commanders clearly express their intent and give the maximum authority and disciplined initiative for subordinates to meet the intent.

4-2. When possible, command posts and control facilities are mechanized. Vehicles and shelters require either self-contained or associated heating and lighting. Command posts mask electromagnetic and thermal signatures to the greatest extent possible. The use of highly mobile signal equipment with cross-country capability is an absolute requirement in arctic operations. Relay capabilities are frequently required both within the unit and between the unit and higher headquarters.

LEADERSHIP

4-3. The process of developing Soldiers and Marines into arctic warriors requires strong, constructive leadership. Leaders maintain a positive attitude toward the mission and their Soldiers/Marines to carry out the tasks at hand. In arctic operations, Soldiers and Marines face many new challenges, but none that they cannot overcome. Tasks may take longer, but they do not become impossible. Initially, the cold environment may be alarming, even frightening, to Soldiers/Marines unaccustomed to operating in wintry conditions, especially when deployed to unfamiliar, remote areas. The cold constantly reminds troops of their vulnerability in the extreme environment and the likelihood of becoming a casualty should they make a mistake. As troops gain experience, they develop confidence in themselves, their clothing, and their equipment. They learn they can fight and win in the Arctic, defeating both the cold and the enemy.

4-4. Leaders understand environmental hazards and develop plans to overcome them in their operation plans or tactical SOPs. Leaders watch for early signs of cold stress in their troops. Signs can include fatigue, lethargy, apathy, irritability, withdrawal, loss of dexterity or decision-making ability, decreased group cooperation, disorientation, and slurred speech. Severe cold affects the mind as well as the body. Essential tasks take longer to perform and require more effort than in temperate climates. All leaders consider time when planning operations and giving orders for all tasks, even vehicle maintenance and making or striking camp. No simple formula exists for the extra time required to accomplish tasks. It varies with differing conditions, state of training, and degree of acclimatization of the troops. Leaders do not ready troops unnecessarily early because troops left standing in the open after striking camp suffer physically. Their morale can fall, possibly at times when it should be at its highest.

4-5. Effective arctic leaders creatively leverage all the leadership attributes and competencies, often to greater degrees than routinely required in temperate environments. Because arctic operations challenge all aspects of soldiering, commanders prepare themselves first. They set standards for practicing mental perseverance, model arctic determination, and maintain an authentic, positive outlook. They experience the rigors of arctic operations and have a deep conceptual and scientific understanding of the arctic OE.

4-6. Commanders visualize arctic operations as a series of opportunities and challenges. They look first towards capitalizing on opportunities, while ensuring challenges are prepared for. After deciding on a course of action, commanders lead with clear intent and ensure subordinates have maximum flexibility to exercise disciplined initiative. Challenges consist of finding balance, managing risk, and instilling confidence. Commanders balance violence of action with tactical patience. Because of the many difficulties of the Arctic, all operations take longer. Commanders plan sufficient time to allow for personal care, sufficient preparations, daily routines, and movement. They apply proper judgment when managing risk. They view challenges in context of the current assessment of the unit's cold weather capability and overall acclimatization to the environment. Lastly, commanders instill confidence in subordinates with their own actions. Commanders instill arctic leadership principles down to the lowest level. They understand that leadership at the company, platoon, squad, and team are the most critical to mission success. The front-line leader is the one who ensures troops are fighting-ready and can get the job done.

4-7. Leaders need to be aware of the symptoms that characterize a unit that is having difficulty coping with the cold environment. The following tips will help combat the effects of the cold when it begins to prey on the minds of Soldiers and Marines:

- If troops find it hard to remember things they have been taught, show patience; review orders and drills. Get them to think through the challenges of the environment and the mission; encourage them to ask questions. Keep their minds busy.
- Be alert for troops who tend to withdraw from the group's focus; keep them involved. Troops who withdraw into themselves should be paired, in a buddy system, with troops who are well acclimatized to the cold environment. Remind them that everyone is in the same situation, including the enemy.
- If troops get depressed or moody, and do not want to talk, encourage them to chat with each other. Circulate among the troops in their duty areas. Keep them talking and interacting.
- If troops become irritable and get on each other's nerves, keep in mind that this is likely to happen. Maintain your sense of humor and show patience. Vary their duties.
- Be aware that troops may tend to shirk from some tasks to keep themselves warm. Remind them that their job is to fight – that weapons and equipment must be kept in fighting order. During winter training, do not let the training become a camping trip; this is a common trap.
- Do not accept the cold as an excuse for not carrying out orders or routine tasks. It may be the reason for taking longer, but it is not a reason for letting things slide. Remember that, although the cold may make tasks more difficult to accomplish, it does not make them impossible. With knowledge, equipment, and proper training, leaders and troops can defeat the cold and be successful in combat.
- Plan frequent rotation of troops into warming tents/areas to provide relief from the cold.
- Provide warm liquids (noncaffeine) at frequent intervals, especially when rotating troops into warming tents/areas.
- Plan and provide extra insulating material for individuals, when available.

MISSION COMMAND

4-8. Mission command requires commanders to issue mission orders. *Mission command* is the Army's approach to command and control that empowers subordinate decision making and decentralized execution appropriate to the situation (ADP 6-0). *Mission orders* are directives that emphasize to subordinates the results to be attained, not how they are to achieve them (ADP 6-0). Commanders use mission orders to maximize subordinate initiative and allow subordinates to capitalize on opportunities. The arctic environment frequently disrupts communication systems. Commanders must become comfortable with the possibility that they may not be able to communicate for long periods. Likewise, subordinates may not have access to request additional guidance from higher echelons. To exercise mission command in this environment takes a high level of mutual trust. Commanders continually seek to build trust with their subordinates through all garrison and tactical activities without demanding continuous updates.

4-9. Commanders prepare to fight with degraded communications. They train to overcome signal challenges but also plan training that is designed to practice the use of analog products. Developing competency in analog products requires a significant effort, especially given modern-day reliance on technology. Units unfamiliar with analog products can build proficiency with a tactical exercise without troops (known as TEWT) or tabletop exercise. This allows individuals to identify issues with clarity, refine products, develop a shared understanding of expectations, and establish SOPs before attempting analog products in a more complex environment.

RISK MANAGEMENT

4-10. Leaders assess risk in arctic operations using the same processes as with other operations but take special care to give attention to unique arctic weather and terrain compared to Soldiers'/Marines' experience level. Figures 4-1 and 4-2 provide a sample risk mitigation tool that can be used with a DD Form 2977 (Deliberate Risk Assessment Worksheet). Figure 4-1 displays common risk factors in arctic operations based on METT-TC (I)/METT-T. Leaders use the scores associated with this chart when assessing hazards in Figure 4-2.

Mission (Planning)	SCORE:		
Guidance	Preporatory time		
	Optimum	Adequate	Minimal
FRAGO	3	4	5
OPORD	2	3	4
OPLAN/MOI/POI	1	2	3

Mission (Command and control)	SCORE:		
Task organization	Event		
	Support non-tactical garrison	Day tactical	Night tactical
Operational control	3	4	5
Attached	2	3	4
Organic	1	2	3

Terrain	SCORE:		
Types of terrain	Trafficability		
	Optimum	Adequate	Minimal
Mountain*	3	4	5
Hills	2	3	4
Flat or rolling terrain	1	2	3

* additional avalanche hazard evaluation is required for snow-covered, avalanche terrain

Weather	SCORE:			
Temperature (degrees F with wind chill)	Exposure duration			
	< 8 hours	8 to 24 hours	24 to 72 hours	Over 72 hours
TEMP ZONE 1: +30 to +20	1	1	2	3
TEMP ZONE 2: +19 to -4	2	2	3	4
TEMP ZONE 3: -5 to -24	3	4	4	5
TEMP ZONE 4: -25 to -40	5	6	7	8
TEMP ZONE 5: below -40	6	7	8	9
Hazardous weather conditions (blizzard, white out, ice fog, snowstorm)	6	7	9	9

Troops (Soldier endurance)	SCORE:		
Environmental preparation	Soldier preparation		
	Optimum	Adequate	Minimal
Non-acclimated	3	4	5
Partially acclimated	2	3	4
Acclimated	1	2	3

Troops (Soldier selection)	SCORE:			
Task	Soldier experience			
	Extensive CW experience	Winter training with some CW experience	Winter training with minimal CW experience	No winter training or CW experience
Complex	3	4	5	6
Routine	2	3	4	5
Simple	1	2	3	4

Troops (Reset and maintenance)	SCORE:		
Personnel rest status	Equipment status		
	Optimum	Adequate	Minimal
<4 hours sleep in 24 hours	3	4	5
4 to 8 hours sleep in 24 hours	2	3	4
>8 hours sleep in 24 hours	1	2	3

F Fahrenheit
FRAGO fragmentary order
OPORD operation order
OPLAN operation plan
MOI memorandum of instruction
POI program of instruction
CW cold weather

Figure 4-1. Sample of arctic operations risk factors

Risk assessment worksheet for cold weather operations

Assessment factors	*Identify and assess hazards*	*Score*	*Risk level*
Mission (planning)	GUIDANCE: OPERATIONS ORDER PREPARATORY TIME: OPTIMUM	2	LOW
Mission (planning and control)	TASK ORGANIZATION: OPERATIONAL CONTROL EVENT: DAY TACTICAL	4	MODERATE
Terrain	TERRAIN: FLAT OR ROLLING TRAFFICABILITY: OPTIMUM (NO AVALANCHE RISK)	1	LOW
Weather	TEMPERATURE ZONE: 2 EXPOSURE DURATION: OVER 72 HOURS	4	MODERATE
Troops (solder endurance)	ENVIRONMENTAL PREPARATION: NON-ACCLIMATED SOLDIER PREPARATION: OPTIMUM	3	MODERATE
Troops (soldier selection)	TASK: ROUTINE SOLDIER EXPERIENCE: WINTER TRAINING/MINIMAL EXPERIENCE	4	MODERATE
Troops (rest and maintenance)	PERSONNEL REST STATUS: LESS THAN 4 HOURS IN LAST 24 HOURS EQUIPMENT STATUS: OPTIMUM	3	MODERATE
Additional considerations	NO AVALANCHE HAZARD	N/A	N/A
		Total Score: 21	
Initial Risk Level: MODERATE			

SAMPLE

Interpreting the Score: Use the cumulative score to determine the initial risk level.
CAVEAT: If any individual area (e.g. weather) receives a high or extremely high risk, the overall initial risk level is high or extremely high even if the cumulative score indicates low or moderate risk level.

Individual area	1 or 2	3 or 4	5 or 6	7,8, or 9
Risk level	**Low risk**	**Moderate risk**	**High risk**	**Extremely high risk**
Cumulative score	**7 to 12**	**13 to 23**	**24 to 35**	**35 to 40**

Figure 4-2. Sample risk assessment worksheet for arctic operations

Note. Figures 4-1 and 4-2 are samples to be used with a DD Form 2977. Commanders determine appropriate risk.

4-11. Figure 4-3 provides a sample Alaska Mountain Safety Center's checklist for troops to assess and identify potential avalanche hazards. This is just one method for assessing potential avalanche conditions. Leaders of troops need to study terrain, snowpack, weather, and human abilities when assessing for these hazards. See also Appendix G for other sample risk assessment considerations.

AVALANCHE HAZARD EVALUATION CHECKLIST

SAMPLE

Critical Data PARAMETERS	KEY INFORMATION	Hazard Rating G	Y	R
TERRAIN: *Is the terrain capable of producing an avalanche?*				
▪ Slope angle (Steep enough to slide? Prime time?)		☒	☐	☐
▪ Slope aspect (Leeward, shadowed, or extremely sunny?)		☒	☐	☐
▪ Slope configuration (Anchoring? Shape?)		☒	☐	☐
	Overall Terrain Rating:	☒	☐	☐
SNOWPACK: *Could the snow fall?*				
▪ Slab configuration (Slab? Depth and distribution?)		☒	☐	☐
▪ Bonding ability (Weak layer? Tender spots?)		☒	☐	☐
▪ Sensitivity (How much force to fail? Shear tests? Clues?)		☒	☐	☐
	Overall Snowpack Rating:	☒	☐	☐
WEATHER: *Is the weather contributing to instability?*				
▪ Precipitation (Type, amount, intensity? Added weight?)		☒	☐	☐
▪ Wind (Snow transport? Amount and rate of deposition?)		☒	☐	☐
▪ Temperature (Storm trends? Effects on snowpack?)		☒	☐	☐
	Overall Weather Rating:	☒	☐	☐
HUMAN: *What are your alternatives and their possible consequences?*				
▪ Attitude (Toward life? Risk? Goals? Assumptions?)		☒	☐	☐
▪ Technical skill level (Traveling? Evaluating aval. hazard?)		☒	☐	☐
▪ Strength or equipment (Strength? Prepared for the worst?)		☒	☐	☐
	Overall Human Rating:	☒	☐	☐

Decision or Action
Overall Hazard Rating or GO or NO GO? **GO** ☒ **NOGO** ☐

***HAZARD LEVEL SYMBOLS:**
R = Red Light (stop or dangerous)
Y = Yellow Light (Caution or potentially dangerous)
G = Green Light (Go or okay)

Figure 4-3. Sample avalanche hazard evaluation checklist

UNIT ORGANIZATION

4-12. Unless specifically designed for arctic operations, units may need to adjust or augment their unit organization to overcome arctic challenges. Because of the unpredictable nature and increased demand for resources, units often require additional assets to create redundancy and resiliency to endure changes in planning and execution.

4-13. Infantry divisions may need additional rotary-wing assets to overcome mobility challenges and should be prepared for large-scale air assaults. Airborne divisions may conduct conventional airborne operations but may need to adjust force package sizes based on sustainment needs. Augmentation by SOF may provide additional flexibility.

4-14. Armored and mechanized divisions construct closely integrated combined task forces that are highly mobile and include rotary-wing, engineer, and signal units. They are supported logistically by a mobile sustainment element. Task forces organize so they can conduct independent operations at extended distances from higher headquarters, adjacent units, and sustainment nodes.

HEADQUARTERS LAYOUT

4-15. Establishing a headquarters can present more issues than normal. Limited or nonexistent road networks, lack of built-up areas, and the extreme difficulty concealing major installations away from civilized areas are major factors. A headquarters requires more detailed reconnaissance and engineer support to enable occupation. A good deception plan, well executed, offers greater security than attempts to completely camouflage a major installation in undeveloped areas. The effects of terrain and limited road networks, combined with the requirement for passive security measures, may increase dispersion.

SECTION II – INFORMATION

4-16. The Marine Corps defines *information* as the material and actions taken to generate, preserve, deny, and project informational power to increase and protect competitive advantage or combat power potential within all domains of the operational environment. Information is one of the seven USMC warfighting functions (MCWP 8-10 and MCDP 8).

4-17. The Army does not define information as a separate warfighting function. However, information activities organize various tasks and capabilities from the Army's six warfighting functions to help leaders visualize and describe how to create and exploit information advantages. (See ADP 3-13 for more on the information activities.)

4-18. Army and Marine Corps forces must be prepared to operate with denied, degraded, and disrupted information when conducting arctic operations. The Arctic is often scarcely populated, which can affect access to data, information, and human intelligence sources as well as limit the effectiveness of communicating information to target audiences.

4-19. Loss of positioning, navigation, and timing can significantly hinder operations in the Arctic where there are few landmarks to aid in navigation. Increased frequency of solar storms (space weather) and central latitude alignment of global satellites limit effectiveness in the Arctic. Disruptions of GPS and high-frequency radio communications are regular occurrences during cold weather periods of the Arctic. Advanced planning and review of space weather patterns are critical for applying space domain effects in an OE and site selection for satellite link locations. The Arctic poses a challenging OE for space support to military operations. At very high latitudes, geosynchronous Earth orbit weather and communications satellites neither provide coverage nor supplement low Earth orbit platforms. Long periods of darkness in winter, persistent low cloud ceilings during seasonal transitions, and the variable albedo (amount of light a surface reflects) of snow and ice limit the capabilities of optical overhead imaging platforms. The Arctic is susceptible to greater atmospheric electromagnetic interference than lower latitudes. This interference multiplies, extends, and exacerbates outages of all wireless communications. Position, navigation, and timing satellites also have degraded performance.

4-20. The isolated and limited LOCs and population centers of the Arctic create islands of electromagnetic activity. Military targeting and planning considerations account for how the vast emptiness of the Arctic enables increased enemy and threat identification of friendly force signatures and vice versa. Cyberspace operations conducted in the Arctic cope with comparatively poor-quality communications infrastructure and dispersed, isolated population centers in all areas except the European Arctic. Cyberspace operations require extensive reliance on space assets and, in some cases, competitors' communications infrastructure. This reliance could, in turn, affect the security of military information networks and complicate extending, maintaining, and sustaining networks. Additionally, cyberspace networks may be vulnerable to physical attacks in some areas. Offensive operations account for disparate information regimes. The combined effects of extreme climate and isolated population centers mean that cyberspace operations against infrastructure and services that would be disruptive in other regions could be lethal in the Arctic.

INFORMATION SYSTEMS

4-21. Information systems are critical to any operation. However, arctic operations challenge information systems in ways that require overcoming multiple contingencies. Greater dispersion between forces, reduced mobility, limited satellite connectivity, and limited civilian infrastructure complicate communications. Often radio transmissions may be the most reliable form of communications. Because of this, units may need additional communications equipment above unit equipment authorization to ensure redundancy and relay capabilities.

4-22. Anytime a unit conducts arctic operations, the headquarters considers it expeditionary. The signal corps deploys means to maintain redundant communications without external support. These means include radio, satellite, cable, wire, visual devices, messenger, and infrastructure. The signal corps also deploys ways to maintain equipment to prevent communications equipment failure. Communications support elements require a cross-country, over-the-snow mobility comparable to the forces being supported. Signal officers coordinate with logistics staff early to request and justify additional items.

4-23. Cold weather reduces the battery life and operating range of portable radios. Units often use a relay so firing elements and the forward observer team can communicate. Units can also use rotary-wing aircraft for this purpose.

RADIO

4-24. Atmospheric disturbances, such as those that create the aurora borealis, affect radio communications. To overcome the effect of atmospheric disturbances, it is helpful for troops to understand how radio energy from a transmitter can reach a distant radio receiver. The transmission of a radio signal from a transmitter to a receiver can occur in one of two ways:

- By a direct path between the antennas of the transmitter and the receiver.
- By a reflection from a layer in the upper atmosphere called the ionosphere.

4-25. The radiated signal from the transmitter is divided into two main components:

- The ground wave.
- The skywave.

The ground wave travels along the surface of the Earth and has a relatively short range. The skywave travels upward into space at all angles up to the ionosphere. The ionosphere is an electrically charged region that exists at altitudes of 50 to 400 kilometers above the Earth and refracts radio signals back to Earth similar to how a mirror reflects light. This reflection allows long-distance communication. However, the ionosphere is variable, and its action depends on the time of day or night, the season of the year, and the effect that radiation from the sun has on the reflective powers of the ionosphere. Also, it is selective in regard to frequency and the angle at which the radio waves arrive. Above a certain frequency (40 to 60 megahertz [known as MHz]), most radio wave energy passes through and is not reflected.

4-26. Tactical radio equipment mostly depends on ground wave transmission, and so is limited to relatively short ranges. For communications in high latitudes, radio equipment operating in the very low and low frequency bands (below 300 kilohertz [known as kHz]) is particularly valuable since these bands experience fewer interruptions from auroras. Complete antenna systems which do not rely on earth ground waves must be used. Counterpoises constructed underneath the antenna, but insulated from the ground, increase the efficiency and reliability of low frequency radio circuits. High frequency radios can take advantage of skywave propagation to extend communication beyond line of sight. Communications using very high frequency (known as VHF) and ultra-high frequency (known as UHF) are not greatly affected adversely by auroral activity. In fact, the greater ionization of the upper atmosphere which takes place during auroras will, on occasion, increase the range of the tactical frequency modulation (known as FM) radios. Units should also consider using Near Vertical Incident Skywave techniques to allow signals to propagate over rugged terrain.

The Auroral Effect

4-27. The reflecting properties of the ionosphere directly relate to the position and radiation activity of the sun. The sun's bombardment of the Earth's atmosphere, coupled with strong magnetic activity concentrated near the poles, causes a visual effect called the aurora borealis in higher latitudes. Ionization of atmospheric particles increases, and radio waves reaching distant receiving points by means of skywave propagation decrease in intensity by increased absorption. This absorption becomes more pronounced during violent eruptions of the sun's surface. Such eruptions cause sunspots that are visible from Earth. During such a period, a radio "blackout" may occur on circuits crossing or passing through the auroral zone. The greatest auroral activity occurs between 60°N and 70°N latitudes and occurs at intervals of 27 to 28 days. Signals from distant stations are usually much stronger prior to such periods. The National Bureau of Standards publishes monthly predictions of expected conditions and are read by division signal officers and SWOs/METOCs. Blackouts occur throughout the HF spectrum and down to 25 kilohertz and may last several days. In addition, HF skywave transmissions are subject to sporadic blackouts which are, at present, unpredictable and erratic in terms of duration and coverage.

Atmospheric Static

4-28. The medium frequency band (300 to 3,000 kilohertz) experiences very little continuous high-level static in northern latitudes. It does have steady rushes of high-level noise. This noise often signifies an aurora blackout on the monitored frequency. Another static occurs during high winds. Flakes or pellets of highly charged snow are occasionally experienced in the Arctic, just as rain and sand static are encountered in many tropical and desert regions during periods of high winds. This phenomenon is commonly called precipitation static. Charged particles of snow driven against metal vehicles, antennas, and other objects usually discharge with a high-pitched static roar that can blanket all frequencies for several hours at a time. While these phenomena are uncommon except in aircraft, they can occur just when communications are vital to some operations.

4-29. Units can build antiprecipitation, static-proof antennas by covering exposed portions of antennas with layers of polystyrene tape and shellac to withstand breakdown voltages of 30,000 to 40,000 volts. The value of such a system depends entirely on the station's isolation, since discharging particles on metal masts and other equipment near antiprecipitation receiving antennas can produce heavy static by radiation from the tiny sparks.

Antennas and Grounds

4-30. Erecting antennas is problematic in the Arctic. The frozen ground makes it difficult to drive stakes into frozen soils and ice. Ungrounded equipment has a higher potential for heavy shocks under arctic conditions. Mountain pitons are considered excellent anchors for antenna guys in frozen earth, ice, or rocky soil. Planners allow for additional time for these operations since troops exercise care in handling lead-ins and metal masts since they become brittle in extreme cold. Vertical antennas are preferred for ground wave propagation in the HF band, but the use of fractional wavelength whip antennas is not recommended except for short distances. All large horizontal antennas need counterweights to give before the wire or poles break from the pressure of ice or wind. Wet snow and sleet freezing to the antenna may be removed by jarring the supports.

4-31. Suitable grounds are difficult to obtain under conditions of extreme cold since the frozen dirt offers high electrical resistance. The permafrost that underlies much of the Arctic offers as much obstruction to ground rods as solid reinforced concrete. Where troops can install a ground rod, the rod should be driven as deeply as possible into the frozen earth or ice. In many instances, it may be infeasible to secure a ground, and it will be necessary to install a counterpoise. Troops avoid connecting more than one transmitter to the same ground or counterpoise. They also avoid connecting electrical noise-producing items such as direct current, battery-charging generators, or metal-walled huts to receiver ground systems.

Effect of Extreme Cold on Battery Power Supplies

4-32. Extreme cold impairs the operation of electrical components which make up radio sets. Such cold significantly impairs dry-type primary batteries used to power the small carried portable radios and many test instruments used to repair signal equipment. To minimize the effects of cold on dry-type batteries, troops use only those batteries designed for cold weather operations for arctic operations. Dry batteries, if kept warm at low ambient temperatures, deliver satisfactory service life. Troops can keep batteries warm by carrying them inside clothing, using insulated containers, or using heating devices to provide a warm temperature for the battery. These techniques work so long as the battery temperature does not exceed 100 °F. (See Appendix A for temperature conversions.)

4-33. Batteries of all types show decreased power capacity at low temperatures; specially designed cold-weather batteries are more efficient. Units store batteries at supply points between temperature ranges of 10 °F to 35 °F. Upon removal from storage, and prior to use, troops slowly warm batteries to 70 °F. Warm batteries will give good results if used promptly upon exposure to cold. The conventional dry cell type battery loses efficiency rapidly at low temperatures and decreases in capacity as the temperature drops below 70 °F.

(The cold does not affect the terminal voltage of the battery. The cold affects the battery's capacity, life, or effectiveness to supply operating voltage over time.) At 0 °F, a battery is 40 percent effective; at -10 °F, 20 percent effective; and at -30 °F, only 8 percent effective. Frozen batteries will explode if charged. Before charging, check small equipment batteries with a meter. If no meter is available a circuit to a small light bulb will work. If a current exists, the battery is not frozen. If no current exists, then warm the battery slowly. Check for bulging or cracking on any battery before use or charging. (See Appendix A for temperature conversions.)

4-34. Units can use insulated containers to protect batteries from the cold. Troops with portable radios can insulate batteries by storing them on a vest and placing them under their outer clothing layer. Troops can extend the useful life of a battery if they warm it in low ambient temperatures prior to operation. Troops can re-activate batteries that become inactive because of the cold by thoroughly warming them at a temperature below 100 °F. A battery that is no longer serviceable in cold weather may be used indoors where the temperatures are warmer.

Techniques and Expedients for Increasing Range and Reliability of Radios

4-35. Where radio communications are the primary means of signal communications, troops use the following techniques at all times:

- Operators must be completely familiar with their set. They should read and understand the technical manual which is part of each radio.
- Operators keep the radio set clean, dry, and as warm as possible.
- Operators handle the set carefully. Radios exposed to extreme cold are particularly sensitive to jars, shocks, and rough handling.

4-36. Preventive maintenance procedures take on added importance. Operators train to set up a routine inspection and check procedure. They check that—

- Plugs and jacks are clean.
- The antenna connection is tight, insulators are dry and clean, and snow and ice are removed.
- Power connections are tight.
- Motors and fans run freely.
- Knobs and controls operate easily.
- Lubrication is checked more frequently.
- Dry batteries are fresh and kept warm.
- Operating spares are available.
- Users use breath shields with all microphones.

4-37. With equipment in good shape, lack of communication can be caused by the following:

- Excessive distance between sets.
- Bad intervening terrain, such as hills and mountains.
- Poor choice of location of one or both ends of the circuits.
- Poor choice of operating frequency for skywave circuits.
- Poor choice of antenna.
- Not enough transmitter power.
- Excessive noise and interference.

4-38. Troops can use the following techniques and expedients to increase the range and reliability of radio circuits:

- For tactical frequency modulation radios, elevate the antennas as high as possible either by siting the set on hills and mountains using an elevated ground plane antenna, an improvised elevated half-wave antenna, or an improvised vertical half-rhombic antenna.
- Use remote control devices to allow stations to be advantageously positioned.
- Use intermediate voice or automatic retransmission stations for both frequency modulation or HF circuits. Radio sets using a retransmission device can be used as intermediate relay stations.
- Use rotary-wing aircraft for frequency modulation radio retransmission or relay when out of normal range, or other means or retransmission as practical. Troops can use either intermediate voice or

automatic retransmission from the aircraft in many situations. This method often proves to be the only means of successful communication to isolated teams and units and for long-range patrols.

SATELLITE

4-39. Reliance on satellites introduces certain challenges and considerations. Commanders understand satellite constellations in the Arctic, the limitations of SATCOM, and signal latency and delays.

Satellite Constellations in the Arctic

4-40. Different satellite orbits exist such as low Earth orbit (known as LEO), geosynchronous Earth orbit (known as GEO), medium Earth orbit (known as MEO), and highly elliptical orbit (known as HEO) satellites. Each orbit comes with specific advantages and constraints. Units employing SATCOM in the Arctic consider orbit options, data prioritization, and redundancy strategies to overcome challenges and optimize the effectiveness of communications systems in this region.

Low Earth Orbit Satellites

4-41. Low Earth orbit satellites orbit at altitudes between 300 and 1,200 miles. Because of their shorter distance between satellite and terminal, low Earth orbit satellites can offer lower latency and reliable SATCOM service at high latitudes. A variety of commercial satellite communications constellations operate in LEO. Many electro-optical and infrared imaging satellites operate in a type of near-polar orbit (called a sun-synchronous orbit), which maintains consistent sun angles in images.

Geosynchronous Earth Orbit Satellites

4-42. Geosynchronous Earth orbit satellites operate at about 35,700 kilometers (22,182 miles) above the Earth's equator. These satellites provide continuous coverage over specific regions. However, at higher latitudes, these satellites have a low look angle can often be obstructed by mountains and other land features. For instance, in northern regions, mountain ranges can block satellite transmissions to terminals on their northern side (known as mountain shadow). Units at a low enough latitude to connect to a geosynchronous Earth orbit satellite may be able to use the higher bandwidth capabilities but must account for higher latency, which can impact certain interactive services.

Medium Earth Orbit Satellites

4-43. Medium Earth orbit satellites are primarily used for navigation satellites. All Global Navigation Satellite System (known as GNSS) constellations have components in medium Earth orbit. GPS provides service throughout polar regions, but positional accuracy may be slightly lower than at lower latitudes. Products detailing GPS accuracy are available from the GPS Warfighter Collaboration Cell.

Highly Elliptical Orbit Satellites

4-44. Highly elliptical orbit satellites are optimized for polar coverage. They have varying distances from the Earth. One part of its orbit is closer to the Earth, while the opposite side is farther away. Its specialized orbit allows for long dwell times over the northern or southern hemisphere, but requires multiple satellites for continuous coverage.

Satellite Communications Limitations

4-45. SATCOM in the Arctic faces several limitations due to geographical location as well as environmental conditions. Commanders consider the following for operating SATCOM terminals in the Arctic:

- Extreme cold.
- Bandwidth capabilities.
- Signal propagation and fading.

To address these concerns, SATCOM users in the Arctic employ smart power management, use adaptive modulation, and operate specialized equipment capable of operating in these regions.

Extreme Cold

4-46. Arctic temperatures can plummet well below freezing, affecting the performance of SATCOM equipment. Most commercial terminals are designed for operating temperatures between -22 °F to 122 °F. However, temperatures in the Arctic can drop below -50 °F during the winter. Such low temperatures can lead to equipment malfunctions or damage, such as frozen gears or broken wires. (See Appendix A for temperature conversions.)

Bandwidth Capabilities

4-47. The availability of frequency spectrum for SATCOM is regulated and often limited especially in specific frequency bands. In remote areas, satellite bandwidth is shared among various users, including scientific researchers, military personnel, and civilian services. This sharing can result in contention for bandwidth, especially during peak usage times affecting data transfer speeds and communications quality.

Signal Propagation and Fading

4-48. Rain and snow can cause signal attenuation, reducing the strength and reliability of SATCOM signals. Antenna size and positioning are crucial to compensating for this signal loss. SATCOM signals can also experience multipath interference in arctic environments when signals reflect off ice and other surfaces, arriving at the receiver via multiple paths. This interference can cause signal distortions and require advanced signal processing techniques.

Signal Latency and Delay

4-49. Signal latency is the time it takes for data to travel from the source to the destination. In SATCOM, signal latency is primarily influenced by the distance that signals must traverse between Earth and the satellite and vice versa. Signal latency can also affect remote operations involving remote-controlled drones or robotics. This latency can affect the drones' ability to make precise maneuvers or manipulations. Telemetry data from remote sensors require real-time data, which is a challenge in remote environments as well.

4-50. When encoding, encrypting, or modulating data, these processes can add additional latency on lines due to the lengthy operations they use. Advanced error correction and packet filtering could also cause delays in signal processing since they also occur on ingress and egress of traffic. Regardless of what operations will be conducted, commanders and teams need to account for latency in all determinations of missions.

CABLE AND WIRE

4-51. Cables, wires, and fiber optics have the same capabilities and limitations in arctic operations as in temperate zones. Due to the distances involved and the difficulty of overland movement, wire communications may be limited. Commanders consider that units need more time to install and maintain field wire lines during periods of extreme cold and deep snow.

Special Considerations Applicable to the Arctic

4-52. Aside from logistics considerations, constructing and maintaining circuits are the most challenging tasks when providing cable and wire communications. Units can lay field wire on the snow, but they must mark it to facilitate maintenance. Units can use trees tall enough to support the lines. Plans for the initial circuit layout must account for high-traffic areas to prevent any damage from vehicles and skiing troops. Units avoid laying field wire lines on trails used for troop movement. Instead, troops break and use a separate communication trail. If the wire circuit is to remain in place during the warm season, units take care with its placement through areas, such as lakes and muskeg, which may be impassable in summer and make maintenance impossible. Units take similar care to avoid locating wire lines in areas subject to snow and earth avalanches.

4-53. Grounds are extremely difficult to obtain in frozen soil. Grounding of wire equipment is necessary. Troops replace aluminum stakes with 12-inch steel stakes to penetrate frozen surfaces. A hand drill with a masonry drill bit can assist with placing grounding rods in frozen ground free of gravel. Units may need to use special blasting devices to obtain suitable ground.

4-54. Due to the difficulties of resupply and the necessity of limiting basic loads to the essentials, the signal officer must make every effort to recover all available wire for reuse. Signal officers plan circuits, as much as possible, to facilitate recovery. They consider that wire or cable laid in or on the snow is extremely difficult to recover because of the melting, refreezing, and drifting action that occurs around the wire. The initial supply of wire, supplemented by limited resupply, may constitute the only source of field wire.

Techniques of Cable and Wire Construction in the Arctic

4-55. Units can use standard, over-snow vehicles equipped with reel units to lay field wire or cable. If troops have recovered field wire that has been properly serviced, they use it first to wire. This simple act conserves the dispenser wire for critical situations. Troops reload serviced wire into dispensers whenever time and facilities permit. Field cable can be most effectively laid from drums mounted on reel units installed on the vehicle itself.

4-56. Troops work diligently to protect wire. They keep field wire and cables away from snow drifts to prevent unnecessary labor or waste of wire. Snow can easily cover cables and wire that interconnect two or more units in a command. One day’s snowfall on wire may take several days to recover or maintain the circuit. Troops can prevent this by moving the cable from under the snow after each snowfall and allowing it to rest on top of the snow. Troops can also use trees or cut poles to support the wire for overhead construction. When deciding the height above ground, they provide space to compensate for drifting snow and reduce the span distance to approximately 65 meters (71 yards).

PLANNING COMMUNICATIONS INFRASTRUCTURE

4-57. In the challenging and remote Arctic, effective communication infrastructure plays a critical role in supporting operations. As commanders plan for operations in such an extreme environment, it is imperative to be well-informed on the unique considerations and potential solutions that come with being in the Arctic. By understanding key challenges and ways around them, decision-makers can arm themselves with valuable knowledge to ensure mission effectiveness and success.

4-58. When planning for the deployment of communications equipment in arctic operations, planners consider several critical factors to ensure effective and reliable operations:

- Logistics challenges.
- Energy consumption and environmental impact.
- Weather conditions.
- Equipment capability.
- Adaptability and scalability.

While some of these factors may be easier to accommodate than others, the same meticulous analysis and design should be performed for all.

Logistics Challenges

4-59. The Arctic presents several logistics and supply issues and can cause extreme hardship when working with older systems that need replacement parts or when trying to upgrade end-of-life appliances. An example of this is Pituffik Space Base in Greenland. A passenger jet arrives once per week, providing less than 1,000 pounds of mail at a time. This can make it difficult to replace failing equipment if the situation arises. Cargo ships must bring any necessary heavy equipment but due to thick ice in the winter, they can only complete the journey in the summer season.

4-60. Signal officers conduct special planning to ensure that instruments, tools, and hardware are available in spares and on backorder in the event they are needed. Table 4-1 can be used as a reference chart for communications equipment replacement and maintenance planning factors. Units keep spares of critical equipment such as crypto devices, core infrastructure appliances, and radios to prevent mission stoppage from wear or damage. Minimizing the need for shipment of goods allows command teams to prioritize supplies and services over failing equipment.

Table 4-1. Replacement timelines for common communications infrastructure equipment

Equipment Type	*Recommended Replacement Rate (est. Months)*	*Maintenance Rate (est. Months)*
Land Mobile Radios	60	1
Switches and Routers	48 to 60	3
Tactical Local Area Encryption	-	36
KOK32 Key Processor	36	6 to 12
UPS Batteries	36 to 60	24
Cabling (such as fiber, copper)	24 to 48	6 to 12
est. estimated	UPS uninterruptible power supply	

Note. All rates displayed are estimations and should only be used as reference. Always consult technical manuals and official websites for accurate timelines.

Energy Consumption and Environmental Impact

4-61. The Arctic often lacks a stable power supply, and traditional power sources may be limited. Redundant power systems and energy storage solutions like batteries rated for the cold environment are essential to maintaining continuous operations. To properly plan for energy requirements, leaders study the power consumption of common communications equipment. This is as important for small operations, such as deploying a tactical communications kit, as it is for larger ones, such as setting up a regional data center. When determining which equipment to deploy, leaders note the difference in power draw between different models of the same functionality. Figure 4-4 visualizes the power usage of the most used communications appliances based on different models and form factors.

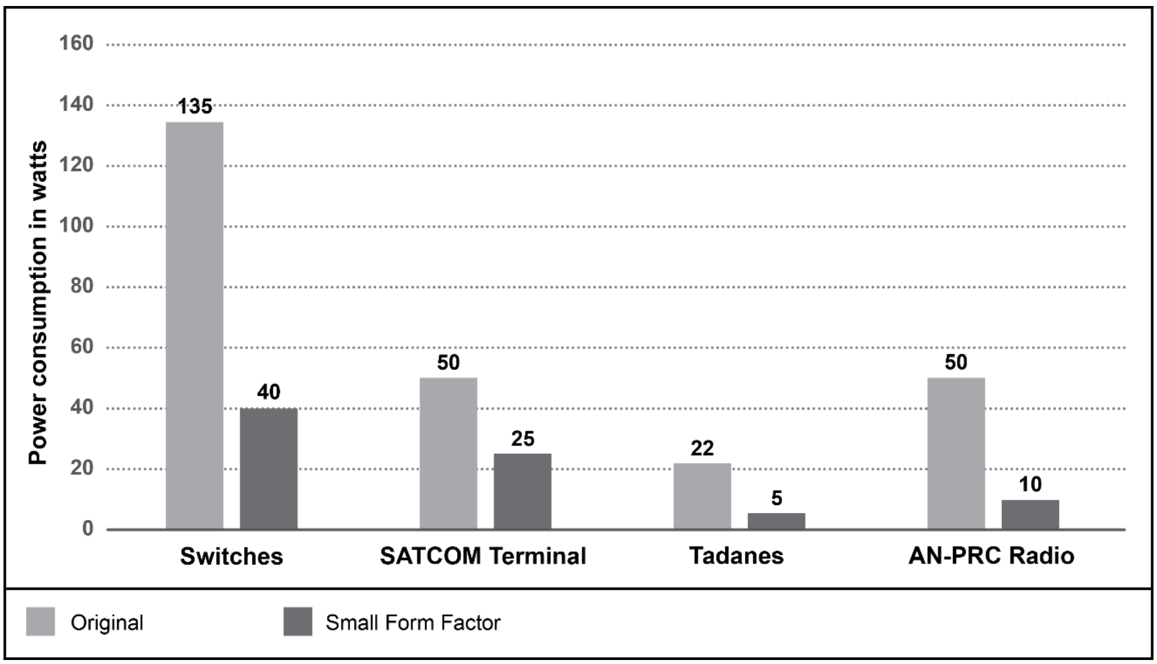

Figure 4-4. Power consumption of equipment

Note. Switches depicted are Cisco 9300s and 2960CX. SATCOM Terminals are Airbus Rangers on different transmit settings. Tactical local area network encryption devices are KG250s and KG175 Micro. AN-PRC radios are PRC-152 and PRC 117.

Weather Conditions

4-62. Extreme cold temperatures create challenges. These temperatures can cause condensation and freezing in critical components such as antennas, cables, and battery packs. Icy accumulations can disrupt signal transmission and degrade equipment performance resulting in disruptions to operations. Moreover, high winds and snowstorms can lead to physical damage to towers, door seals, and can obstruct satellite dishes from operating at peak performance.

4-63. To mitigate these challenges, units implement specialized equipment able to withstand these conditions along with—

- Weatherproof enclosures.
- Ruggedized components.
- Heaters to prevent freezing.
- Ice removal supplies.
- Appliances with built-in snow and precipitation removal.

Equipment Capability

4-64. Leaders consider equipment characteristics when determining what hardware to bring on arctic missions. In the Arctic, SATCOM in C-band and Ku-band have been proven to be highly effective due to their ability to penetrate through heavy cloud cover and precipitation. These frequency bands provide relatively high data rates and are useful for voice and data transmissions. Cold metal contraction can affect radio frequency equipment by leading to changes in operating frequencies of some systems. Leaders ask the following when determining communications equipment to use:

- Will there be coverage in the area if satellite backhaul is being used?
- If it begins to snow or heavy cloud cover occurs, will the connection terminate?
- Will equipment work optimally in extremely cold temperatures?

Adaptability and Scalability

4-65. It is equally crucial to allow networks to contract or expand seamlessly to accommodate changing needs. Redundancy planning with backup communications links and power sources enhances network resiliency and minimizes downtime in case of equipment failure. To achieve rapid elasticity, teams can employ software-defined networks and virtualization technologies to cut down on maintenance times, rack space, and vulnerability surface area. Best practices for maintaining these systems involve conducting regular equipment inspections, calibrations, and software updates. These practices ensure optimal performance and help identify potential issues early in such an evolving environment.

MAINTENANCE AND CARE OF EQUIPMENT

4-66. Units can use standard types of signal communications equipment at very low temperatures with satisfactory results if they take proper precautions and properly winterize the equipment. Generally, units install and operate signal communications equipment in a warm shelter. Warm shelters are an absolute necessity for maintenance personnel. The general principle of keeping equipment warm and dry, in addition to following winterization instructions closely, ensures the best possible performance of signal communications equipment.

Storage Batteries

4-67. When used in subzero temperatures, storage batteries should always be maintained in a fully charged condition, or recharged frequently, to make the maximum capacity available. Troops never charge frozen batteries. Troops first warm batteries until the electrolyte melts before charging is started. Charging batteries at temperatures below -20 °F (-28 °C) is not advisable. Units avoid high charging voltage because of the excessive gassing that occurs, which reduces the efficiency of the charging process.

Insulation materials

4-68. Insulation materials become increasingly stiff and brittle with lower temperatures. When cold, Soldiers/Marines flex cordage slowly and carefully to minimize breakage. They warm power cables and coaxial cable transmission lines before setting them in the open. Units can expect frequent failure of cables of these types, and of field wire, if recovering and re-reeling them during extreme cold. Staffs anticipate higher rates of wire replacement. Units seek ways to insulate cables from extreme cold weather. Where possible, they avoid placing rubber items in contact with fuels and lubricants. If possible, units warm rubber items before flexing them. Insulation is especially vulnerable at splices. Standard friction and rubber tape lose their adhesiveness when subjected to extreme cold. Splicing of field wire and cables is a problem because Soldiers/Marines must protect their hands with mittens or gloves which restrict handling. Soldiers/Marines can use special cold-weather type electrical insulating tape without prewarming.

Radio Receivers and Transmitters

4-69. Upon exposure to extreme cold, radio receivers and transmitters may experience issues in their frequency-determining circuits if they are adjusted for operation in a relatively warm place and then exposed to the extreme cold. Low battery voltage will also have a detrimental effect on frequency-determining circuits. All radio operators train how to check for proper frequency.

Microphones

4-70. Breathing causes moisture and can freeze on buttons and perforated cover plates of microphones, causing them to become inoperative. Soldiers/Marines use microphone covers during periods of extreme cold. If covers are not available, they can improvise a cover using a thin cellophane or cloth membrane.

Mechanical Malfunctions

4-71. Plugs, jacks, keys, shafts, bearings, dials, and switches can easily malfunction when their metal parts contract in extreme cold. The result is binding, difficulty in turning and adjusting, or complete locking of the part. In addition to the trouble caused by contraction, moisture condensation which freezes in such assemblies will also render them inoperative. Moisture condensation caused by localized heating may freeze in subassemblies during shutdown periods and may render them difficult to operate, or even inoperative.

Breathing and Sweating

4-72. Any equipment that generates heat during operation will "breathe" or draw in cold air as the equipment itself cools. If such heated equipment is brought into contact with extremely cold air, the glass, plastic, and ceramic parts may break. "Sweating" is the reverse of the process described above. If cold equipment is brought into contact with warm air, the moisture in the air will condense on the equipment. That condensation will subsequently freeze when the equipment returns to the cold again. Troops wrap cold equipment in a blanket or parka before bringing it into a heated shelter.

VISUAL INFORMATION SYSTEMS

4-73. Visual information equipment, such as photo and video cameras, have certain challenges and considerations in the arctic environment. Commanders understand the limitations of visual information equipment in the Arctic and the challenges associated with acquiring, transmitting, and storing images and videos in the harsh Arctic environment. Whenever possible, units use equipment rated for operation in extreme cold temperatures. There are several techniques and expedients that can improve camera reliability in extreme cold. Operators should use insulated camera cases, hand warmers, remote triggers, camera covers, dry bags, thermal blankets, and battery warmers to protect cameras from the cold, prolong battery life, and maintain a consistent temperature.

INFORMING DOMESTIC AND INTERNATIONAL AUDIENCES

4-74. Public affairs, visual information, and combat camera servicemembers consider the impact of arctic operations on domestic audiences. Commanders immediately address any impacts to a local population's environment or infrastructure (especially those that threaten health, wellness, or survivability). Public affairs staff prepare guidance to the commander and anticipate any actions taken by the enemy that affect the population. This includes cyberattacks on communications and infrastructure. Public affairs officers account for limited infrastructure and communications sources in the Arctic, especially in small remote population centers.

4-75. In the Arctic, audiences may include tribal, native, and Indigenous communities that are legally defined as sovereign nations. Before interacting, public affairs officers need to ensure they understand the protocol, rights, and privileges afforded to these leaders under federal law. Barriers in language, cultural expectations, and historical norms need to be acknowledged and accounted for in public affairs operations.

INFLUENCING FOREIGN RELEVANT ACTORS

4-76. The extremes of weather, terrain, and climate encountered in arctic operations present commanders with unique opportunities to influence relevant actors. The decentralized and dispersed nature of arctic operations presents additional psychological vulnerabilities among enemy forces. The following target audiences are examples:

- Isolated units removed from the mainstream of activity for prolonged periods.
- Small-unit leaders operating with unaccustomed freedom and independence beyond the control of immediate political and military superiors.
- Front line units that have long endured the rigors of cold arctic life.
- Civilian inhabitants forced to surrender their fuel, food, or shelter to the enemy.

4-77. Examples of themes effective in arctic operations in attacking hostile target audiences are those that stress—

- Solitude, hardship, and monotony.
- Scarcity of equipment and comfort items versus United States abundance.
- Personal dangers such as frostbite, loss of limb, cold injuries, and disease.

4-78. Media considerations unique to the arctic environment include—

- Blackouts from the auroral effect or atmospheric static that can affect radio broadcasts.
- Antenna erection in frozen ground.
- The effect of extreme cold on batteries.
- Snowstorms, muddy ground, low temperatures, and high winds during leaflet operations. If leaflets are packed in humid conditions and then exposed to very cold temperatures, the leaflets can freeze into a solid mass. Frozen leaflets become a potentially lethal projectile if dropped from a high altitude.
- Ground immobility, static winter quarters, and limited road networks.
- Planning for the use of loudspeakers should consider—
  - Portable devices.
  - The application of existing vehicular-mounted loudspeakers to modes of transportation commonly found in the area.
  - Rotary-wing or fixed-wing aircraft.

Chapter 5

Movement and Maneuver/Maneuver

A mobile force can gain surprise, strike quickly deep in the enemy rear areas, and disappear into the emptiness, safe from pursuit.

FM 31-70, *Basic Arctic Manual* (1951)

This chapter describes unique arctic considerations for the movement and maneuver/maneuver warfighting function. Section I – Movement and Maneuver/Maneuver Considerations provides overarching effects of the Arctic on the warfighting function. Sections II through V provide specific considerations for infantry, armor, and special operations.

SECTION I – MOVEMENT AND MANEUVER/MANEUVER CONSIDERATIONS

5-1. Movement and maneuver are slow, difficult, and require purpose-built equipment for success in the Arctic. Winter operations require the ability to move and maneuver across snow and ice in the coldest conditions during long periods of darkness. Roads may be completely snow-covered during much of the year. Conversely, summer operations require traversing abundant lakes and peat bogs as well as varied, mountainous terrain. Units frequently have to conduct summer operations without cover of darkness. Satellite navigation will be imprecise and unreliable at best and nonexistent in some cases. As a result, formations using nonspecialized equipment will have slow movement and limited ability to maneuver. Aviation support is critical. The use of fixed- and rotary-wing aviation assets is essential to supplementing ground mobility and accessing otherwise unreachable objectives in the Arctic.

SECTION II – INFANTRY

5-2. The role of infantry in arctic operations remains essentially the same, although the technique of accomplishing a mission may vary considerably. Small, decentralized operations are the norm. Most operations will likely involve taking control of or holding developed areas, especially those that are of operational or strategic significance. Because these areas can be so far removed from other towns and cities, sustainment of these operations can present unique challenges.

5-3. Units must be organized into highly mobile, self-sustained tactical groupings with only weapons and equipment suited to the operation. Specialized equipment (shelters, tracked vehicles, individual equipment for over-snow movement, and cold weather clothing) and expertise in their use are mandatory. Infantry units need equipment with suitable weapons to provide their own fire support. Individuals must be experts in fieldcraft and in the use of alternative means of movement including skis, snowshoes, snow machines, and rivercraft.

EFFECT OF TERRAIN ON THE INFANTRY

5-4. Terrain and climate combine to decrease mobility of infantry units. Infantry personnel must be well versed in ski, snowshoe, and skijor techniques, as well as the use of cargo sleds. In summer, muskeg, swamps, and lakes form obstacles which personnel must overcome or bypass. They can often use frozen lakes, swamps, and rivers as roads.

5-5. In the forested areas, trees conceal troop movements. Troops can build cover from hostile fire by using existing timber, digging emplacements, and using icecrete (frozen soil, gravel, and water mixture), snow, and ice. In open tundra areas, few recognizable terrain features exist. Units can gain concealment by camouflage, deception, and the use of defiles and inter-visibility lines. They also can use fabricated bunkers for additional protection. Due to permafrost, the placement, construction, and concealment of defense positions prove more difficult than farther south. In winter, snow is normally the only construction material, but fortunately deep hard-packed drifts usually accompany tactical features. During summer, permafrost and poor drainage make digging difficult and may necessitate building up breastworks using peat, rocks, or surface gravel. When using rocks as breastworks, troops beware of spalling and scabbing caused by enemy fire. Because of the difficulties of concealment, dispersion and deception are critical. During movement, units must use caution since the advantage lies with the observer, who can remain motionless. (For more information on the effect of terrain, see Chapter 1.)

EFFECT OF COLD, ICE, AND SNOW ON INFANTRY WEAPONS

5-6. Infantry weapons function under arctic conditions when units have been trained in their proper maintenance, lubrication, and use. The main problem is keeping snow and ice out of the working parts, barrels, and sights. Units distribute special breech and muzzle covers and train troops in their use. Special lubrication is necessary because of the effect of cold on normal lubricants. In deep snow, bipods and tripods require flotation to stay atop snow cover. Troops place bipod and tripod weapons on top of ahkio sleds to provide flotation and make them easier to carry. In extreme cold, metal becomes brittle and requires specialized lubricants. Increased parts breakage occurs in all types of weapons. Many weapons create ice fog which, on a still day, may obscure the gunners' vision, requiring movement to alternate positions or the use of a flank observer to direct the fire. Mortars experience increased breakage of firing pins and cracking of baseplates. When troops use ground-mounted mortars, they must cushion the base plates against the frozen ground with items such as spruce bows or sandbags. They also take precautions to prevent the mortar mount from freezing to the ground. Rocket launcher gunners wear face masks for protection from flying particles of propellant. Gunners also double back-blast areas to compensate for the amplifying effects of cold, dry air.

TACTICAL CONSIDERATIONS FOR THE INFANTRY

5-7. The factors of METT-TC (I)/METT-T and available fire support dictate the tailoring of task forces. The attachment and detachment of units are ideally suited for arctic operations. The use of tank and mechanized units gives opportunities for envelopment and deep penetration. The use of infantry units for deep operations by airlift gives the commander greater flexibility in developing operation plans. Mechanized infantry units with their organic carriers have the capability to maneuver over difficult terrain. The carriers have the ability to transport units within assaulting distance of hostile forces. In addition, the carriers may transport the troops' equipment, thus relieving the troops from the fatiguing problems of transporting their equipment.

5-8. Infantry operations may become restricted because of limited roads and LOCs. Terrain is less accessible in all seasons than in temperate zones. Troops require more time to devote to living and shelter needs during winter months. Leaders direct efforts toward over-snow mobility. Infantry must not become road bound. The guiding principle in providing equipment for infantry should be to provide only the minimum amount consistent with the health of the troops and the success of the mission. Infantry need snowshoes or skis for individual movement and sleds for each small group to carry tentage, stoves, fuel, and other equipment necessary for sustained combat.

5-9. In attaining individual mobility, leaders primarily consider how much one can leave behind without impairing combat capability. Troops avoid pack loads above 40 pounds for long marches, even for experienced troops. They do not waste weight-carrying capabilities on nonessentials. Only ammunition and indispensable items, including rations, should be carried. A robust supply of ammunition for a few weapons is more desirable than a wide variety of weapons with little ammunition. Troops use unit trains to transport items not necessary for fighting or survival.

5-10. Impact bursts of artillery and mortars are less effective in deep snow or mud because of the dampening effect. Mines often fail to explode when pressure is applied. Leaders carefully consider the use of such weapons with mission requirements. If properly maintained, direct fire weapons perform consistently. In tundra regions, open terrain often allows troops to use direct fire weapons at maximum engagement ranges.

***Note*.** The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines.

SECTION III – ARMOR

5-11. The mission of armor units in arctic operations, as elsewhere, is to attack, disrupt, and destroy enemy forces by fire, maneuver, and shock effect. Maneuver and shock effects dimmish with deep snow and extreme cold in winter and by the vast areas of muskeg in the summer. The firepower and shock effect of tanks against unprotected personnel is as demoralizing in arctic regions as in any other area. Leaders employ tanks in elements of platoons, companies, and battalions as part of a combined arms task force.

5-12. Leaders require terrain analysis for tank employment since trafficability is a problem. Ground force commanders conduct terrain-focused reconnaissance in advance of any armored vehicle movement. Troops on the ground conduct this reconnaissance whenever possible. These troops physically assess the trafficability of terrain for armored vehicle movement. Terrain analysis, local recommendations, and maps are all useful tools. However, conditions often differ from what sources indicate.

EFFECTS OF DEEP SNOW ON ARMOR

5-13. Varied snow conditions make it impractical to establish definite rules for over-snow operations. To accurately predict snow trafficability, units recon for each separate action to determine current snow conditions. Most tracked vehicles cannot travel through 3 to 6 feet of wet snow. Heavy tracked vehicles may negotiate fine, dry snow of 3 to 6 feet in depth. Tracked vehicles can maintain normal speeds after several heavy vehicles form a packed snow trail. A packed snow trail compacts into a hard mass resembling well-packed wet sand and all types of vehicles can easily traverse it. In the event of a thaw, troops use proper driving techniques to prevent vehicles from tracking and eventually becoming mired. Freeze-ups frequently follow thaws and produce ice which can make roads practically impassable to tracked vehicles, particularly on slopes of 35 percent or greater. Dry snow causes few operating difficulties as it has little tendency to pack on suspension systems. Wet clinging snow tends to accumulate on the track, suspension idler wheels, and sprockets and may require occasional halts for removal. (See Appendix A for length conversions.)

ARMOR DURING ICE CROSSING

5-14. Tracked vehicles can cross lakes and streams during winter months if ice is sufficiently thick and they exercise reasonable precaution. Forward troops inspect crossing sites for cracks, pressure ridges, and thin spots prior to placing vehicles on the ice. (For more information on ice reconnaissance, see Appendix C.)

ARMOR DURING SPRING THAW

5-15. During the breakup as the active frost layer begins to melt, the ground becomes soft and marshy. Although traction is poor, operation is possible during this period if tanks can penetrate the mud and find footing on the frost layer below. Vehicles mired in deep frozen mud or ice require special recovery techniques. Units park tanks on high dry ground, unthawed snow, or brush or logs to prevent freezing in. As the season progresses, the active layer thaws. In this situation, vehicles sink deeper into the muck, may "belly down," and become immobile. To provide greater mobility under these conditions, vehicles do not follow in the same tracks of preceding vehicles. Movement is possible in areas where permafrost is still near the surface, such as on the shaded side of woods, on ground with a good moss cover, and on the shaded slopes of hills. Even when the valleys become impassable, vehicles may still have limited operation on crests with good drainage. Extreme caution is necessary when crossing large streams and lakes late in the season.

ARMOR DURING FREEZE-UP

5-16. Conditions during the early freeze-up are similar to spring conditions. The ground thaws in the daytime and freezes at night. When the frost comes to the surface and the ground is completely frozen, the tank has a period of high mobility. The frozen ground offers good footing, and the shallow snow does not effectively reduce the speed of the tank. Frozen ruts, especially during early fall, create hazards. Units cannot use stream and lake ice for crossing; however, units can ford by breaking through the thin ice. In areas with few streams, the late freeze-up offers the best opportunity for tank employment.

ARMOR DURING SUMMER MOVEMENT

5-17. In summer, much of the arctic terrain is a soft mud-based marshland, muskeg, or swamp covered with a thin layer of moss and lichens. Once the moss layer ruptures, the mud offers no support above the permafrost level. In some areas during summer, the frost layer recedes to a depth that limits tank operations. Troops avoid muskeg by careful reconnaissance and route selection. In some areas, muskeg is scattered with large glacier boulders just below the surface. Those boulders can damage suspension systems and tracks during operations. Floating bogs consist of masses of thickly matted vegetation and rotting vegetable matter that float on pools of water. They are difficult to locate by normal inspection as they will usually support an individual; however, they do not support even the lightest vehicles. If Soldiers/Marines suspect a floating bog, they use a long prod pole to determine where the bog lies.

5-18. When it becomes necessary to cross open muskeg, vehicles do not follow in the same track. In very soft spots, each vehicle makes its own track. Vehicles avoid making abrupt turns. Recovery in muskeg is exceptionally difficult because tanks “belly down” and tracks do not regain the surface. Recovery involves winching a tank to a spot where the muskeg is solid enough for the tracks to regain the surface. Seldom can recovery be accomplished with less than two vehicles.

PREPARATION OF ARMOR FOR WINTER OPERATIONS

5-19. The commander ensures that tanks and other equipment are completely winterized prior to cold weather. Failure to winterize tanks renders them nonmission capable in extreme cold. Units embarking for the Arctic during the winter months require completed winterization prior to departure. This preparation ensures tanks operate immediately upon arrival. Tank crews travel with snowshoes, tents, and heating equipment.

ARMOR OBSERVATION OF FIRE

5-20. Visibility in the Arctic, as it affects tank gunnery, presents many problems. The formation of ice fog, blowing snow, snowfall in driving winds, and snow blown up by muzzle blast all reduce visibility. These conditions also severely degrade laser accuracy and other sensors. Soft snow blown by the muzzle blast probably exists under any condition with light dry snow on the ground. The burning propellant creates ice fog. The explosion of a high explosive shell creates a similar condition in the target area. Masses of dry snow are also blown into the air by the burst. Because of these conditions, first round hits are of greater importance. When these conditions obscure a gunner’s vision, observation from another tank may provide the quickest means of adjusting fire. The tank commander, because of an elevated position and the availability of magnifying sights, has much better visibility and depth perception on snow-covered terrain than troops on the ground.

5-21. Extreme cold has a definite effect on muzzle velocity and hence the accuracy of tank ammunition. Troops need corrections for firing table data and for ballistic computer settings by ammunition type. Without these corrections, then units must determine them by actual firing.

HANDLING OF TANK AMMUNITION

5-22. Certain difficulties in handling ammunition exist. The binding tape around the fiber carton is difficult to remove while wearing mittens. Soldiers/Marines cannot touch ammunition with bare hands without danger of contact frostbite. Ammunition tends to freeze in the wooden fuse protective ring, making it sometimes necessary to cut ammunition from the fiber cases. Cold ammunition placed inside a tank will grow frost crystals if the tank interior is even slightly warmer than the outer air. These crystals increase the difficulties of ammunition handling. Soldiers/Marines cannot operate ammunition racks while wearing mittens; however, they can use leather thongs or extensions on rack latches and other handles to operate racks.

ARMOR OPERATIONS IN EXTREME COLD

5-23. Soldiers/Marines consider the following when conducting armor operations in extreme cold:

- Tank crew comfort.
- Avoid exploring.
- Vehicle starting.

TANK CREW COMFORT

5-24. Clothing, open hatches, winds, and exhaust affect tank crew comfort. Heavy clothing necessary for extreme cold weather operations crowds tank crews and hinders entry and exit through hatches. Confined crew positions in tanks cause parts of the body to become cramped, thereby restricting circulation. In these confined positions, clothing tightens or becomes compressed and loses its insulation value. Armored vehicles conduct heat from inside the vehicle to its outside, and the energy loss can create the sensation that it is colder inside the vehicle. Crew required to ride with their heads outside the hatch experience increased windchill with the wind generated by the tank movement. Constant supervision is necessary to prevent frostbite. Halts enable troops to rotate crew positions, restore circulation, and warm body parts chilled by loss of insulation. Units use windbreaks during movement in extreme cold to reduce the windchill factor. Crews remain constantly alert for carbon monoxide. Leaders prohibit troops from using open flame heaters or engine exhaust to heat closed areas.

AVOID EXPLORING

5-25. Troops avoid exploring because of risks. Tanks avoid driving in deep snow, snowdrifts, or on ice unless the route is prescribed or the mission requires it. Plunging through woods is dangerous as the tops of frozen trees may break off and fall straight down on the tank. If necessary, tanks push trees down slowly and cautiously with the tank hatches closed.

VEHICLE STARTING

5-26. Effective units avoid letting vehicles become cold soaked. Soldiers/Marines start engines periodically to keep lubricants and engines warm. They do not jumpstart vehicles with frozen batteries since that can cause the battery to explode. Operators can check to see if batteries are frozen by checking the accessory lights on the dashboard. If they light up, then the battery still has some current and is not frozen. Another way is to inspect the battery for bulges which signals a frozen battery. Troops remove frozen batteries and slowly warm them up which can take up to 24 hours. They do not put frozen batteries on a charger until batteries are completely unfrozen, or they will also explode.

5-27. Troops can easily damage frozen power trains and engines of extremely cold vehicles by towing to start the vehicle. Often it is impossible to start track vehicles by towing because the suspension and final drives are so cold that the tracks will not rotate. Troops use extreme care in towing or pushing to avoid applying sudden shocks. Metal is very brittle in the cold; and tow-cables, final drives, or push bars may fail under shock loads. However, an engine may be started by towing if troops have no other means of starting.

5-28. After troops start and warm up the tank engine, they move the tank out slowly. They gently break the power train loose to prevent failures due to sudden shock. Also, they avoid sharp turns until the transmissions and differentials have had time to warm up. Drivers restrict initial movement to low gear operations for some distance until final drives, wheel bearings, and support rollers become free. At each halt, troops remove packed snow from the suspension and drive sprocket to prevent track throwing.

ARMOR MAINTENANCE IN EXTREME COLD

5-29. Maintenance of mechanical equipment in extreme cold is exceptionally difficult in the field. Shop maintenance time dramatically increases since troops need to allow equipment to thaw out and warm up before making repairs. Mechanics exercise extreme care in performing maintenance in extreme cold as bare hands stick to cold metal. Also, fuel in contact with the hands results in supercooling, and hands can be painfully frozen in minutes. For detailed maintenance instructions, reference the vehicle's technical manual. (For more information on cold weather maintenance, refer to TM 4-33.31 and the discussion starting at paragraph 8-27.)

5-30. At temperatures below -40 °F, crews may require as much as five times the normal maintenance time. Starting and warmup time is also increased and may approach 2 hours if temperatures are below -50 °F. Complete winterization, diligent maintenance, and well-trained tank crews are necessary in winter operations. (See Appendix A for temperature conversions.) The degree to which cold affects operations can be stated in three general temperature ranges:

- Down to -10 °F, operation is not difficult but resembles operations in the northern portion of the United States during the hardest winters.

- From -10 °F to -40 °F, operations are more difficult. At the warm end of the range, lack of winterization results in a slight loss in efficiency. At the bottom of the range, lack of winterization and training results in many failures.
- Below -40 °F, operations become increasingly difficult. At temperatures in the vicinity of -60 °F, maximum efforts of well-trained troops are required to perform even a simple task with completely winterized material.

Performance of field maintenance at temperatures below 25 °F is extremely difficult unless troops have some type of heated shelter. Maintenance shelter tents, portable shelters, or large tarps and air duct heaters are necessary whenever mechanics work on tanks in arctic regions.

SECTION IV – ROTARY-WING AVIATION

5-31. Rotary-wing missions do not change when operating in arctic operations but are in higher demand due to difficult surface transportation. Tactical considerations are the same as normal operations; however, the effects of terrain and weather require special equipment and modified training programs. Paragraphs 5-32 through 5-60 discuss only rotary-wing operations as they differ from normal operations in FM 3-04, ATP 3-04.1, and TC 3-04.4.

5-32. Challenges for rotary-wing aviation include payload capability, threat air defense systems, and navigation. Arctic operations reduce the payload capability of aircraft due to the added aircraft weight caused by ski or float installation and required survival equipment. Leaders carefully study all available charts to ensure that troops do not exceed the manufacturer’s recommended maximum power settings in extremely low temperatures. Threat air defense systems are another significant consideration in aviation mission planning. Leaders carefully assess these systems when objectives involve prepared defensive positions already hardened against the environment. However, threat maneuver units in the Arctic may not have robust air defense systems because of electronics sensitivity and extensive transportation or sustainment requirements. Navigation in extremely high latitudes may pose challenging, particularly in areas where GPS signals are degraded based on the line of sight to the respective GPS constellation orbital paths. A degraded line-of-sight also severely limits the availability of satellite-based voice and digital communications to aircraft which do not regularly operate in these areas. HF radios are highly effective and do not degrade based on latitude.

5-33. Low-level navigation challenges occur due to a lack of identifiable terrain features and a lack of detail on maps. Troops can use lakes, which are numerous in many arctic regions, with navigation. However, during spring thaws, the number of lakes in some regions multiplies making accurate identification extremely difficult. In the winter, deep snow often hides many water features. Pilots must exercise caution to always ensure proper orientation. Basic map reading and terrain association can be challenging in such conditions depending on the availability of identifiable terrain features. Aviators using terrain association need to recognize extreme magnetic declinations and anomalies, depending on the location and latitude.

5-34. Cold weather also challenges rotary-wing aviation. Rotor wash greatly increases windchill factors and the risk of CWIs, especially if troops have exposed skin while approaching or exiting a helicopter. Troops take appropriate measures to ensure proper protection of personnel exposed to propeller and rotor wash. They exercise caution during external load operations in snow or dry cold air since static electricity is generated more quickly and at much higher voltages than in normal operations. Troops use a grounding probe or reach pendant to dissipate static electricity. During cold temperatures, open doors used by crew chiefs and door gunners increase the possibility of frostbite for all flight crew and passengers. Door gunners and crew chiefs may have to limit their exposure to the elements to those critical modes of flight such as takeoff, landing, and periods when crew-served weapons must engage unanticipated threats. During lengthy flights, pilots keep the interior temperature of a helicopter relatively cool (approximately 40 °F) to avoid overheating troops dressed in cold weather clothing.

5-35. Commanders establish weather minimums early in the planning to prescribe the least acceptable weather the unit may conduct the operation in. The arctic environment has limited traditional weather reporting facilities. Weather can change rapidly with adverse weather conditions lasting for several days. Current aviation weather forecasts are mandatory. Weather permitting, the best source of weather information is an on-the-scene report made by a pilot flying in the area of interest. If possible, pilots make a weather reconnaissance flight if weather is marginal or shows signs of deteriorating. Weather factors that must be considered in planning and conducting arctic rotary-wing operations include temperature, density altitude, wind speed, direction, icing, visibility, turbulence, snow and ice, and windchill.

5-36. Arctic weather conditions which frequently render flight impossible include snow, clouds, fog, white outs, and flat light. Blowing snow is a hazard in all hovering operations during winter months. It can be minimized by disturbing the surface and allowing it to refreeze. After refreezing, the snow will crust and form a hard surface. Ice fog may be found in the vicinity of populated areas at low temperatures. Visibility in ice fog may be reduced to almost zero at ground level; however, ice fog does not usually rise above 100 feet (30 meters). It can also be self-induced by rotor systems and engine exhausts. Ice fog frequently takes from 15 to 30 minutes to dissipate after aircraft takeoff. Some degree of turbulence is almost always present in mountain passes and can reach extremes that prohibit flight. When operating in mountainous terrain, wind direction and velocity may be indicated by observing drifting snow. Swirling action indicates turbulence.

5-37. Only those aircraft equipped with anti-ice and de-icing equipment are capable of safe instrument flight into clouds or visible moisture with temperatures at freezing or below. Frost and ice covering wing surfaces destroy the aerodynamic efficiency of aircraft. No pilots should attempt takeoff under any condition until troops remove frost and ice from wings. Crews attempt to move away from any conditions that cause icing as soon as possible. Covers are essential to arctic operations to reduce the time involved in removing snow, ice, and frost. Covers serve a secondary camouflage purpose when colored to blend with the background. Troops can use nonmission capable parachutes for this purpose as a field expedient.

5-38. Visibility challenges rotary-wing aviation. The tactical situation may dictate the conduct of rotary-wing operations during darkness or periods of limited visibility. This particularly applies at high latitudes because of the shortened daylight during the winter months. Troops can use flares, helicopter-mounted searchlights, night-vision devices, and other suitable techniques to illuminate an area of operations. Commanders can conduct helicopter operations during bright moonlight nights on snow-covered terrain with little or no artificial light. Conversely, summer months experience little to no periods of darkness. This creates transition periods in which troops may need training to regain proficiency during darkness periods prior to a mission. Units avoid areas with deep powdered snow or greatly increase the intervals between landing helicopters if more than one aircraft is to land simultaneously.

5-39. Navigation during darkness is extremely difficult. A sparsely populated country has few lights, although reflection from snow covered terrain aids visibility under some circumstances. Units avoid navigating through mountain passes after dark or under overcast conditions except for emergency flights. Personnel receive intensive training in night external loading operations. Lack of a visual horizon, blowing snow, and the fact that aircraft lights frequently cause loss of visual reference make night operations extremely dangerous. During summer months, extended daylight hours can make night currency challenging. Aviators recognize this and make necessary adjustments to their flight training plans.

ATTACK, RECONNAISSANCE, AND SECURITY

5-40. Attack helicopters, both with and without their unmanned counterparts, are ideally suited to conducting attack, reconnaissance, and security operations in support of division and brigade maneuver requirements in the Arctic. Standard tactics apply in arctic operations but require special considerations for the extreme environment. Point-detonating munitions have significantly reduced effectiveness in deep snow or muskeg, which can absorb a majority of the intended effects depending on terrain. Examples of these munitions are the 30-millimeter high-explosive, dual-purpose, and other variants of 2.75-inch folding-fin aerial rocket. Survival equipment and skis limit munition-carrying capacity and therefore reduce the volume of targets that troops can shoot. Helicopter skis may reduce gun articulation and the capability to fire off-axis. If no software restrictions prevent over-articulation, then crews must self-limit to avoid ski or barrel damage. Radar and laser systems, including the millimetric-wave fire-control radar, perform well in cold conditions but are degraded by adverse weather conditions such as heavy snowfall. In the cold, extended warm-up periods for sights and sensors can cause launch delays.

5-41. Attack aviation units equipped with forward-looking infrared targeting systems have a distinct advantage in periods of darkness and cold temperatures. These systems do not rely on amplifying ambient light sources as traditional night vision devices do. Instead, these systems depict variances in heat signatures. When used in a sparsely-populated wilderness, especially in winter, enemy personnel, warming shelters, and vehicles contrast significantly with the surrounding environment, making infrared an exceptional sensor in the arctic twilight and darkness.

5-42. Armed rotary-wing aircraft excel at conducting deliberate reconnaissance and counterreconnaissance in the Arctic. Operations at extremely high latitudes may limit some forms of intelligence collection. (See Chapter 6 for more on intelligence collection.) Aerial reconnaissance provides visually observed routes, obstacles, terrain, and enemy forces in real time whenever possible. The austere environment naturally constrains ground maneuver forces and limits the enemy's available courses of action, which then become easily observable from above. The enemy's continuous need for survivability, sustainment, and mobility helps to facilitate deliberate priority intelligence report development, reconnaissance synchronization, and timely execution. Planners also consider how the enemy reacts to few available roads and infrastructure, extreme weather and terrain conditions, and limited basing options for shelter and sustainment.

5-43. Security operations work well when undertaken by rotary-wing aviation forces unconstrained by terrain and distance. Assuming safe operation is possible in the extreme environment, attack aircraft can operate with more regularity and continuity than their ground counterparts who are exposed to low temperatures without relief. Attack aviation also adds flexibility to security operations because it can transition quickly between security, reconnaissance, and attack roles. These factors, combined with the increased standoff provided by sensors, munitions, and layered UASs, allow trained rotary-wing forces with UASs to set an initial screen up to 75 kilometers deep across a front approximately 30 to 50 kilometers wide. Under satisfactory conditions, troops can maintain such a screen continuously. (See Appendix A for distance conversions.)

AIR ASSAULT AND AIR MOVEMENT

5-44. Commanders give specific considerations to increased weight and special equipment required for arctic operations. In most cases, these considerations reduce the capacity for each aircraft. On most missions, troops carry fully loaded rucksacks. As much as possible, the ahkio, with shelter, supplies, and skis or snowshoes accompany personnel on the same aircraft. Heavy-lift platforms ensure troops and equipment stay together. Units require additional time for loading and unloading with winter clothing and equipment. Units also may require protection against subzero temperatures and other adverse weather conditions with external loads.

5-45. During the winter, skis and snowshoes should accompany all personnel on each helicopter. Certain aircraft may allow for snowshoes to be worn while in flight. For instance, a CH-47 Chinook helicopter may have plywood placed on the floor to allow troops to embark and debark with snowshoes without damaging the aircraft floors. When troops wear snowshoes in flight, they reduce space in the cabin, but Soldiers/Marines will be better prepared to move and fight as soon as they disembark. Soldiers/Marines tie skis and unworn snowshoes together to conserve space and for ease and speed in loading and offloading. Skis not tied in a bundle must be carried under the arms parallel to the ground to prevent them from striking the rotor blades on the helicopters. The situation permitting, troops on snowshoes break a trail to the exact landing site, pack down the snow at a landing pad, and then remove and lash down individual skis or snowshoes to reduce loading time. Troops must not be on the landing site at time of touch down.

5-46. The small-unit leader ensures troops have all the equipment required to accomplish the mission and sustain the unit under the most adverse climatic conditions. During subzero temperatures, individuals always carry survival kits and can self-sustain for at least 72 hours with sleeping bags, rations, and the like. Unit and aircrew survival bags add weight and reduce cargo and personnel space. After initial operations, units require and deliberately plan for significant follow-on sustainment support to be air lifted forward. Because of concerns with limited mobility, units make deliberate retrograde plans if a mission is unsuccessful. To the greatest extent possible, the ground tactical plan remains within range of artillery support to aid operations.

PERSONNEL HOLDING AREAS

5-47. During extreme cold conditions, units establish troop warming areas in the immediate vicinities of the pickup zones (PZ) and LZ, if the tactical situation permits. Delays caused by weather below minimum execution criteria occur frequently in the Arctic. Leaders make weather decisions as close to the pickup time as possible. Locating troops in warming areas immediately adjacent to the PZ simplifies operational requirements. Leaders take care not to overheat troops dressed for the cold weather environment. Troops are then readily available, can react to the most recent developments with least delay, and are not exposed to the cold during inactivity when delays are encountered. Reserve units that must be immediately available for pickup require warming tents at the PZ while waiting to be committed.

5-48. In mountainous areas, snow may accumulate to a depth of several meters. Units pack down a trail from personnel holding areas to the aircraft landing site. This improves the walking surface and eliminates the need to wear snowshoes if required. Alternately, troops can cover the helicopter floor with 3/8-inch plywood so troops can keep snowshoes on without damaging helicopter floors. In the absence of this measure, personnel debarking from the aircraft can toss snowshoes on the ground and dismount on them to keep from sinking into the snow.

DANGER

Personnel must be extremely cautious and check the vertical clearance when approaching or departing helicopters in winter conditions. Helicopters can sink into the snow several feet, which lowers their blade height and increases risk of severe injury or fatality. The helicopter should be approached and departed only when cleared by the crew chief.

Pickup Zone and Landing Zone Considerations

5-49. When units conduct landing operations in deep snow, the air assault force follows specific techniques. Because of blowing snow and loss of visibility near the ground, helicopters may need additional spacing or may be staggered into the LZ at 20 to 30 second intervals in powder snow conditions. On windblown, hardpacked, or crusted snow, units can reduce the interval between helicopters. When exiting helicopters, personnel follow all aircraft debarking instructions from aircrew members breaking trail through the snow. Other personnel follow the trail made by the lead Soldier/Marine. Personnel move approximately 50 meters or one-half the distance from helicopters to avoid the maximum windchill effect and blowing snow created by the rotor downwash. Personnel within the radius of the rotor downwash protect their faces by wearing goggles, turning away from the main blast, and pulling the hood over their heads and around their faces. After the aircraft depart, individuals check each other for frostbite.

5-50. Unloading requires speed and efficiency. Troops first unload unit equipment, ahkios, and bundled skis or snowshoes as soon as the personnel have exited the aircraft. They pull the equipment away from the skis of the helicopter. Troops avoid throwing small items of equipment into the snow where they may become lost or blown up into the rotors. When unloading in the landing area, troops will frequently get completely disoriented. At a minimum, an aircrew member tells the troop commander which direction is north in relation to the way the aircraft faces. Direction can easily be established for the ground commander by landing the helicopter in a predetermined direction. Troop commanders orient themselves as completely as possible prior to touchdown so they can assemble squad, platoon, and company with the least delay.

5-51. Hot or cold load training and detailed planning help provide situational awareness on the LZ. Because of the slowness in unloading troops and equipment from helicopters during winter operations, initial landings should not be made in a defended or hot LZ. An ideal LZ resides in an undefended or lightly defended area as close as possible to the objective area.

5-52. Helicopter landing site selection factors are the same as for normal operations such as size, approaches and exits, takeoff and landing direction, and security. Troops can hastily prepare helicopter landing sites in winter using a tracked vehicle to pack the snow. Soldiers and Marines pack down loose snow by walking on it repeatedly with snowshoes. They prepare individual landing points as well as pathways to personnel holding areas. In snowy areas, troops can place spruce boughs in lieu of panels to identify landing points. They secure boughs into the snow to avoid foreign objects and debris hazards. For helicopters equipped with skis or skid mounted pads, snow-surface preparation is not necessary, but it is still recommended to mitigate white out conditions caused by rotor wash.

5-53. Helicopter operations in deep snow and muskeg are hazardous since the basic landing gear design offers no flotation. Deep snow can also hide hazardous objects such as small trees and bushes. Pilots use wheel-through skis or skid pads for arctic operations during all seasons. Use of skis in the summertime increases surface area on muskeg and helps mitigate unstable soil hazards. The tactical scenario and known LZ obstacles determine the landing technique. When pilots do not know LZ obstacles, they only use the forward and down technique when tactical threats on the LZ exceed the risk of damaging helicopters on unseen objects. Unlike dust landings, snow will generally blow out given enough time. If unable to blow out snow on the LZ, hidden obstacles may exist that are undetectable to flight crews. Leaders consider having pilots stack down on final approach paths for multiship landing zone sequences. Stacking down can minimize white out conditions for the entire formation.

5-54. When landing on a frozen lake surface, helicopter pilots start shutdown procedures only after they are sure that their landing surface is solid. Many lakes receive overflow from nearby streams, creating a mushy layer detectable only by ground reconnaissance. Leaders select LZs and PZs as close to the shoreline of a lake as possible – preferably the downwind side where the ice is thickest. Depending on the landing technique used, pressure exerted on the ice may be over 50 percent more than the weight of the aircraft. Soldiers/Marines will be exposed to enemy observation for much longer if the LZ or PZ is in the center of a lake or even an open field. (See Appendix C for more information on ice reconnaissance.)

AEROMEDICAL EVACUATION

5-55. Leaders make plans for aeromedical evacuation of casualties. Evacuation is particularly urgent during subzero temperatures. In addition to battle casualties, casualties from CWIs often increase. Because of LZ limitations, troops need to practice hoist evacuation. Cabin temperature is difficult to maintain and is quickly lost once troops open aircraft doors. Medics and corpsmen carefully protect patient core body temperature while accessing the patient for treatment. They can use thermal blankets to warm patients while the cabin reheats. Medics and corpsmen remove bulky gloves to provide medical care. They may lose dexterity in their hands in extreme cold temperatures which can hinder treatment. Effective medics and corpsmen maintain hand warmth as much as possible prior to treating patients and while pilots restore cabin temperatures.

COMMAND AND CONTROL SUPPORT

5-56. In addition to standard command and control support, aviation assets can courier messages or reports between units. If possible, aviation assets deliver messages during scheduled resupply missions.

AVIATION SUSTAINMENT

5-57. Low temperatures of the Arctic increase maintenance requirements. Maintenance time factors can quadruple in areas of extreme cold. Aircraft mechanics' heavy winter clothing and gloves greatly hamper their performance. Leaders consider extended time when planning pilots' duty-day, as extended preparation time can reduce pilots' available flight time. Units provide shelter for mechanics and aircraft. In the absence of maintenance tents, units can improvise by deploying and inflating a personnel parachute and warming it with a standard portable heater. Units follow special precautions and need equipment to ensure efficient aircraft operations. Installation of auxiliary equipment also adds a time factor to normal maintenance operations. Units keep wheels on dry surfaces or blocks to prevent them from freezing to the ground.

5-58. Cold-soaked aircraft at temperatures substantially below freezing have significantly slow start-up and run-up times. If temperatures and durations are significant, cold soaking may prevent units from using aircraft at all. POL, metals, electronics, logbooks, seals, and digital displays react adversely to intense cold. Units protect aircraft and aircraft components, including POL, against cold soaking whenever possible. However, threat-targeting systems will undoubtedly identify large and sufficiently heated facilities. Pre-heating critical components through forced-air heating and extended run-up or warm-up periods may be possible. This increases survivability, but it will require prepositioning adequate heaters and parachutes, deliberately increased maintenance times, and increased mission prep times.

5-59. Leaders need to consider higher fuel consumption when planning to use aircraft. Refueling proves challenging on extended flights. Long distances and an inability of surface transportation to move fuel to isolated points can hinder long flights. Due to this, commanders consider installing aircraft with extended range fuel tanks.

5-60. Forward arming and refueling point operations can use similar techniques as described in paragraph 5-52 to prepare landing sites for helicopters. Forward arming and refueling point personnel must ensure fuel nozzles are not placed into snow to avoid introducing water into the aircraft during fueling. In extreme cold weather, fuel hoses and collapsible fuel bladders may become inflexible and risk breakage. Soldiers and Marines wear personal protective equipment at all times to protect from excess windchill created by spinning rotor blades and fuel burns. (For more information on forward arming and refueling points, refer to ATP 3-04.17.)

SECTION V – SPECIAL OPERATIONS

5-61. This section provides arctic-specific considerations when integrating SOF into combined arms operations with conventional forces. Conventional forces establish command relationships with SOF to create complementary and reinforcing effects during operations. The mission and OE drive the command and support relationships between conventional and SOF during an operation. Regardless of command and control and support arrangements, both types of forces integrate and synchronize operations to increase effectiveness, promote interdependence, provide mutual support, limit redundant resources, and reduce the risk of friendly fire. (Refer to FM 6-05 for more information on integrating conventional forces and SOF. For more information on SOF operations, refer to JP 3-05.)

5-62. SOF contributions during deep and extended deep operations are often critical to setting conditions for conventional close and rear operations. However, for these contributions to work effectively, SOF must be well acclimated to the extremes of the environment.

5-63. The SOF core activities:
- Civil affairs operations.
- Direct action.
- Special reconnaissance.
- Unconventional warfare (UW).
- Military information support activities.
- Counter weapons of mass destruction.
- Counterinsurgency.
- Counterterrorism.
- Foreign humanitarian assistance.
- Foreign internal defense.
- Security force assistance.
- Hostage rescue and recovery.

Note. This manual does not discuss the activities counter weapons of mass destruction, counterinsurgency, counterterrorism, foreign humanitarian assistance, foreign internal defense, security force assistance, and hostage rescue and recovery. Their conduct, considerations, and principles are like those conducted elsewhere. For more information on SOF operations, refer to JP 3-05. For information relevant to military information support activities, see discussion starting at paragraph 4-76.

CIVIL AFFAIRS OPERATIONS

5-64. Civil affairs operations provide the commander with an understanding of the civil component of the OE through the collection and development of civil data and civil information by performing four core competencies of transitional governance, civil network development and engagement, civil knowledge integration, and civil-military integration. (See FM 3-57 for more information on civil affairs core competencies). Civil networks developed and integrated into planning and operations across the competition continuum enable resource allocation, create effects, and reduce operational friction that supports mission end states and goals. The Arctic is an isolated environment, which makes information collection and infrastructure challenging. Resources may be limited and difficult to obtain. Civil knowledge integration and civil network development and engagement during competition below armed conflict allow commanders to have an operational understanding about local tribes and their influence, information, terrain, weather patterns, and adversary activities. (See ATP 3-57.50 and ATP 3-57.30 for more information on civil knowledge integration and civil network development and engagement) Civil affairs staff develop an area study about the civil component common to the area of operations. The civil affairs area study presents a description and analysis of the geography, historical setting, and the social, political, military, economic, health, legal, education, governance, infrastructure, and national security systems and institutions of the area of operations. (For more information relevant to on civil considerations, see discussion beginning on paragraph 2-1.)

DIRECT ACTION

5-65. Arctic operations are extremely conducive to direct action. *Direct action* are short-duration strikes and other small-scale offensive actions conducted as a special operation in hostile, denied, or diplomatically sensitive environments and which employ specialized military capabilities to seize, destroy, capture, exploit, recover, or damage designated targets (JP 3-05). SOF can conduct direct action to—

- Employ, raid, ambush, or direct assault tactics.
- Emplace mines and other munitions.
- Conduct standoff attacks by fire from air, ground, or maritime platforms.
- Provide terminal guidance for precision-guided munitions and air assets.
- Conduct independent sabotage.
- Conduct anti-ship operations.

Note. The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines.

5-66. The Arctic usually has no continuous fronts. Units may operate independently many miles apart. Installations and communications centers are often isolated. LOCs, where they exist, are long and vulnerable to attack. Surprise is always a possibility, and security can only be guaranteed by accurate knowledge of enemy disposition, composition, movement, capabilities, and constant vigilance. When necessary, units use commercial-off-the-shelf equipment with military equipment to maximize mobility and cold-weather survivability.

5-67. Severe weather conditions enhance the effect of such operations. For maximum effect, units coordinate these actions with conventional assaults to impose multiple dilemmas on the enemy. An attack on the enemy's rear LOCs during a conventional frontal attack divides forces and causes confusion. Units apply special consideration to—

- Disruption of communications and headquarters. This, along with the already frequent communications interruptions associated with the Arctic, isolates and desynchronizes the enemy.
- Destruction of sustainment capabilities, particularly those that provide warmth in the winter such as fuel, heaters, and field kitchens. Destruction of these elements subjects the enemy to prolonged cold, thus causing cold-weather injuries, reduced efficiency, and reduced endurance.
- The delay of reinforcements. Sabotage of enemy transportation networks compounds already complicated mobility issues for the enemy. Frequent ambushes and guerilla tactics cause reserve forces to move slowly and more cautiously, thereby delaying potentially critical reinforcements.

SPECIAL RECONNAISSANCE

5-68. *Special reconnaissance* is reconnaissance and surveillance actions conducted as a special operation in hostile, denied, or diplomatically and/or politically sensitive environments to collect or verify information of strategic or operational significance, employing military capabilities not normally found in conventional forces (JP 3-05). SOF can conduct special reconnaissance to—

- Locate command and control headquarters, troop concentrations, missile storage and sites, airfields, electromagnetic warfare sites, and hostages or prisoners of war.
- Provide area assessments.

- Locate and report data on preselected, alternate, or potential targets.
- Provide DZ and LZ parties or guides to assist parachute and air assault forces during the critical assembly period.

5-69. Degraded communications and surveillance in the Arctic often require physical verification of intelligence. SOF are well suited to conduct these operations in enemy deep areas; however, they are susceptible to the same communications issues as conventional forces. Operators must have robust primary, alternate, contingency, and emergency (known as PACE) plans to relay information.

5-70. Physical reconnaissance of terrain for DZs and LZs is of critical importance in the Arctic. Map or satellite images often do not adequately depict ground conditions, especially tundra, muskeg, and ice surfaces. Ice thickness and serviceability are of significant concern. SOF have training in ice survey techniques, and if possible, ski-landing area considerations.

UNCONVENTIONAL WARFARE

5-71. UW is a form of irregular warfare and always considered an essential component of U.S. military strategy. *Unconventional warfare* is activities conducted to enable a resistance movement or insurgency to coerce, disrupt, or overthrow a government or occupying power by operating through or with an underground, auxiliary, and guerrilla force in a denied area (JP 3-05).

5-72. UW provides a lighter military footprint and signature to the policymakers compared to large-scale conventional forces. The inherent risk of using UW is the time to develop viable forces, the risk to small numbers of SOF operating with the insurgents or resistance forces, and diplomatic or political risk depending on the desired signature and effects. Regardless of the size of the effort, the actual joint force footprint deployed into the denied area can be a small percentage of the equivalent conventional force required to create similar effects.

5-73. Two distinct types of UW efforts support strategic outcomes. One type consists of UW as a supporting line of operation within the military effort of a larger military campaign. The second type of UW is employed as the strategic main effort, either as an initiative or as a response to aggression. In this case, overt military force is impractical or impossible; therefore, the military instrument of power is a supporting role to another instrument, such as diplomacy.

5-74. UW operations normally exist before the commitment of conventional combat forces. When a corps is committed and its area of interest nears the UW operational area, guerrilla operations expand to assist the tactical commander. The SOF operational base provides an SOF liaison party to the corps headquarters. Prior to linkup, SOF-advised guerrilla forces can complement, support, or extend conventional force offensive, defensive, and retrograde operations. In arctic operations, these forces have a distinct advantage in natural acclimatization to extreme weather and an innate knowledge of terrain and weather patterns.

5-75. Communication and language often prove challenging. Arctic Indigenous languages are not widely spoken, which may pose as a language barrier in UW. SOF can communicate with most Indigenous peoples through the host nation's official language. However, when doing so, SOF must accept the risk of translating misunderstandings since the host nation's language may differ from the community's primary language. Translation errors and miscommunication may occur more frequently.

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Chapter 6

Intelligence

The only difference between you and those who have lived in subarctic and arctic areas is knowledge—knowledge of the country and knowledge of the ways to make use of its advantages and overcome its difficulties.

FM 31-70, *Basic Arctic Manual* (1951)

This chapter provides arctic considerations for the intelligence process. It identifies arctic considerations in intelligence planning, directing, collecting, processing, producing, disseminating, and integrating.

THE INTELLIGENCE PROCESS

6-1. The intelligence process remains unaltered, regardless of the environment. However, intelligence efforts are both enhanced and degraded by the arctic environment. Low population levels and low temperatures easily highlight pockets of thermal, visual, and electromagnetic signatures. However, the extreme environment degrades and restricts information collection. Satellite and communications interference reduce the availability of cloud-based systems and analytic reach-back support. Lack of persistent, broad-area satellite coverage hinders precise weather forecasting, particularly long-range forecasts. Satellite mapping requires active sensor systems to offset the limitations of electro-optical systems in snow-covered terrain. Some equipment, such as server stacks, require a minimum operating temperature of 50 °F (10 °C) and may be unavailable until shelters can be heated. Shortages of reliable interpreters and translators exist, particularly when conducting stability operations with Indigenous circumpolar and cross-border peoples who represent a disproportionately higher number of displaced communities.

***Note*.** The Marine Corps uses the intelligence cycle (planning and direction; collection; processing, exploitation, and production; dissemination; and utilization). This chapter is organized according to the Army's intelligence process, but the information is equally applicable to the Marine Corps' intelligence cycle. For more information on the information cycle, see MCWP 2-10.

PLAN AND DIRECT

6-2. Planning and directing intelligence requirements are critical in the restrictive arctic environment. Commanders and staff avoid prematurely applying assumptions based on previous experiences in other environments. Instead, leaders thoroughly analyze and understand the many unique aspects of the Arctic as they present themselves. Often, the environment can pose a greater risk than an enemy threat can. Additionally, the commander considers how the environment impacts both friendly and enemy operations.

6-3. Commanders consider weather forecasts to be a priority information requirement. Important changes include temperature, humidity, or precipitation, which can drastically change terrain and mobility considerations. Commanders heavily emphasize both terrain and mobility analysis, especially for avenues of approach and mobility corridors for enemy and friendly forces. Unit movement takes significantly longer in the Arctic and is often underestimated. Wind speeds affect the windchill on personnel as well as the intensity of drifting snow which can choke roadways and facilities.

6-4. Effective information collection plans provide significant direction with regard to littorals, especially key waterways, navigability, and ice conditions. Navigability includes the depth, banks, civilian traffic, tidal effects, and tidal times. (See Appendix C for more information on ice assessments.) During stability operations, information collection plans concentrate on criminal activities, including piracy, that military forces may need to counter.

COLLECT AND PROCESS

6-5. Collection and processing procedures are essentially the same as in temperate regions. The arctic region has much larger areas of responsibility, and its cold temperatures degrade equipment more quickly. Successful collection plans address cold weather limitations on collection equipment, communications challenges, and the enemy's proficiency to conceal in the Arctic. The planning phase of arctic operations secures detailed information on the area of operations from strategic intelligence agencies. Planners make every effort to obtain aerial or satellite photos of the area for each season. Streams, lakes, swamps, and the general ground configuration are much easier to distinguish in photos taken in the summer versus in the winter when the ground is covered with snow and waterways are frozen.

6-6. Analysts consider detection challenges. All dismounted movement and most mounted movement off heavily trafficked road networks is visible, particularly after a fresh snowfall. When building information collection plans, leaders consider the value of change detection. Change detection can identify cleared routes for enemy movement and friendly trafficability. Dismounted friendly units consider creating multiple trails to deceive the enemy or using brooms and other instruments to cover tracks as they move.

6-7. Successful troops effectively use air reconnaissance by rotary-wing aircraft, UAS, and fixed-wing aircraft. Overhead sensors are very effective in the Arctic, however, at certain cold temperatures some air reconnaissance assets may become unavailable. Units likely to demand aerial photographs must have a working knowledge of aircraft limitations in the Arctic. Initial collection efforts should use aerial and overhead collection to detect and identify manmade objects.

6-8. Leaders can use subsequent ground assets to verify and further analyze overhead collection information. Patrols have many opportunities to work behind enemy lines to gather information; however, ground patrols move at a slower rate than normal under arctic conditions. Leaders consider troop movement and other time-related planning factors carefully. Long-range surveillance detachments require special equipment and training and often require the use of snowmachines to tow sleds loaded with several hundred pounds of life support. During seasons when waterways are open, boat patrols facilitate gathering information.

6-9. Observation posts with UAS and signals intelligence enable locating the enemy, monitoring movements, and covering defensive gaps. Frozen tundra or plains that enable rapid enemy movement require reconnaissance in depth to maintain contact with the enemy and prevent turning movements. UAS can provide effective surveillance in these areas. Areas with dense overhead cover or heavy snowfall limit aerial and thermal surveillance. In degraded visual environments, units leverage the electromagnetic spectrum to its fullest extent for surveillance.

6-10. Surveillance and target acquisition devices have variable performance in cold weather. Low temperatures and snow enhance thermal images and image intensification. For infrared devices, warm target contrasts against the cold background allow for easy detection. Strong heat signatures from vehicles may wash out fine details and make identification difficult. Cold, clear, dry, stable air can also enhance light-intensifying devices. However, heavy snowfall and densely wooded areas can mask enemy signatures and reduce the effective range of thermal devices. Snow-covered ground reflects moonlight exceptionally well and can provide good night-time illumination for light-intensifying devices. Cold dry conditions can enhance radar, but precipitation and environmental clutter can degrade performance. The millimetric-wave fire-control radar and ground-moving target-indication radar both perform well in cold conditions. Deep snow degrades seismic and acoustic sensors. Poor weather and terrain conditions may make electronic surveillance one of the few effective methods of collection, even in different propagation conditions.

6-11. Under normal operating conditions, most surveillance and target acquisition equipment require special care and calibration. Cold temperatures increase the need for proper equipment care. Rubber and polymer parts become brittle and are more susceptible to breakage. Troops also attend to the cold's effect on battery life.

PRODUCE

6-12. Intelligence production requires additional time and resources for detailed analysis of the terrain, weather, and enemy. The priority, as with other operations, are named areas of interest to accurately predict enemy movement and target areas of interest. Detailed knowledge of the terrain and climatology is one of the greatest combat multipliers in arctic operations. Its importance cannot be understated.

TERRAIN

6-13. Leaders must determine the location and condition of existing road networks. Staff estimates provide information regarding soil trafficability, vegetation, water routes and expected ice thickness, snow conditions, and average snow depth to the commander. The commander assesses general features of the terrain from the viewpoint of cross-country movement and mobility. Improved roads that are reliable in the summer may be impassable in the winter, depending on a unit's ability to organically clear snow prior to mounted transit. Unrestricted terrain identified on a map that could serve as mounted movement corridors may prove severally restricted in summer because of muskeg bogs (essentially an arctic marsh). During the summer, units cannot use dismounted or mounted movement over muskeg as people and vehicles can easily sink in muck. Conversely, in winter when the muskeg has frozen, previously severely restrictive terrain could become the most reliable for everything from mounted movement to airborne assaults. For summer operations, leaders determine suitable water routes and dry ground routes for transportation. Glacial fields have prevalent crevasses, which also restrict movement. Unless a unit is trained and equipped for glacial traverse, glacial fields are considered an obstacle.

6-14. Snow depth is a critical determining factor for dismounted mobility. Analysts need to understand their unit's over-snow capability to understand the viability of movement corridors. For instance, in knee-deep snow, units without skis and snowshoes often have a very limited ability to travel dismounted. Likewise, units without snowmachines, SUSVs, or CATVs have a limited ability to travel mounted, possibly reducing their ability to conduct reconnaissance, casualty evacuation, or resupply.

6-15. Geospatial analysts can produce terrain slope analysis and assess areas of higher avalanche risk. The most common slope angle for avalanches is 38 degrees. Heavily sloped strategic mountain passes may actually be unusable because of highly sloped terrain. Leaders can use creative solutions to create obstacles, such as deliberately triggering an avalanche to close a strategic mountain pass.

WEATHER

6-16. Weather is one of the most important factors in arctic operations. Intelligence analysts work with SWOs/METOCs to develop a foundational understanding of arctic weather patterns. Commanders ensure staffs disseminate weather data to the lowest level. Because arctic weather effects can severely impact operations, intelligence analysts ensure weather forecasts also come with directly stated tactical implications. It is not enough just to show the effects on the weather impact matrix. Staffs have to distribute, and personnel have to understand weather running estimates. In particular, the conclusions should convey effects on—

- Materiel and equipment (to be carried or resupplied; degrading conditions).
- Mobility (time considerations and limitations on transport).
- Measures to preserve combat power.
- Employment of weapons and munition.

6-17. During periods of darkness, snow and ice can reflect illumination by as much as 20 to 30 percent. Clear skies with a full moon can produce enough illumination to eliminate the need for night vision optics. Additionally, in the summer no absolute period of darkness exists for up to four months. Seasonal transition periods can also lead to periods with extremely low cloud ceilings, which impede over ahead collection assets.

ENEMY ASSESSMENT

6-18. In addition to the essential elements of intelligence required for other types of operations, leaders answer the following two important questions for successful winter operations in the Arctic. The questions are:

- What is the enemy capability for moving cross-country?
- What is the enemy capability for living and fighting for prolonged periods in extreme cold (cold weather capability)?

6-19. Probing questions to assist staffs in determining the answers might include—

- How is the enemy equipped to conduct arctic operations?

- How is the enemy trained to conduct arctic operations?
- What kind of over-snow vehicles does the enemy have?
- What is the enemy capability for cold weather maintenance?
- What kind of snow-removal equipment does the enemy have?
- What types of artillery does the enemy use (self-propelled or towed)?
- What guns are ski equipped?
- What type of over-snow transport systems are used to move equipment?
- What kind of shelters does the enemy use?
- How are shelters moved cross-country without using vehicles?
- What kind of improvised shelters does the enemy use?
- What type of winter clothing does the enemy use? What protection will it afford?
- What is the effectiveness of enemy weapons in extreme cold?
- How do heavy weapons follow infantry units in cross-country movement?

6-20. Units can determine other enemy capabilities. In addition to surface mobility, units also assess the enemy's ability to insert by submarines and under the surface of polar icecaps. Such enemy movement can significantly decrease indications and warning times. For summer operations, units determine if the enemy has cross-country vehicles capable of negotiating muskeg or swampy terrain. Troops determine if the enemy has boats and for what purpose the enemy uses the boats. Troops also determine if the enemy has bridging equipment and units.

Aerial Photo Interpretation

6-21. Terrain features and waterways frequently change in the Arctic, especially from season to season. Aerial photographs provide up-to-date information on the landscape and show smaller trails and paths that maps may not display. Because the sun remains relatively low and close to the horizon at high latitudes, objects cast very long shadows. For this reason, shadows tend to blot out details, making accurate interpretation difficult. Along with the abnormal shadow, dense vegetation often grows in boreal terrain. Together these effects can produce a distorted image that shows brush as a dead black patch through which staffs cannot see details. The many well-used animal trails can complicate photo interpretation and appear to the inexperienced analyst as human tracks. Until the unit notes the error, this mistake usually means unnecessary patrolling in search of nonexistent enemy.

DISSEMINATE AND INTEGRATE

6-22. Timely dissemination and integration of intelligence and finished intelligence products are critical to operational success. This dissemination must be deliberate and carefully controlled to ensure the commander, staff, and other appropriate personnel receive the intelligence when needed in the right form at the right time. Commanders, staff members, and unified action partners must receive and use combat information and intelligence to facilitate situational understanding and support decision making and targeting. Units must consider the effects of the arctic environment on dissemination methods of intelligence assessments, products, and reports while also implementing emissions control measures and countersurveillance techniques.

Chapter 7
Fires

With practice and focus, you can extend yourself far more than you ever believed possible.

Sir Edmund Hillary, first person to reach both poles and summit Everest

This chapter describes unique arctic considerations for the fires warfighting function. Section I – Fires Considerations provides overarching effects of the Arctic on the warfighting function. Sections II and III provide specific considerations for artillery and air defense artillery.

SECTION I – FIRES CONSIDERATIONS

7-1. Fires have substantial limitations in arctic operations but still are an essential element in combined arms. Inclement weather often limits supporting arms by air and naval elements, resulting in artillery and mortars becoming the only means of indirect fire support. For this reason, units task-organize to allow forward troops with the most flexible fire support possible in any weather condition. Offensive operations should stay within artillery fire support and have a plan to withdraw if necessary. A rule of thumb for field artillery assets during offensive operations is that two-thirds of their maximum range should be beyond the objective. In arctic operations, this planning factor is even more critical due to the reduced mobility of any attacking force. Therefore, maneuver forces are highly reliant on indirect fires to cover both their advance and withdrawal, especially during delays.

7-2. Fires in arctic operations encounter munitions, mobility, and electronic problems. Impact bursts of artillery and mortars have a reduced effect in snow and muskeg, which in turn requires more munitions and time to achieve the desired effect. Conversely, ice or frozen ground without snow enhance artillery effects. Units experience challenges when supplying munitions because wheeled vehicles that conduct resupply have limited mobility in snow and muskeg. Mobility challenges also apply to the positioning of artillery. However, self-propelled tracked vehicles have much greater freedom of maneuver. Extreme cold temperatures also limit or prohibit electronic functions. Fires in arctic operations may be less precise than other places because of degraded electromagnetic communications and position, navigation, and timing satellite support.

SECTION II – ARTILLERY

7-3. Field artillery operations in arctic conditions present unique challenges not replicated in any other environment. Artillery units must contend with extraordinary maintenance requirements, challenging mobility conditions, intermittent or interrupted resupply, peculiarities in observation and target location, demanding survey requirements, and inconsistent communications. Units must execute focused training prior to deploying to arctic regions to prepare personnel and equipment to overcome grueling environmental conditions. Units need to account for the specific challenges that are not only associated with extreme cold weather in the Arctic, but also the muddy swamp-like conditions experienced in muskeg and tundra during the summer, which pose their own unique set of challenges.

7-4. Glacier and mountain operations may require using artillery by sling-load. Units assigned such a support mission bring supplementary weapons to perform the task. Personnel train to standard in sling-load techniques as well as loading, lashing, rigging, and palletizing equipment. Leaders address tables of organization and equipment (TO&Es) and anticipate additional special equipment necessary to load, transport, and support the firing units. Units augment TO&Es with equipment specialized for arctic operations as necessary. During winter, units winterize all equipment prior to its arrival in the theater.

MOVEMENT OF ARTILLERY

7-5. Artillery units successfully accomplish movement because of careful, detailed, and comprehensive route reconnaissance. Leaders consider extensive reconnaissance, both air and ground, in detail prior to any operation. Artillery requires the same mobility as the supported unit. This includes appropriate tracked vehicle transportation and proficiency with snowshoes and skis, particularly for the forward observers and liaison personnel. Army aircraft can assist in maintaining direction, determining locations, reconnaissance, communications, and observation of fire. Whenever feasible, units replace wheeled vehicles assigned to maintenance, survey, reconnaissance, and communications elements with tracked vehicles. Tracked vehicles provide a cross-country capability necessary in this area of practically nonexistent road networks.

7-6. Seasons affect movement of artillery as they affect other elements. Winter is the best time of the year for cross-country movement in the Arctic. However, artillery elements encounter problems when crossing certain rivers and muskeg areas which do not freeze even at temperatures of -45 °F to -50 °F. Since most self-propelled artillery vehicles can only ford a river at 112 centimeters depth, troops must determine ice depth before crossing frozen lakes and rivers. (For load-bearing capacities of ice, see the Appendix C.) During the summer months, movement across the extensive arctic muskeg is severely restricted. Units rely heavily on engineer support. (See Appendix A for temperature and length conversions.)

7-7. Artillery movement also encounters restrictions because of terrain and loading. Personnel encounter increased problems of determining location and orientation while moving due to limited map coverage and difficult terrain. In many cases, units can only orient a vehicle column movement when the column commander dismounts and determines direction with a compass. Load plans also cause issues with artillery elements. Correct load plans reflect the presence of additional cold weather equipment, such as tents and stoves, on each vehicle. Weight and balance issues can also increase the risk of rollovers, uncontrolled slides, or sinking into snow or muskeg. Additionally, wheeled vehicles require snow chains for effective cross-country movement in the snow. Since artillery has large bulk and weight resupply problems, leaders encourage aerial resupply. Continuous exploitation of the tracked vehicle capability for resupply purposes is necessary to ensure mission accomplishment.

POSITION AREAS FOR ARTILLERY

7-8. Field artillery leaders plan for complex arctic challenges when preparing or occupying a position area for artillery (PAA). Leaders account for the significant additional time it takes to prepare arctic artillery sites—up to several additional hours depending on snow cover, soil hardness, accessibility, slope angle, vegetation, and available equipment. Heavy snow cover requires significant time to plow. If possible, units modify vehicles with plows. Frozen ground makes digging in of spades a very arduous task. Without frozen soil, standard emplacement time for a howitzer is 12 minutes. With frozen soil, emplacement time can exceed an hour. Specialty construction equipment, such as jackhammers and exothermic flame devices, can expedite the process, but some equipment also produces distinct and loud sound signatures. Because of extended emplacement times and mobility challenges when displacing, commanders weigh the advantages and disadvantages of displacement versus hardening of positions.

7-9. Leaders chose a PAA based on where their unit can best support operations. However, in arctic conditions commanders must also consider the ability of a PAA to support ingress and egress, trafficability, location of friendly forces, cover and concealment, and protection from the elements. Units prepare areas prior to occupation whenever possible. Troops often build up parapets and gun positions with snow, available brush, and wood rather than digging them in. Units with High Mobility Artillery Rocket System (known as HIMARS) prepare hide points, firing points, and movement paths before occupying a position. Effective and continuous operation requires warming tents or shelters within the PAA. When selecting a PAA, leaders also consider its accessibility for throughput sustainment. Many wheeled vehicles used for throughput cannot travel far from main roads unless units prepare and groom trails.

7-10. Snowplows allow units to prepare individual firing positions in snow covered areas. Units can modify the family of medium tactical vehicles (known as FMTVs) and Medium Tactical Vehicles Replacement (known as MTVRs) with a snowplow. Operators familiarize themselves with operating the snowplow and must recognize the limited capabilities of the family of medium tactical vehicles compared to engineer equipment to push snow. FMTVs/MTVRs with snowplows can only clear a position half the normal size of a standard individual firing position. FMTVs/MTVRs have limited capability to drive or plow through snow over 12 inches in depth. In such conditions, FMTVs/MTVRs can maintain positions established by engineer assets, but cannot be relied on to establish a PAA on their own. Units deploying to arctic regions from more temperate climates may not have the snowplow equipment or experience to clear positions and may need snow and ice clearing assets attached to them to support. Units without plow modified vehicles require engineer assistance for snow removal.

7-11. Camouflage in arctic conditions requires planning and awareness of terrain, existing vegetative forms and coloration, environmental and seasonal conditions. Units can use camouflage netting, vegetation, and terrain to break up equipment outlines and conceal positions from observation. Dispersion can improve concealment by decreasing a unit’s signature size at one location. However, heat sources such as heaters, stoves, and running vehicles can create signatures visible to the enemy. When using heat sources, leaders must balance the risk of enemy detection against risks to personnel readiness and safety. Leaders also establish displacement criteria and have additional PAAs available to increase survivability.

OBSERVATION FOR ARTILLERY

7-12. Arctic conditions impose considerable challenges on effective observation of artillery fires. During the winter months, short periods of daylight limit daytime observation. Troops must be proficient in nighttime observation with optical devices, illumination, auditory signals, and other non-standard means to adjust artillery fires. Fog, ice fog, snowstorms, and blowing snow also limit observation. Bursts are difficult to observe on snow covered terrain and in muskeg due to the dampening effect. Additionally, snow can impact observer’s depth perception and can obscure ground features and landmarks. When exact locations are unknown, the observer may need to make preliminary adjustments by airbursts or use colored smoke. Safety of friendly troops must be carefully considered at these times. In addition to ground-based forward observers, units coordinate to use unmanned aerial systems or rotary-wing aviation to observe and refine target location and indirect fires.

7-13. Arctic conditions can negatively impact electronic and manual navigation aids used for observation. Therefore, observers train on orienteering, self-locating, target locating, dead reckoning, polar target location, and the impacts of magnetic declination.

7-14. Observers must be equipped to move with their supported elements. They use snowmachines as much as possible and ahkio sleds to carry sustainment loads. Leaders give special consideration to the observers’ radio equipment. The weight of radios, batteries, and other equipment may overburden observers if they must use skis or snowshoes as a means of transportation while attached to the infantry elements. Observers wear anti-glare eye protection to prevent injury and eyestrain caused by glare and reflection from the sun and snow.

SURVEY FOR ARTILLERY

7-15. Traverse type survey is impractical over extended distances. Instruments fog up and other mechanical failures occur in the Arctic. Recording and computing under winter weather conditions prove extremely difficult. Surveyors rarely have survey control and adequate maps. They can determine grid azimuths by astronomic observation or by using a gyroscopic direction determining instrument. Often leaders must accept risk by assuming starting coordinates.

7-16. Triangulation is usually more feasible than traverse. Units can use helicopters to transport survey parties to inaccessible locations and to mark stations for triangulation. Electronic distance measuring devices are the most practical means of carrying out arctic surveys over extended distances.

DELIVERY OF FIRE

7-17. Units still must meet the five requirements for accurate predicted fire to achieve first round fire-for-effect. The extreme cold weather environmental conditions, effects on equipment, and potential impact on survey data require units to plan and compensate procedures to derive these data. Units can expect potential delays in fire mission processing if this data is not continuously updated.

7-18. In most areas, survey control will be scarce or unavailable. Therefore, units often need to fire from an observed firing chart. Due to poor visibility, shortened daylight hours in the winter, ice fog, dense brush, and wooded areas, high burst registrations are common.

7-19. Extreme cold weather will affect the ballistic characteristics of the weapons and ammunition. The cold affects the muzzle velocity from the cannon and yields more range dispersion. Cold powder burns slower, and the range is decreased.

7-20. Extreme cold weather impacts the operability of munitions and equipment. Severe cold weather can degrade or disable electronics, requiring units to use manual methods of fire-direction and counter-fire. Cold negatively effects electronic displays and battery life. It also weakens certain metals, which can break under sharp impact. Therefore, troops take deliberate care in storage, crew-drills, and monitoring equipment in arctic conditions. When swabbing the bore at freezing temperatures, troops use food-grade antifreeze to prevent icing that rapidly occurs when swabbing with water alone.

7-21. Troops select fuses with special care based on the target area terrain. Deep snow and unfrozen muskeg reduce the effect of impact bursts by as much as 80 percent. Fuse time and variable time are particularly effective against personnel in the open. Variable time fuses tend to malfunction when temperatures fall below 20 °F (-6 °C). When possible, troops warm these fuses by placing them inside gun carriages, prime movers, special warming tents, or shelters constructed from gun tarpaulins. Extreme low temperatures also cause illuminating rounds to malfunction by freezing the parachute and its components. Warming these rounds greatly reduces malfunctions.

SMOKE

7-22. Most of the year, meteorological conditions are ideal for smoke-producing munitions. Standard smoke-producing munitions may be used, but have limitations. Artillery smoke shells containing canisters filled with hexachloroethane smoke mixture have limited uses. They work poorly on terrain covered by loose snow because the canisters bury themselves in the snow and are extinguished by water from the melting snow. However, if units use these munitions on terrain covered by hard packed snow and ice, they lose little of their smoke producing capability. White phosphorus smoke munitions can also bury themselves in snow and lose their effectiveness. However, because of the burn characteristics of white phosphorus it is still the most effective smoke munition in arctic environments.

SECTION III – AIR DEFENSE ARTILLERY

7-23. Air defense artillery missions in arctic operations are the same as those in other terrain, but the climate, terrain, and nature of the operations may require technique modifications. Lack of roads may reduce mobility and make resupply operations more difficult. Extremely cold weather causes longer warm-up times for electronic equipment and requires special heating devices for ready missiles. In air defense missile units, troops operate generators, fire control equipment, and launching equipment at frequent intervals under extreme weather conditions.

7-24. Mission, terrain, and available transportation dictate the types of air defense artillery units employed in arctic operations. Units often augment TO&Es to accomplish the assigned mission. These units complete winterization and modification of equipment where necessary before entering an arctic region. Personnel must attain a high state of training to perform efficiently in the Arctic. Units provide heated shelters for maintenance personnel to perform their duties. Commanders select air defense artillery positions based on tactical utility and logistics factors. Air defense missile units should, if possible, occupy previously prepared positions. In adverse terrain or under winter conditions, it may be difficult to dig in positions. Units can use explosives to expedite protection of the position or build parapets from logs or ice and snow. Leaders also choose and prepare alternate positions early and as time permits. Leaders consider helicopter lift capabilities for resupply.

Chapter 8
Sustainment/Logistics

Victory awaits him who has everything in order—luck, people call it. Defeat is certain for him who has neglected to take the necessary precautions in time—this is called bad luck.

Roald Amundsen, the first person to reach the South Pole

This chapter outlines procedures for sustainment of arctic operations. The chapter is divided into five sections. Section I – Sustainment Considerations provides overarching planning factors for sustainment operations. Sections II through V provide specific considerations for logistics, financial management, personnel services, and health service support, accordingly.

SECTION I – SUSTAINMENT CONSIDERATIONS

8-1. The *sustainment warfighting function* is the related tasks and systems that provide support and services to ensure freedom of action, extend operational reach, and prolong endurance (ADP 3-0). The sustainment warfighting function consists of four elements: logistics, financial management, personnel services, and health service support. The Marine Corps lists *logistics* instead of sustainment as a warfighting function (see MCDP 1-0). The Marine Corps definition of *logistics* is 1. The science of planning and executing the movement and support of forces. 2. All activities required to move and sustain military forces (USMC Dictionary).

8-2. Sustainment support in arctic operations is critically affected by—

- The long and difficult terrain distances over which support must be rendered.
- The lack of ground communications systems, even near population centers.
- The general lack of civil and industrial facilities that can be adapted for military purposes.
- Environmental factors, including winter cold, low-bearing capacity soils in summer, permafrost phenomena, vegetation cover, and terrain.

8-3. Mobility is a primary concern of sustainment. Tactical mobility is limited by sustainment mobility. Sustainment mobility requires—

- Rapid, convenient, and economical supply storage and handling methods.
- Responsive resupply systems.
- Effective maintenance and service support systems.
- Effective ground and air transport, all integrated into competent support organizations.
- Responsive and effective medical support.

8-4. The unusual weather and terrain conditions in the Arctic make supply, evacuation, transportation, and services more difficult and more time consuming. Time and space factors vary with the terrain, the climate, and the season. Leaders allow more time for movement of supplies and troops because of the environment. Commanders and staffs measure distance in time rather than space.

8-5. Commanders issue their orders early to allow adequate time for subordinates to move supplies and equipment. Thorough logistics planning is required, even for small unit operations. Units must provide adequate support to troops to ensure survival and comfort as well as combat resupply. Plans include resupply for food, water, fuel, clothing, sleeping gear, tentage, mountain gear, winter equipment, repair parts, medical supplies, and ammunition. Leaders consider all means of transportation for moving supplies and equipment. Transportation includes aircraft, watercraft, wheeled and tracked vehicles, and individual means.

8-6. Exchange of individual and organizational seasonal equipment presents a major logistics challenge, particularly at the division and higher. Seasonal equipment includes skis, ahkio sleds, snow removal equipment, and many others. Troops exchange winter gear for summer in the spring. They exchange summer gear for winter gear in the fall. To guarantee an uninterrupted operation, careful planning includes a schedule for gradual exchange and shipment, or storage of the equipment as dictated by the tactical situation and seasonal transitions.

SUSTAINMENT PLANNING

8-7. Success in combat operations in undeveloped arctic areas depends on adequate sustainment plans. Every command decision fully considers resources and their accessibility. Arctic sustainment plans become more complex due to the increased severity of the terrain and climate. In more temperate regions, a generally robust and well-developed all-weather transportation network with support infrastructure facilitates military operations. However, in arctic operations, these road networks become scarce and less developed than those found in temperate regions. The same goes for support facilities due to the reduced number of towns.

8-8. A force should not move out in arctic operations until it has developed adequate sustainment plans. With realistic sustainment plans, the commander can fight in response to the tactical situation as it may develop. If the support, as planned, breaks down during the operation, then the tactical operation may not succeed. Troops committed to arctic operations on short notice may struggle to familiarize themselves with special items of equipment. Training on such specialized equipment is essential to maximizing combat capability.

8-9. Development of an adequate sustainment plan requires the commander’s close personal attention, as well as the participation of operations and logistics staff. In a cross-country movement, the operations officer and the logistics officer formulate concepts and prepare detailed plans jointly and concurrently. The operations officer must understand and accept the limitations of logistics capabilities.

REQUIREMENTS PLANNING

8-10. Requirements planning begins with the first stages of operation planning. The lead time required to obtain and issue special equipment sets a minimum time within which a unit can mount an operation. Ordered items may take considerable time to obtain even if supplies have a national stock number (known as NSN) since stocks of cold region equipment are generally limited. Units can use nonmilitary local supply sources to acquire certain commercial-off-the-shelf specialized items and reduce requirements lead time.

8-11. Special equipment is required to afford the combat force adequate mobility and environmental protection. Typical equipment required for arctic operations includes—

- Snowshoes.
- Skis and ski poles.
- Heaters.
- Sleds such as the ahkio.
- Over-snow vehicles such as the snowmachine and CATV.
- Arctic tents.
- Specialized uniforms such as Extended Cold Weather Clothing System items and vapor barrier (known as VB) boots.

8-12. Strategic transport to the Arctic is limited, and large volume deliveries depend upon seasonal shipping. Therefore, planners continually anticipate requirements and use long-range forecasts. Units place orders well in advance to accommodate shipping delays. The logistics staff maintains a control record of all equipment and support resources required and on-hand. The staff logs and maintains actual consumption rates to improve forecasting ability. They pass this information to a force arriving in the Arctic. In the absence of such a formal record, a new force may overlook important capabilities. Units limit supplies and personal equipment to those required for the terrain and weather.

8-13. During summer, units need mosquito netting or screens and aerosol-type repellant to provide respite for sleeping, eating, and administrative duties. Units can use boats, outboard motors, and low-ground-pressure floatable vehicles to negotiate rivers, lakes, and marsh areas, and transport personnel and critical supplies.

8-14. In the winter season, it is imperative that units have a variety of special equipment on hand to overcome the challenges of extreme cold weather. The special equipment required for small unit living during the winter season will depend on the depth and characteristics of the snow, extent of vegetation, and other terrain and climatic conditions. It can be expected that most of the following items will be needed: tent, tent heater, 200-pound sled, machete, bowsaw, axe, shovel, and spare ski tips and bindings.

8-15. Different echelons have different additional requirements. At the company level, units need additional items. For individual transport, they need ski-wax, spare ski bindings, extra skis and poles, and spare snowshoes. For individual digging, they need pick mattocks, shovels, ice augers, cross-cut saws, and ice saws. For protection from the weather, they need tent heaters with repair parts, tent repair kits, wire for lashing, nails, and sleeping bags. Other items that company-level troops may need includes insulated food containers, iron wire for lashing, nails, and casualty evacuation bags. Low-ground-pressure over-snow vehicles are also required to provide mobility. At battalion and brigade levels, units consider the following items: auxiliary cold-starting aids (NATO jumper cables), air duct heaters, extra battery chargers, antifreeze compounds, special cold weather hydraulic fluids, cold weather lubricants, cold weather batteries, cargo sleds, mobile heated shelters in which to operate the engineer water supply equipment, low-ground pressure over-snow vehicles, and water pumps.

8-16. Generally, units can expect to need increased stocks of repair parts and arctic lubricants for equipment exposed to extreme cold. The greatest increase will occur with those parts that depend on lubrication for long life. Extreme cold weather reduces lubrication efficiency, puts a heavy drain on batteries, results in materials becoming brittle, and restricts the amount of maintenance that units can accomplish in the open.

8-17. For operations in extreme cold, maintenance and other combat service support activities require heated shelters. The continued efficiency of all personnel depends on being able to get into a warm shelter frequently. Accordingly, units plan some type of shelter with heating equipment for all echelons. This includes tents with heaters for the combat troops in contact with the enemy.

8-18. Arctic sustainment plans become more complex due to the increased severity of the terrain and climate. Logisticians address materiel retrograde processes early in sustainment planning processes to minimize the impacts on transportation availability, the environment, and materiel loss. Integrating waste management tasks within sustainment plans and operations helps identify safe and effective transport of waste throughout the operational area. This integration includes the retrograde movement of hazardous waste, special waste, and recoverable items. (For more information, refer to TM 3-34.56/MCRP 3-40B.7.)

MOBILITY PLANNING

8-19. Units carefully balance sustainment and mobility requirements to meet mission needs. Extra sustainment equipment (especially those required for heat, clothing, and shelter) will restrict mobility. Unit leaves behind nonessential items and equipment that reduce mobility. If possible, units transport group equipment by special means, such as tracked cargo carriers or snow machines pulling sleds. This lightens individual loads and improves troop mobility during combat and on the march. Such transport must be close enough to forward elements to deliver tents, heaters, fuel, and food each night or whenever troops take a long halt. To the greatest extent possible, units use cross-country and all-terrain vehicles to transport supplies and essential maintenance services. Cross-country transportation gives units maximum flexibility and self-sustaining capability. Units also use rotary-wing aviation to supplement ground transport.

8-20. Units can use natural waterways during summer seasons for logistics movements. Successful stream navigation requires the lead pilot to have detailed knowledge of local conditions. They locate logistics hubs away from the riverbank to avoid detection, frequently move unloading points, and treat unloading points like ground-based logistics release points. When units establish a river LOC, troops provide cross-country supply handling and ground transport equipment to move supplies from the riverbank to the supported force. Leaders establish effective movement control procedures for coordination between waterborne and ground transport equipment. Troops use powered boats with shallow draft for both troop transport and supply movements in upstream areas. Near the mouths of large rivers, they may use conventional ship-to-shore lighterage effectively to support units. For bulk hauls upstream near shallows, units use amphibious vehicles. Troops also use conventional equipment for long-distance bulk river transportation.

8-21. During the winter, frozen river surfaces can be used for ground transportation when used with caution. Surface ice thickness varies according to local conditions, including river depth and velocity, the proximity to hot springs, the range and previous duration of low temperatures, and other factors. In addition, ice movement makes the surface extremely rough and broken in many places. With careful reconnaissance, troops can use frozen river surfaces for local vehicle movements and for river crossings. (For more information on ice reconnaissance, see Appendix C.)

REAR AREA SECURITY PLANNING

8-22. An independent unit in cross-country operations does not have a continuous rear zone through which support can move under friendly control and protection. Elements left behind the main body are vulnerable to guerrilla forces characteristic of undeveloped areas. As an independent force moves, it moves its associated activities, including the direct support element, always keeping its rear support protected. Tactical plans provide for all-around protection of the unit's perimeter. Units can use air cavalry as rear area security forces.

8-23. Leaders make specific provisions for defending each sustainment complex, including field trains and the mobile direct support element. All personnel in rear areas are armed and integrated into the local defense plan. Defense plans include provisions for blocking airstrips and other cleared and open areas against enemy helicopter and airborne landings. Support elements train and prepare to defend themselves physically and psychologically. Support elements that lack adequate defense training are highly vulnerable to enemy attack.

SELECTION AND LAYOUT OF SUSTAINMENT SITES

8-24. The site selected for a sustainment organization should facilitate logistics support by road, air, water, and rail, where available. If not available, units use cross-country means of transportation. Leaders pick a site conveniently near the units to support. Cities and villages in arctic regions may provide such accessibility. Leaders consider using existing structures to decrease construction time. They avoid locating sites on flat ground in the immediate vicinity of northern streams since they often flood and change course. Leaders choose the following factors when picking a location for a sustainment organization:

- Proximity to a stream or lake. Many streams and deep lakes remain open even in extremely low temperatures, and, when frozen, may still be usable as a water source.
- Proximity to local source of fuel for heating purposes.
- Downwind side of hills, part way up the slope, and free of danger from avalanches. Cold air flows to the bottom of valleys in calm weather.
- Terrain which lends itself to defense.
- Good soil conditions (rock, sand, or gravel) to minimize unfavorable effects of permafrost.
- Timbered areas. Timber affords concealment and wind break and may be used as a source of fuel, material for construction, and bedding.
- Proximity to fixed communications facilities for long-distance communications.
- Area of sufficient size to allow proper dispersion.
- Proximity to terrain suitable for establishment of an all-season airstrip.

SECTION II – LOGISTICS

8-25. *Logistics* is planning and executing the movement and support of forces. It includes those aspects of military operations that deal with design and development; acquisition, storage, movement, distribution, maintenance, and disposition of materiel; acquisition or construction, maintenance, operation, and disposition of facilities; and acquisition or furnishing of services (ADP 4-0). Army logistics elements are—

- Maintenance.
- Transportation.
- Supply.
- Field services.
- Distribution.
- Operational contract support.
- General engineering support.

MAINTENANCE

8-26. Maintenance requirements in arctic operations are significantly higher than in other regions and must receive command emphasis. Factors that increase maintenance requirements include—

- Long distances and heavy strain of cross-country movement on all equipment.
- Increased breakages caused by extreme cold caused by decreased lubricant efficiency and increased brittleness of some materials.

- Longer repair times caused by extended darkness and bulky clothing.
- A higher maintenance workload caused by additional equipment required for environmental protection and cross-country mobility.
- The general effect of the Arctic to make all activities slower and more difficult.

8-27. All equipment used in arctic operations is affected by extreme cold and must be maintained in the best possible mechanical condition. Troops completely winterize all equipment before arriving in theater in accordance with TM 4-33.31. Troops store adequate lubricant on board each vehicle to keep it combat serviceable. Staffs avoid issuing substandard equipment to combat and combat support units since the rapid resupply of major items is often difficult. Units properly forecast the installation, maintenance, and repair of vehicle heaters and engine preheaters as well as the changeover to arctic lubricants. Contracted support can expedite this process to help meet deployment requirements.

8-28. Because of challenges, units require additional maintenance shelters and more experienced maintenance personnel than normal. Units ensure maintenance shelters have sufficient heat to warm broken vehicles before repair. Without adequate facilities, units may not be able to perform maintenance when engaged in combat operations. Under these conditions, the maintenance officer is responsible for recommending to the commander ways and means of solving preventive maintenance challenges. Some maintenance challenges include—

- Advising operators on proper lubricants for each piece of equipment. It is important to instruct units to lubricate vehicles immediately after operations. At that time, working parts are warm and enable maximum penetration of lubricants.
- As much as possible, keeping optical instruments from sudden and extreme changes in temperatures.
- Keeping chains, shovels, and sand with all vehicles.
- Keeping batteries warm and fully charged.

Operators perform required maintenance to avoid exceeding maintenance capabilities. In extreme cold, staff balance the consideration to perform on-site field maintenance on disabled equipment against available shelter or the possibility of erecting shelter at the site.

Preventive Maintenance Checks and Services

8-29. Preventive maintenance checks and services (PMCS) take on special importance in arctic operations. Effective PMCS greatly reduces the workload of unit maintenance personnel and ensures operational readiness rates remain high. See Table 8-1 for general techniques for arctic operations to prevent breakage. (Refer to TM 4-33.31 for detailed cold weather maintenance procedures.)

Table 8-1. Techniques to prevent breakage

Focus	*Technique*
Engine	• Operate vehicles periodically to prevent cold-soaking of engines and power trains.
	• Keep machine surfaces clean at all times.
	• Perform as much maintenance as possible to avoid overwhelming the capabilities of supporting units.
Fuel	• Minimize condensation of moisture inside fuel tanks by refilling immediately after stopping.
	• Keep fuel tanks at least one-quarter full.
Batteries	• Keep all types of batteries fully warmed and fully charged.
	• Check to see if batteries are frozen by checking the accessory lights on the dashboard. If they light up, then the battery still has some current and is not frozen.
	• Do not attempt to jumpstart frozen batteries or they will explode. Frozen batteries must be removed and slowly warmed, which can take up to 24 hours.
Interior	• Keep optical instruments from undergoing sudden and extreme changes in temperatures when possible.
	• Realize that windshields crack easily when subjected to sudden blasts of warm air.
Lubrication	• Winterize equipment according to the appropriate equipment lube order and technical manuals.
	• If lubrication is needed, lubricate immediately after operating the vehicle while parts are warm. This ensures maximum penetration of lubricants.
	• Keep stored lubricants warm.
	• Apply lubrication according to the temperature range of the equipment lube order.
	• Complete daily checks to ensure that water or antifreeze is not present in crankcase oil. If detected, determine the cause immediately and change out the oil.
Safety	• Resist the tendency to operate equipment in a closed area to avoid carbon monoxide poisoning.
Wheels	• Realize that links are stiff when cold and should not be forced.
	• Chock wheels instead of setting the hand brake. This prevents the brakes from freezing.
	• Park vehicles on timber, brush, or any other material that will keep tires or tracks from freezing to the ground.
	• Clear ice buildup from all drive line and suspension parts when vehicles are parked.
	• Cap tire stems.

MAINTENANCE PLANNING

8-30. Maintenance becomes increasingly difficult as temperatures drop. PMCS and equipment repair planning become paramount in arctic conditions. Leaders and planners consider man-hour requirements for operators and maintainers to complete all tasks when planning and executing maintenance operations in extreme cold temperatures, periods of heavy snowfall, and extended hours of darkness. At temperatures below -20 °F, maintenance tasks could require up to five times the average completion time. Complete equipment winterization, diligent maintenance programs, and well-trained crews enable effective cold-weather operations. Several factors that affect maintenance directly and require detailed planning include—

- Shelters sized to accommodate vehicles.
- Heaters capable of thawing the equipment.
- Personal protective equipment for personnel who may have to work outside.
- Repair parts availability.
- Storage areas for fluids.
- Snow and ice removal and dump sites.

- Limited recovery vehicles.

8-31. Units will require higher than normal Class IX repair part stockages and an adequate supply of arctic lubricants. Leaders balance additional stockages with mobility considerations, since increased weight will degrade mobility. Units emphasize battle damage assessment and repair (known as BDAR) with forward maintenance contact teams and hold heavier, less mobile stocks at rear echelons. For this reason, units should acquire additional battle damage assessment and repair kits prior to entering the arctic theater.

MAINTENANCE DURING ARCTIC OPERATIONS

8-32. In extremely low temperatures, crews have various maintenance requirements. In defensive operations, maintenance support moves forward with supported units. Field maintenance emphasizes on-site repair by maintenance contact teams. Maintenance contact teams carry light cross-country vehicles and portable heaters. Contact teams also carry survival gear while away from their parent organization. In offensive operations, field maintenance units position in rear areas and primarily rehabilitate damaged equipment. Normally, units exploit recovery and on-site repair by maintenance contact teams to the maximum extent. Drivers periodically operate vehicles to prevent cold soaking of engines and power trains. This requirement makes surprise and concealment extremely difficult. Commanders authorize cannibalization or controlled exchange to reduce evacuated items and to keep the maximum possible number of items operational. Each echelon performs Aviation maintenance. The general support organization provides contact teams for spot repairs in forward areas as necessary. (Refer to TM 4-33.31 for detailed information on cold weather maintenance techniques.)

RECOVERY AND BATTLE DAMAGE ASSESSMENT AND REPAIR OPERATIONS

8-33. Units need to recover damaged or abandoned items of equipment immediately. Prompt action prevents snow from covering items or items becoming inaccessible in muskeg areas after the spring thaw. At a minimum, the operator and one other Soldier/Marine stay with damaged vehicles. The logistics support unit deploys for repair or recovery. If feasible, the unit evacuates the entire crew/squad to assist with repair.

8-34. Unit expect and prepare for more frequent vehicle recovery because of heavy snow, extensive muskeg areas, unpredictable weather, and limited road networks. Leaders increase the amount of recovery equipment on hand. As much as possible, all vehicles have self-recovery or like-recovery equipment such as tow-straps, towbars, and tow-chains. This equipment reduces the demand on dedicated recovery assets. Crews receive extensive training in self-recovery techniques to reduce unnecessary recovery requests.

8-35. When conducting battle damage assessment and repair, the operator carefully writes the initial evaluation of the nature and extent of the damage. When the operator makes a good evaluation, then unit maintenance personnel or supporting units can dispatch the right personnel, the right tools, and repair parts. Operators and maintenance teams need to familiarize themselves with recovery and battle damage assessment and repair techniques discussed in ATP 4-31.

TRANSPORTATION

8-36. Transportation units operate in subzero temperatures in much the same manner as in more temperate zones. However, individuals need additional training in cold weather operations and in the increased maintenance requirements in arctic operations. Units often require additional troop strength and equipment. When units conduct operations over frozen terrain, over-snow and tracked vehicles work best for cross-country movement. When units conduct operations during summer weather, inland waterways are sometimes best for cross-country movements.

8-37. In pre-deployment, planners evaluate the area of operations for potential LOCs. Key features evaluated include rail networks, usable ports, road networks, and pipelines. The lack of infrastructure in the Arctic makes airfields more important, especially in early stages of deployment for the units and initial supplies. Units strictly control movement to prevent congestion and delay on limited road networks. Due to the extended LOCs in which convoys operate, units incorporate a robust air defense plan since the enemy will rely upon air power to disrupt resupply. Due to the slow rate of resupply and the long distances units cover in arctic operations, units may need additional support. The logistics civil augmentation program or host-nation often provide additional transportation support when available. The length of the LOC and the tonnage to move dictates the number of augmentation units needed.

PORTS

8-38. The limited number of facilities reduces the ability to discharge cargo at arctic ports. Some facilities are also limiting in availability and accessibility. Many arctic ports are only available during the months of July, August, and September due to sea ice. Rail and highway networks tend to limit the amount of cargo handled through any port. Where multiple port facilities are operated, personnel and equipment require augmentation. Environmental conditions limit the number of efficient working hours performed by terminal service personnel.

RAIL

8-39. If available, rail transportation facilitates moving large tonnage of cargo and large numbers of personnel over long distances. The heavy snowfall, snow slides, and extreme temperature changes often hamper rail transportation in the Arctic. Trains require additional equipment and operating personnel as snow removal crews. Train weights may be limited due to lightweight rail and low-capacity trestles and bridges. Maintenance and wear on rail equipment increase, requiring more shop-repair personnel. Troops or other people supplement rail track crews and inspect tracks more frequently since slides, glaciation, roadbed disturbances, and rail deficiencies often render the right-of-way impassable.

HIGHWAY

8-40. The restrictive terrain of the Arctic increases the use of highway networks and justifies a requirement for more transportation units. Leaders consider the need for maintenance and recovery points, roadside rest stops, and messing facilities for drivers on long-haul routes. Units apply great effort to clear ice and snow along main and alternate supply routes. Usually, units restrict wheeled vehicles to road movement and not in cross-country operations.

8-41. Vehicles that support small units must be mobile through muskeg, tundra, brush, and light timber and able to break trail in deep snow. With adequate reconnaissance and engineer support, frozen rivers may prove better routes for movement. Units must exercise caution on frozen rivers since surface ice thickness varies with local conditions. (For information on ice reconnaissance, see Appendix C.)

8-42. Military police oversee the regulation and control of highway traffic in arctic operations. These operations require a well written and coordinated plan so units can maximize highway use, particularly during the winter months. Highway regulations address challenges of using arctic roadways. Challenges can include oversized and overweight equipment; convoy clearances; short daylight hours; winding, icy, narrow roadways; longer turnaround times; safety conditions; snowslides; and avalanches. (See discussion on traffic management and enforcement starting in paragraph 3-151.)

AIR TRANSPORTATION

8-43. The Arctic generally lacks adequate road and rail networks and requires more aircraft for troop movements and logistics support missions. Aircraft (rotary and fixed wing) provide a flexible mode of transportation for troop deployment, resupply, and evacuation during arctic operations under both winter and summer conditions. Commanders establish and plan for priorities far before actually using aircraft. These plans address reduced weight limitations and meteorological flying conditions. (For additional considerations during air-land and airdrop operations, see discussion beginning in paragraph 3-188.)

SUPPLY

8-44. Units have special storage procedures to prevent supplies from freezing in the extreme cold. Units stack all supplies stored in the open on pallets or dunnage to keep them from freezing to the ground. Troops locate stacks in areas that minimize the effects of drifting snow. Snow fences can help offset blowing snow. Troops place stacks well upwind and with space allowed for the drift to form. Units plan to remove the drift after the wind event. Units mark supplies subject to drifting snow with poles and small flags since a snowstorm may bury these items in the snow. Troops accurately survey large storage facilities from permanent landmarks so that snowplow blades do not damage materials buried in the snow. Logistics areas require a robust snow and ice clearing (known as SNIC) plan to include snow dumps. Units can use the snow as berms in the defensive plan. During summer seasons, units choose well-drained ground for storage sites. Troops operate materials handling equipment with the same cold weather precautions as other petroleum powered equipment.

8-45. The cold affects the different classes of supply in unique ways that planners consider. This manual describes how units can compensate for the effects of the cold on each class of supply.

CLASS I: SUBSISTENCE

8-46. For subsistence planning considerations, see paragraphs 8-63 through 8-66 for field feeding and paragraphs 8-68 through 8-77 for water production and distribution.

CLASS II: CLOTHING AND ADMINISTRATIVE

8-47. Requirements for clothing, individual equipment, and shelter increase for arctic operations. To the largest extent possible, troops store Class II items at the company and battalion levels. Severe cold requires numerous tents for many purposes, including the warming of personnel, mess activities, maintenance operations, and critical supply storage. Class II items have a high priority for movement since they support the operating force and ensure its survival.

CLASS III: PETROLEUM, OIL, AND LUBRICANTS

8-48. When planning for Class III, leaders focus on the greatly increased POL consumption in arctic winter operations which results from space heating, warmup of equipment, and the greater distances traveled by all elements in dispersed operations. Units and staff maintain a fuel consumption log for each piece of equipment for forecasting purposes.

Fuel

8-49. The consumption of fuel may be so great in arctic operations that supplying a modular brigade can require up to one-half of the total cargo capacity of supporting transportation units. Soldiers and Marines start vehicles frequently to prevent cold soaking of engines and power trains. Since vehicles use lower gears to traverse unimproved roads and snow-covered ground, fuel consumption can increase by as much as 25 percent. Vehicles use large amounts of fuel for heaters to keep personnel and sensitive equipment warm. When troops use fuel for space heating, fuel requirements increase as temperatures drop. To ensure survival of the force, movement of fuel must have a high priority. Units need to maintain fuel reserves at each echelon to guard against interruptions in resupply operations.

8-50. Army fuel handling equipment has been tested to operate down to -25 °F. Troops may need additional precautions to operate below this temperature. Operation under conditions of extreme cold may cause equipment problems due to loss of elastomer flexibility. Nozzle seals and coupling face seals are especially subject to damage. At -25 °F, fuel hoses and collapsible fuel bladders can harden from cold weather exposure and have an increased likelihood of leakage from gasket shrinkage or impingement. Prior to stopping operations for the day, troops drain all water from filter separators until clear fuel discharges from the drain valve. Properly additized fuel allows the water found in the filter separator to remain liquid down below -40 °F. The M978 Fuel Servicing Truck is operational down to -25 °F and has an arctic engine heater kit (national stock number 2990-01-369-1295), which can keep the M978 operational to -50 °F. (See Appendix A for temperature conversions.)

8-51. Troops take precautions to keep snow out of gasoline and fuel oil during decanting and other handling operations. They control hose nozzles at all times to prevent snow from clogging them and cover nozzles with trash bags as a preventive measure. Troops can use small brushes to clean off filler necks of fuel tanks. Wherever possible, units keep vehicle fuel tanks filled to decrease condensation.

8-52. To prevent frostbite, fuel handlers always wear gloves designed for handling petroleum products when working with fuels in extreme cold temperatures. Handlers take extra care to avoid contact with splashes, spills, or leaks under cold temperature operations. Jet fuel requires special attention in freezing conditions. Decreasing temperature also decreases the solubility of water in fuel thereby increasing the likelihood of free water detection failures. After fuel has been given adequate time to settle, petroleum supply specialists must frequently drain excess water from fuel tanks.

Oils and Lubricants

8-53. Special cold weather type oils and greases that remain fluid in extreme cold are required for arctic winter operations. These special oils and greases range from extremely light oil for lubrication of instruments to wheel bearing grease. TM 4-33.31 authorizes and prescribes products for use in wheeled and tracked vehicles that operate in arctic and subarctic climates where temperatures are anticipated to be consistently below 0 °F (-18 °C). Nomenclature and specification numbers are given for each product. TM 4-33.31 also prescribes general instructions that apply to the processing of wheeled and tracked vehicles for arctic winter operations.

8-54. At the approach of winter, units need unusual amounts of specialized lubricants for a complete change of all lubricants, hydraulic, and recoil fluids in equipment, especially artillery equipment. The low viscosity of motor oils used during cold weather results in higher consumption rates because of oil escaping past piston rings and oil seals. Units complete lubrication and oil changes more frequently.

CLASS IV: CONSTRUCTION MATERIALS

8-55. Additional quantities of Class IV are required to construct fighting positions above ground due to the permafrost. Traditional methods of digging and excavating fighting positions may not work if machines cannot excavate frozen soils. In addition, if positions are excavated in frozen soils and then that soil is exposed to heat and/or temperatures above freezing, the remaining frozen moisture in the soil may thaw and then re-freeze as water in the base of the position possibly making it untenable. For this reason, units may need additional Class IV to build walls that engineers usually build from dirt. In some cases, if emplaced properly, units can use compacted snow and ice as both a construction and barrier material under the guidance of a subject matter expert.

CLASS V: AMMUNITION

8-56. Units need to keep ammunition on hand. They may establish pre-designated levels of on-hand quantities and restrict firing when they reach these levels. Like in any operation, units make every effort to keep the basic load on hand to guard against interruption in resupply operations.

8-57. Fires units typically consume large volumes of ammunition and require continuous resupply to support combat. To facilitate this end, units can load ammunition by type on supporting unit vehicles to provide for rapid movement when called forward by the fires unit. However, this method may tie up critically needed transportation assets. Instead, units can tailgate ammunition from support vehicles to unit vehicles at logistics release points. The preferred method of resupply travels by throughput shipments directly from the point of entry into the combat area or the ammunition supply point to the firing battalion.

CLASS VI: PERSONAL DEMAND ITEMS

8-58. Personal items receive the lowest priority of movement while units conduct offensive and defensive combat operations in arctic operations. Extended LOCs, limited transportation assets, and the increased use of supplies limit the availability of Class VI. Leaders can make Class VI available by placing Class VI items with rations whenever possible. However, when the nature of the conflict turns to stability or civil support operations, Class VI supplies take on a much higher priority.

CLASS VII: MAJOR END ITEMS

8-59. The requirement for major end items depends on the intensity and duration of the conflict. Challenging arctic transportation limits Class VII reconstitution. Leaders emphasize maintenance and repair rather than item replacement. Class VII items are intensely managed and controlled through command channels. When they become available, the quartermaster support company in the sustainment brigade or from the strategic level distributes these items to the brigade support battalion distribution company.

CLASS VIII: MEDICAL MATERIEL

8-60. Units give medical supplies a high priority for movement and move them by air whenever possible. Normally, medical items require heated transportation since they are particularly susceptible to damage from freezing. The following items are particularly vulnerable to the cold:

- Oxygen or compressed gas tanks.

- Surgical sinks.
- X-Ray machines.
- Combat lifesaver bag contents.
- Medications, intravenous solutions, and especially whole blood.

CLASS IX: REPAIR PARTS AND COMPONENTS

8-61. Extreme cold, rough unimproved roads, snow, and rugged terrain increase repair parts requirements during arctic operations. Leaders emphasize operator-level maintenance. Units carry and hold parts with high-usage factors as far forward as possible to speed repair of equipment. Whenever possible, unit maintenance leaders adjust shop stock and bench stock before deployment so the unit can carry more high-demand parts. Units deploying from a more temperate environment to the Arctic adjust shop stock and bench stock lists to account for common cold weather repairs as described in TM 4-33.31. Forward elements should limit stocks of major assemblies to reduce weight and increase mobility. Instead, units hold and posture major assemblies at rear echelons for rapid release and movement. Stocks, including spare parts, may be transported on trailers or in containers, which afford good environmental protection.

FIELD SERVICES

8-62. Field services include—

- Field feeding.
- Water production and distribution.
- Shower and laundry.
- Contingency fatality operations.
- Aerial delivery.

Note. For information on the topic of aerial delivery, see discussion beginning in paragraph 3-184.

FIELD FEEDING

8-63. Feeding a force in arctic operations requires sustainment plans to address the extreme cold. Freezing temperatures affect the amounts, types, storage, preparation, and distribution of foods. Units prevent rations from freezing. They provide heated transportation and storage space. Units use intermodal shipping containers to store rations requiring protection from weather but not requiring heated storage. Units storing nonperishable rations without heat closely monitor the temperature to avoid damage by freezing and thawing. Prepared meals are preferred but not always practical for feeding. If units cannot prepare meals, they should still provide a warm shelter in which Soldiers and Marines can eat.

8-64. Units carry a three-day supply of meals in the event resupply efforts falter. Units issue squad and individual heaters with rations so Soldiers and Marines can thaw rations even in the severe cold. Individuals avoid eating frozen food since they burn more energy by trying to digest frozen food than heated food. Personnel can also use these heaters to generate water by melting snow and ice. Soldiers and Marines must boil this water for sanitation. Commanders make every effort to provide at least one hot meal per day. (For information on water considerations, see discussion starting in paragraph 8-71.)

8-65. The caloric requirement in extreme cold is 4,600 calories per day on average for men and 3,150 for women, an average daily energy requirement increase of 25 percent. Supplements exist for operational rations. Operational rations include Meal, Ready-to-Eat (known as MRE); the meal, cold weather; the First Strike Rations® (FSR); and Modular Operational Ration Enhancement (known as MORE). Troops can eat Meals, Ready-to-Eat as the sole ration for up to 21 days. They can eat restricted rations as the sole ration for 10 days before the ration mix must be changed (in accordance with AR 40-25). Restricted rations include the meal, cold weather and the First Strike Ration ®. The Modular Operational Ration Enhancement high altitude/cold weather pack is a supplement. It provides about 1,100 calories of eat-on-the-move items, caffeinated gum, dried fruits, powdered carbohydrate beverages, and energy bars. It provides extra calories beyond the standard operational rations to combat weight loss and decreased physical and cognitive abilities. The Unitized Group Ration series has an arctic supplement available to provide an additional 900 calories.

8-66. The body consumes food to counteract heat loss in cold weather and requires increased calories during outdoor activity. Outdoor activity in extreme cold results in body dehydration. Soldiers/Marines avoid consuming abnormal amounts of thirst-provoking foods, both for comfort and logistics reasons. Hot drinks serve not only to quench thirst and correct fluid deficiency but also to transfer heat physically to the body. In extreme cold, serving ratios of proteins, carbohydrates, and fats are the same as in temperate climates. Fats and carbohydrates are quick energy-producing foods. An ounce of beef fat contains more calories than the same weight in sugar, but normal individuals cannot tolerate an increased intake of fat unless accompanied by a corresponding increase in lean meat.

WATER PRODUCTION AND DISTRIBUTION

8-67. Units consider the following factors for arctic water production and distribution:

- Water production.
- Water storage and distribution.
- Ice as a water source.
- Water quality and surveillance activities

Water Production

8-68. Units require water for consuming and cleaning. In arctic operations, they gather water primarily from under river or lake ice, melting ice, melting snow, and well drilling (semipermanent and permanent camps). Units position sites on a lake as far from the shore as possible within effective camouflage limitations. On the downwind side of the lake, snow accumulates due to drift and ice is thicker, which can complicate operations. Troops cut holes in ice at water points using ice augers, air tools, steam jets, or other such equipment. They can also use shaped charges to access water through thick ice. However, gas-powered tools and explosives create noise and increase enemy detection. In a tactical environment, units drill ice holes using hand augers. Hand tools cut ice best when ice is less than 24 inches thick. Ice usually freezes thinnest where covered by the most snow. Methods used vary with the condition of the ice and with the equipment, personnel, and time available. At low temperatures, troops can prevent ice from forming over a hole by placing a suction strainer about a foot below the surface when pumping. Continual pumping or insulating the surface keeps the hole clear.

8-69. When producing water using the reverse osmosis water purification unit, it may be difficult to find water during the winter. Additionally, extreme temperatures diminish water production and cause stored water to freeze. The optimal temperature for water purification is 77 °F (25 °C). Reverse osmosis water purification unit operators have several methods to keep water temperature as close to the optimal as possible:

- They erect tents over storage bags. This reduces heat loss and neutralizes the windchill factor. By throwing hay on the ground, operators insulate bags from losing heat to the ground. When they distribute the water through hoses, they can encounter other problems. They can circulate heated water through distribution hoses, but severe cold makes this difficult to maintain.
- They take an M1077 flatrack, enclose it with plywood and insulation to minimize heat loss, and place two 500-gallon collapsible water tanks in it. Units chain tanks to the floor with a distribution pump and a commercial heater. Units can easily load and haul the tanks to the field for distribution and then reload them and take them to the nearest potable water source for resupply.

8-70. Because of the normal low turbidity, units can provide safe water by chlorination without pretreatment if they accomplish filtration by means of an improved diatomite or ceramic filter. Solutions to some treatment problems encountered in the Arctic include—

- Heavily chlorinated water. Water in certain areas requires heavy chlorination to obtain a standard residual test of 0.4 parts per million after a 30-minute contact period in active parts of distribution systems at fixed installations, and of 1 part per million after a 10-minute contact period under field conditions.
- Heavy scaling in water systems. Water softeners and controlled acidity are required in most cases to prevent scaling in heating systems and power plant cooling systems.

Water Storage and Distribution

8-71. For small amounts of water, units in the field can store water in 5-gallon cans and insulate them at the unit level if possible. For larger amounts of water, units use immersion-type heaters in a water supply tank or trailer to prevent freezing. This item comes in a modification kit that requires installation prior to entering theater, but it does not prevent dispensing spouts from freezing. For this reason, units keep water supply tanks and trailers inside a tent with a heater. A general purpose small can fit an M149 water trailer, commonly referred to as a "water buffalo."

8-72. Units handle field distribution of water to individuals and small units in several ways. For immediate use, individuals or units fill their containers directly from the source. If they do this, they sterilize the water by boiling it for at least 5 minutes or treating it with individual water purification tablets if not already sterilized. As units pump the water from beneath the ice, they fill unit mobile-storage tanks with water and then dispense it to troops. Individuals may furnish their own cooking and drinking water by melting snow or ice. All field water distribution units have insulation or some form of heating device to keep the water in a liquid state. (To ensure safe and compliant potable water production and distribution in arctic environments, see TB MED 577.)

8-73. Transporting water by truck works well only when the force has an established road network. The best way to transport water in the Arctic involves using tracked vehicles that do not depend on a road for maneuverability. If units use 5-gallon cans to carry water, they fill the cans only three-quarters full to allow agitation of the water during transit. Troops fill 5-gallon cans with the hottest water available and transport cans in a heated vehicle. Troops store cans off the floor in heated shelters as soon as delivered. Sled-mounted 250- to 300-gallon water tanks on which troops have installed immersion-type heaters suffice. (See Appendix A for volume conversions.)

8-74. Individuals keep their water carriers inside their sleeping bags during rest cycles. Insulated water carriers replace the standard 1-quart canteen. Since water freezes from top to bottom, Soldiers/Marines stow their canteens upside-down to prevent the opening from freezing over. Hydration bladders can keep water in a liquid form, but the hose is very susceptible to freezing. Also, the bladder's interior requires frequent maintenance that may not be performed in extreme cold.

Ice as a Water Source

8-75. Melting snow is not recommended for supplying water in quantity except in an emergency. Seventeen cubic inches of loose snow, when melted, yields only one cubic inch of water and consumes a significant amount of fuel to produce. Locally sourced water ideally comes from open leads in lakes and streams. The next option is to use chunks of ice. Either way, troops must purify water before drinking it. If large units use snow as a water source, they can shovel it into any available tank or container and heat by any method available. When units use powdered or loosely packed snow for water, they pack it tightly in the container, tamp it down, and stir it frequently while melting to increase the moisture content and to increase its heat conductivity.

8-76. The procedure for making water for a squad is as follows:

- Gather snow or ice chunks as available. Liquid water from a creek is always the best option.
- Place the two "big pots" from the squad cook sets on the space heater, arctic (SHA) full of snow and ice. Allow this to melt or at least be slushy.
- Transfer these pots to the squad stoves to boil while the two "small pots" are used to achieve the initial melt on the SHA.

Note. The first two initial pots of boiling water are primarily used to sanitize the pots. Troops can use the water for hand washing but not for drinking.

- Keep rotating the pots between the SHA and squad stoves until enough water has been made.

Priority is to provide everyone with a hot drink first, fill personal canteens, and then fill the 5-gallon water can in the ahkio. The can remains in the tent until it is time to pack and move. If possible, this water should be hot to preclude freezing.

SHOWER AND LAUNDRY

8-77. Units establish bath and laundry units adjacent to rivers or lakes to reduce the problem of water freezing between the source of supply and the water heater. This location facilitates the disposal of the wastewater. Since these facilities are not always within reasonable distance of major units, their equipment authorizations should provide them with organic capability for displacement, organization of area, and resupply.

CONTINGENCY FATALITY OPERATIONS

8-78. The theater sustainment command executes fatality management (also known as mortuary affairs) operations through sustainment brigades. Remains do not deteriorate as quickly in extreme cold temperatures, but units evacuate them as soon as practically possible by any means. Troops recover and evacuate remains promptly to prevent snow from covering remains.

DISTRIBUTION

8-79. Unit distribution is the preferred method for all deliveries. The distribution system uses all available means of transport for essential movements. Units can use air delivery for throughput but need to manage it closely because of its high demand in arctic operations. Units consolidate loads for forward movement. Loaded vehicles are routed through to the farthest forward breakdown point. As far as practical, units exchange loaded vehicles and containers for empties at the point of use. Units move empties to the rear by the earliest available transport. Prompt return of empty containers, with particular emphasis on rolling liquid transporters, helps prevent interruption of the distribution operation. When the battle area consists of several areas controlled by independent combat elements operating with little or no mutual support, leaders regard these zones as equally accessible to friendly and enemy elements.

OPERATIONAL CONTRACT SUPPORT

8-80. Units provide operational contract support in the Arctic as in other areas of operation. In addition to standard contracts required of expeditionary operations, operational contract support units anticipate arctic specific requirements to include snow and ice clearing, augmented transportation, and communications support. (For more information on operational contract support, refer to ATP 4-10.)

GENERAL ENGINEERING SUPPORT

8-81. Engineers in arctic operations carry out their normal general engineering missions. Special aspects of general engineering tasks are covered in the UFC 3-130-1. Environmental factors increase the volume, scope, and difficulty of engineer operations. The scarcity of roads increases the need for road construction. At the same time, effects of the extreme climate increase the manpower and equipment effort required for both road construction and maintenance.

8-82. Units can adapt existing engineer organizations for arctic operations. This modification varies much more widely in the Arctic than in other regions depending on the season, the operational theater, and the mission of the supported force. During the planning stages, leaders consider all these factors to determine the proportion of engineers in the task force, the type of equipment needed, and the organization they require.

8-83. Environmental characteristics of arctic operations which complicate engineer tasks are—

- Permafrost.
- Extreme and rapid temperature changes.
- Wind, snow, and ice storms.
- Flooding.
- Alternate thawing and freezing.

8-84. Because of the extreme cold, arctic engineer work must be exceptionally organized. Parties forced to stand about idle in the open rapidly become chilled and lose much of their efficiency. Engineers lay out tasks and have equipment and materials on hand before working parties arrive. Fire-fighting equipment and techniques differ in extreme cold because of the difficulty obtaining and transporting water. Fire prevention measures and inspections are of the utmost importance and must receive constant attention. Water stored for fire-fighting purposes needs calcium chloride added to keep it from freezing. Nonfreezing fire-fighting chemicals are preferred. Units cannot rely on using snow to extinguish fires because troops usually tramp the snow down in a camp and make snow unavailable in sufficient quantities.

8-85. If tents have electric power, air-duct type heaters that rely on small gasoline motors to operate the blowers can be modified to make them safer. Replacing gasoline engines with electric motors makes the heaters more reliable and less of a fire hazard.

SECTION III – FINANCIAL MANAGEMENT

8-86. Units conduct financial management functions and procedures in the same manner as elsewhere but require additional considerations to overcome the challenges of the environment. Limited communications restrict access to automated, cloud-based services traditionally used to process administrative actions. Units come prepared to process hard-copy paperwork. Staffs print standard forms, important rosters, and significant reference material in bulk before deploying. The extreme cold may freeze ink and prevent printing. Staffs keep printers, computers, and other equipment sensitive to the cold in a warm environment. To avoid problems with condensation, staffs avoid exposing electronics to rapid changes in temperature. In some instances, staffs route paperwork to a rear echelon with better connectivity for batch processing to web-based systems and programs. Additionally, staff sections accommodate time zones. Since so many time zones span the Arctic, staff sections maintain a steady battle rhythm to synchronize with higher headquarters and account for degraded communications.

SECTION IV – PERSONNEL SERVICES

8-87. Personnel services include—
- Human resources support.
- Legal support.
- Religious support.
- Band operations.

HUMAN RESOURCES SUPPORT

8-88. Units receive human resource support. These personnel conduct personnel functions and procedures in the Arctic in the same manner as elsewhere, but they account for challenges the environment places on administration. Human resources personnel look for personnel with arctic skill identifiers, additional skill identifiers, or any operational experience in a nonarctic cold weather environment. The latter can include experience at places such as Korea, Poland, Germany, and northern U.S. regions. Arctic skill identifiers include—
- J1, Arctic skills specialist.
- J6, Arctic Soldier.
- E9, Arctic leader.
- E2, Arctic aviator or operator.

8-89. Human resources personnel screen potential personnel's medical records for specific medical conditions before deployment. While these conditions do not necessarily prevent deployment, the following conditions are deemed as a high risk:
- Circulatory diseases affecting the extremities.
- Skin grafts on the face or neck area.
- Chronic inner-ear medical problems.
- Previous cold injuries.

8-90. Human resource elements are not responsible for housing, feeding, training, equipping, or transporting personnel replacements. However, they are responsible for personnel accounting and strength reporting as part of the reception process and for tracking personnel to their destinations. They account for extended replacement timelines associated with properly equipping and indoctrinating replacements for arctic operations. Indoctrination often includes training in areas that parallel the area of operations and include a period of acclimatization before deploying to the combat area. These efforts reduce the chance of these new personnel becoming casualties due to a lack of experience or training.

LEGAL SUPPORT

8-91. No matter the location, units conduct legal services in the same manner. Legal officers account for the challenges the environment places on administration. See paragraph 8-87 for similar administrative constraints.

RELIGIOUS SUPPORT

8-92. Chaplains in arctic operations can perform their duties in subzero temperatures in much the same manner as in any other climate; however, these duties will be affected by the extremes of the environment. Because of the possibility of frostbite, troops exercise caution when conducting services in the open during periods of extreme cold. Chaplains handle metal objects used in the worship service with care. Chalices and cups may freeze to the mouth or hands. Water and sacramental wine may freeze in these objects if they are not already frozen before pouring. If liquid is an integral part of the service, chaplains take actions to keep wine warm enough to be poured.

8-93. Chaplains make every effort to conduct services for small groups in heated shelters. During periods of extreme cold and because of the lack of heated shelter, chaplains may not be able to conduct certain types of services. High winds and cold may eliminate the possibility of setting up an altar with religious adornments, making it necessary to streamline the worship service wherever possible. Chaplains may have to adjust religious garments worn over their field uniforms. Troops should be permitted to wear headgear and other protective clothing throughout the service.

8-94. Religious staff meet challenges with flexibility. Chaplains often have an assigned wheeled vehicle which lacks cross-country mobility. Units should provide an alternate means of transportation, such as a tracked vehicle or helicopter. Also, chaplains may lack adequate space for counseling. Units provide alternate heated space if possible. Lastly, chaplains may find communication difficult with other elements when supported units are operating during adverse weather and at extreme distances. Often, they have to wait until weather or distances improve before communicating.

BAND OPERATIONS

8-95. Army band operations are limited in the Arctic due to the prevalence of extreme cold weather. During freezing temperatures, bands limit conducting performances to heated areas to avoid performance issues, damage to instruments, or bodily injury.

SECTION V – HEALTH SERVICE SUPPORT

8-96. Health service support pertains to the treatment and medical evacuation of patients from the battlefield and the medical logistics in support of them. Health service support includes four of the ten medical functions:

- Medical treatment (organic and area support).
- Hospitalization.
- Medical evacuation (to include medical regulating).
- Medical logistics (to include blood management).

This section provides a brief description of each health service support medical function in support of arctic and extreme cold weather operations. For more information on each medical function, refer to FM 4-02, ATP 4-02.1, ATP4-02.2, ATP 4-02.4, ATP 4-02.6, ATP 4-02.7, ATP 4-02.10, ATP 4-02.13, and ATP 4-02.6.

8-97. While preparing the medical support plan, all medical units consider the tactical commander’s plan. Effective medical units rapidly adjust to changes in the situation and are as mobile as the supported unit. Medical units allow for flexibility due to decreased communications. Commanders place units as far forward as possible to reduce how long patients wait in the cold for evacuation. Units anticipate that not all medical care will be available in extreme cold weather conditions.

8-98. Medical personnel require specialized training for operating in arctic environments. Personnel train prior to deploying to the Arctic or shortly thereafter. Training includes at minimum: cold weather physiology and injuries; personal cold weather care; patient handling, treatment, and transport techniques; and cold weather handling and protection of equipment and materiel.

MEDICAL TREATMENT

8-99. Medical treatment consists of those measures necessary to recover, resuscitate, stabilize, and prepare the casualty for evacuation. It also includes routine sick call and care of minor illness or injury. During winter, medical personnel prepare to treat increased numbers of cold weather nonbattle injuries. This number can drastically increase if a unit is not acclimatized to extreme cold weather and altitude, undernourished, dehydrated, sleep deprived, and improperly clothed. Cold weather nonbattle injuries can include hypothermia, frostbite, nonfreezing cold injuries (chilblains, trench foot), snow blindness (solar keratitis), dehydration, and immersion syndrome. Overdressed troops are also at risk of overheating. Any injury in a cold environment enhances the risk of circulatory shock due to a reduction in blood flow. Other common nonbattle casualties include general and orthopedic trauma, burns, and carbon monoxide exposure. Carbon monoxide exposure and poisoning from indoor heating sources are major concerns. All personnel train on symptoms and treatment of carbon monoxide poisoning. (For more information on CWIs, see Appendix D).

8-100. Units set battalion aid stations and casualty collection points as close to point of injury and, when practical, as close to roads and routes of travel as possible. Casualty treatment areas require heating and insulation both to treat hypothermia and to prevent hypothermia during tactical casualty combat care and advanced trauma care. Medical personnel can treat mild hypothermia and superficial frostbite effectively and return Soldiers/Marines to duty when needed to maximize fighting force. Aid stations use nonexposed-flame-type heaters (such as ducted, forced air heaters) in patient areas where oxygen or anesthetics are used.

8-101. All personnel in combat units require extensive first aid and self-aid training. Due to the limited accessibility of arctic regions, units may be unable to evacuate casualties and must provide immediate life-saving care at their forward position. Prolonged field care will be the primary care option for most casualties. Leaders make allowances for warming casualties at the point of injury or casualty collection point.

8-102. Protecting a casualty receiving first aid is more difficult due to the increased risk of cold injury if medics/corpsmen remove cold-weather clothing. In extreme cold, medics/corpsmen leave the casualty clothed in a shelter. However, bulky cold and wet weather clothing may conceal injuries such as exit wounds, blood loss, and fractures, leading to underestimating patient severity. When in shelter, medics/corpsmen expose, treat, and recover the casualties' wounds. They carefully administer fluids to patients as cold fluids can induce hypothermia, exacerbating the treatment process and timeline. Refer to TC 4-02.1 for a full discussion on cold weather injuries.

HOSPITALIZATION

8-103. Operating in the Arctic has challenges for the Role 3 hospital. Hospital leaders study an OE to apply the hospitalization operational framework that best suits the supported force. Effective hospital units perform definitive treatment if weather conditions make air evacuation to the zone of the interior impossible for an extended period. Treatment should be dictated by severity of injury or disease and oriented towards cure or facilitating evacuation. The hospital unit should not perform unnecessary procedures or care that medical personnel can do at a higher level of care.

8-104. Units may use specific tentage, shelters, and heaters (to include laundry and bath, eating, and sleeping areas) when operating in an extreme cold weather environment. A unit size dictates bed requirements. Hospitals in medium general-purpose tents require liners. Flooring is essential in the Arctic and should be elevated to minimize thawing. However, the use of flooring will increase transportation requirements. Units keep water trailers inside heated areas or use heater units to prevent freezing. When preparing to deploy to an arctic region, units inspect all tents and tent heater systems (especially, component parts) well in advance to include those for laundry, bathing, eating, and sleeping areas.

8-105. Site selection for the Role 3 hospital in an arctic environment includes:

- Select terrain that is relatively flat and near the supported force.
- Avoid areas affected by seasonal changes. For example, ice may hide muskeg or bogland, which becomes unstable for structures and equipment when thawed.
- Consider how ground mobility affects access to the hospital from season to season. For instance, the spring thaw makes large swaths of territory impassible for many ground vehicles.
- Use terrain for cover, concealment, and protection from the wind and blowing snow.

- Use refrigerated and heated storage areas, such as warming tents, vehicles, and containers, for storing liquid medications, packed red blood cells, or fresh whole blood.

MEDICAL EVACUATION

8-106. Medical evacuation timelines in the Arctic take longer than normal. The general nature of the arctic terrain makes surface evacuation of patients difficult in winter and exceptionally challenging in summer. The frozen ground and permafrost form an exceedingly rough roadbed which makes patient evacuation slow. In summer, the ground becomes marshy, streams vary from mere trickles to large torrents, and operating ambulances off the existing road network is often impossible. Landing zones for rotary-wing aircraft are also limited. The lack of adequate road networks and the military necessity of moving supplies over the same route greatly restrict patient evacuation. Windows to conduct medical evacuation operations are limited. Units conduct casualty evacuation whenever possible. Every supply platform, even a snowmobile with a sled that arrives with supplies, should evacuate casualties rather than leave empty. Refer to ATP 4-02.2 for more information on medical evacuation and ATP 4-02.13 for information on casualty evacuation.

8-107. When feasible, the most practical means of patient evacuation is by air. However, air evacuation may be unavailable due to weather and extreme cold temperatures. Deep snow and limited areas for suitable LZs often require hoist operations. Aircraft resupplying a forward unit can also carry patients on the return trip.

8-108. In the deep snows, storms, and bitter cold of winter, prompt evacuation and treatment of casualties is even more essential than in temperate zones. It is extremely difficult to find and evacuate casualties, and early medical aid can be rendered only if trained personnel are immediately available. Medical/casualty evacuation vehicles require heat to enable en route treatment, to provide functioning medical equipment, and to preserve casualty body heat. In cold weather and in high mountains, patients have a higher risk of shock. Preventing casualty hypothermia in an arctic environment starts at the point of injury and requires careful mission planning and asset staging to enable successful patient transfer and evacuation.

8-109. If a unit experiences multiple casualties in a short period, medics and corpsmen can be overwhelmed. Oftentimes, LZs that are under fire prevent or delay casualty evacuation. Arctic environments often exacerbate problems with weather, terrain, high altitude, and frequency modulation radios. Combined with enemy fire, these problems delay even the best-laid plans to evacuate casualties. Such factors increase the need for on-the-spot medical aid.

8-110. Leaders establish procedures for rendering medical aid on patrols, at strong points, and in heated first aid stations (tents or snow caves) near the front lines. If medical personnel are not readily available, troops make arrangements for other personnel to promptly evacuate casualties. Forward elements need more personnel to pull sleds for patient evacuation when operating in deep snow and extreme cold.

8-111. In forward areas under winter conditions, plans for medical evacuation address means for keeping patients warm during evacuation. Special evacuation bags, heating devices, and warmed tracked or untracked vehicles for casualty evacuation are a necessity. (Units can order the hypothermia prevention and management kit: national stock number 6515-01-532-8056.) Medics and corpsmen wrap casualties immediately after or during medical assessment and treatment. Medics and corpsmen wrap casualties in moisture impervious packaging such as the hypothermia prevention and management kit. The preferred method of packaging is one chemical heater below the patient, a wool blanket around the patient, and a second chemical heater above the wool blanket. Medics and corpsmen wrap intravenous fluids inside the packaging on a pressure infuser.

8-112. In muddy seasons, units place facilities for emergency treatment well forward in the combat area to prevent unnecessary losses due to time delays in evacuation. In summer, the evacuation and care of the wounded are hampered by poor road conditions, dust, and insects.

MEDICAL LOGISTICS

8-113. Unit leaders and medical logistics personnel anticipate higher consumption rates for medical supplies, such as lip balm, sunscreen, cough syrup, decongestants, and hypothermia management kits. When building the authorized stockage list, logisticians select solid medications and freeze-dried material instead of liquids to minimize freezing, storing, and handling problems. As with other supply chain items, available stocks in theater may be limited because of the remote nature of the Arctic. Units use climate-controlled areas, such as warming tents, vehicles, and containers, for storing, transporting, and administering liquid medications and blood products. Many medical supplies are susceptible to damage from freezing. Troops pack and mark perishable materials for special handling. Leaders establish and troops follow procedures for special handling requirements for Class VIII material from embarkation to its destination. For additional information on the storage of Class VIII items, refer to ATP 4-02.1 and TC 8-270.

8-114. Medical logistics staff help select the site for medical assets and supply storage, as well as provide requirements for storage and distribution. This includes considerations such as terrain, required space, accessibility, and material handling equipment. Leaders make allowances for storing temperature-sensitive equipment in heated areas. In extreme cold weather temperatures, biomedical equipment and accessories require at least 24 hours to acclimatize prior to operation.

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Chapter 9

Protection/Force Protection

Difficulties are just things to overcome after all.

Ernest Shackleton, Antarctic Explorer

This chapter describes unique arctic considerations for the protection/force protection warfighting function. Section I – Protection/Force Protection Considerations provides overarching effects of the Arctic on the warfighting function. Sections II through VI discuss specific considerations for survivability; chemical, biological, radiological, or nuclear operations; electromagnetic protection; explosive ordnance disposal support; personnel recovery; detainee operations; and force health protection.

SECTION I – PROTECTION / FORCE PROTECTION CONSIDERATIONS

9-1. Protection in arctic operations begins with individual Soldiers and Marines being proficient in common tasks and field craft as a matter of survival in the harsh environment. Protection is then increased as tactical units integrate camouflage, cover, concealment, and electromagnetic protection to make themselves harder to detect, disrupt, and destroy. Commanders and staffs also employ protection capabilities to enable freedom of action and mitigate enemy effects for commanders and units. The fundamentals of protection apply to arctic operations but with some modifications to accommodate the environment. The protection warfighting function primary tasks are: risk management; survivability; air and missile defense support; chemical, biological, radiological, and nuclear (CBRN) operations; electromagnetic protection; area security; operations security; cybersecurity and defense; physical security procedures; antiterrorism measures; explosive ordnance disposal support; personnel recovery; police operations; detention operations; populace and resources control; and force health protection.

Note. Only survivability, CBRN operations, electromagnetic protection, explosive ordnance disposal support, personnel recovery, detention operations, and force health protection are discussed in this chapter. For more on risk management, see discussion beginning with paragraph 4-10. For more on air and missile defense, see discussion beginning with paragraph 7-23. For more on area security, operations security, cybersecurity and defense, physical security procedures, antiterrorism measures, police operations, and populace and resource control, see ADP 3-37.

SECTION II – SURVIVABILITY

9-2. Leaders assess survivability as the ability of a friendly force to withstand enemy effects while remaining mission-capable. It represents the degree to which a formation is hard to destroy. *Survivability* is a quality or capability of military forces which permits them to avoid or withstand hostile actions or environmental conditions while retaining the ability to fulfill their primary mission (ATP 3-37.34/MCTP 3-34C). Survivability operations are those military activities that alter the physical environment to provide or improve cover, camouflage, and concealment (ATP 3-37.34/MCTP 3-34C). Survivability operations enhance the ability to avoid or withstand hostile actions by altering the physical environment. Units accomplish this by providing or improving camouflage, cover, and concealment by constructing fighting positions, constructing protective positions, hardening infrastructure, and employing camouflage and concealment.

SURVIVABILITY POSITIONS

9-3. Troops can construct fighting and protective positions and harden infrastructure on snow and frozen ground using available materials. This can include emplacing protective obstacles with wire, networked munitions, and timber under the special conditions of winter and the preparation of demolition obstacles in the ice of rivers and lakes. They can also use snow and ice as nontraditional materials for survivability positions. Troops can build hastily-made firing positions and trenches in the snow and reinforce them with readily procurable material such as ice, wood, or branches. Adequate protection from small-arms fire requires at least 2 meters (6.5 feet) of solidly packed snow. If possible, troops dig positions into the ground using special tools and explosives while simultaneously building shelters.

9-4. Excavation is difficult in frozen ground. In frozen ground, hand tools are of little use. When properly used, explosives work well but require large quantities. An expedient, although slow, method requires troops to build a fire on the ground and dig out the soil as it thaws. Too much thawing of large areas, however, makes digging difficult unless adequate drainage exists. Gravel is easier to excavate because it does not freeze as solidly as silt or clay and has better drainage. Digging in on the tundra in the summer results in mud pits and should be avoided.

9-5. Areas easily traversed by the enemy or that consist of little snow are weak spots in the defense. Troops reinforce these areas with obstacles such as wire, abatis, minefields, networked munitions, and iced slopes. In forested areas, troops take measures to protect defensive positions against deliberately set forest fires. They build fire breaks in areas littered with dead branches. They can also construct a dam in low ground in front of a defensive position that they can flood.

> ***Note.*** The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines.

9-6. Dummy positions, which are especially effective in winter, can mislead both ground and air observation. Commanders coordinate the defensive plan with road and trail networks. This plan includes roads and trails for movement of reserves, artillery, and supplies. Units take great care to conceal all routes, especially those to positions in forward areas. Seasonal changes will affect defensive positions. The thaw season usually destroys positions built during the winter, especially those built with snow. During the thaw season, low spots fill with water. Troops pay special attention to drainage of trenches and shelters. Positions or obstacles built during the summer may be made useless by heavy snow in the winter.

9-7. Units can erect breastworks of snow and tunnels if possible. Sandbags filled with sand or snow are effective in the silent and speedy construction of defensive positions on frozen ground. Water poured on the bags freezes and improves their protective qualities for the duration of the cold weather. If snow is deep enough, troops build tunnels. These tunnels do not provide effective protection against artillery fire but do afford complete concealment. Snow tunnels must be revetted. Long tunnels need ventilation with shafts. Units use snow walls for cover when the ground is too frozen for trenches. The minimum thicknesses for protection from rifle bullets and shell splinters are given in Table 9-1.

Table 9-1. Breastwork construction

Snow wall material	*Minimum thickness in centimeters*
Newly fallen snow	400
Firmly frozen snow	250 to 310
Packed snow	200
Ice	100
Icecrete	31
Frozen snow water mixture	125 to 155
Note. These materials will disintegrate under sustained fire. (See Appendix A for measurement conversions.)	

9-8. Units have several methods to deter enemy vehicles. Troops can build obstacles from ice and freeze them into place. In forested regions, troops can build them from logs. In early winter, troops can build tank traps in the water by cutting out a section of ice approximately 4 meters wide and floating it under the ice on the downstream side. It leaves a clear water gap. Troops prevent refreezing of the gap by laying a mat across it and insulating it with a snow cover. The snow also provides concealment. This trap is effective but tends to freeze within a short period if not properly insulated. If the ice on the gap is less than 4 cm thick, the trap also serves as an antipersonnel obstacle. By using explosives to break ice, a body of water becomes an effective obstacle. In blasting, troops place an explosive under the ice. Troops cut or use explosives to blow holes in the ice and hold the charges in position under the ice by bridging these holes with poles. (For more information on demolition, see Appendix C. See Appendix A for length conversions.)

9-9. Roadblocks can be created by icing drifts and roads or by using icecrete, timber, and wire cable in conjunction with anti-vehicle mines and barbed wire. A cable block consists of a piece of 1-inch wire cable painted white and stretched diagonally across the road at 60 centimeters above the surface of the ground. (See Appendix A for length conversions.) It works best when placed so that vehicles approach coming from downhill or behind a blind curve. Troops place anti-vehicle mines in a ditch toward which the vehicle is deflected by the diagonal block. Icing the road near the cable increases the effectiveness. This type of block is easy to construct, difficult to detect, and simple to remove for the passage of friendly troops or vehicles. In forested areas, troops can construct an abatis by using fallen trees and barbed wire. Iron pickets work better than wooden pickets in frozen ground. Pickets, however, should be painted white. If deep snow conditions are expected, troops use long pickets. Troops use explosives, power drills, steam jets, and heated iron rods to sink holes. They hang wire at the necessary height in woods and forests by attaching it to trees. The wire is placed close to the ground to prevent tunneling. If time is lacking or there is uncertainty as to the amount of snowfall, the upper strands of wire can be added later. Wire installations require constant maintenance, especially during heavy snowfall. Concertinas are the best wire obstacles for use in deep snow, however, troops must move or replace them when hard packed snow covers them. The small reflective surfaces of the wire are invisible from the air at relatively short lateral and oblique distances.

Note. The U.S. acknowledges the importance of protecting noncombatants while enabling legitimate operational requirements. See the current U.S. land mine policy and consult with a legal advisor for additional employment guidance for scatterable mines, including authorizations for the use of antipersonnel and antivehicle mines.

CAMOUFLAGE AND CONCEALMENT

9-10. Units use special camouflage techniques in the Arctic to prevent enemy observation and targeting, especially during winter months. Camouflage techniques include the correct use of camouflage clothing. Over-white uniforms are critical. Units camouflage shelters, weapons, defensive positions, camps, and bivouacs. They select sites that take advantage of natural camouflage. Camouflage often requires—

- Nets and natural materials.
- Enforced track discipline.
- Control of lights, smoke, and noise.
- Use of specially constructed dummies.
- Decreased thermal infrared signatures.

(For small-unit and individual camouflage techniques in a cold weather environment, see TC 21-3.)

9-11. Leaders and troops plan for all potential natural and enemy threats and hazards, and account for being under constant observation. The lack of natural cover and concealment in many arctic areas may allow for easier detection and observation by enemy forces (particularly UAS).

9-12. Snow exaggerates contrasts and makes camouflage essential. Snow tracks give off a different heat signature than undisturbed snow and can be detected with infrared devices. Long periods of light can also increase the risk of detection. If possible, troops cover tracks that reveal positions. Deceptive track plans are essential. Troops use snow and other natural materials to conceal trenches and foxholes by placing loose snow on the side of the enemy. They slope the snow gently hiding all sharp angles. Leaders choose locations of emplacements and vehicles to take advantage of existing dark patterns. Units build dummy installations profusely.

9-13. Light discipline becomes imperative as light can reflect off snow and can be seen for miles. Lunar, artificial, and low-light conditions limit depth perception and visual acuity, which contribute to accidents. Thermal sights work especially well at night to identify warm troops and equipment against increasingly cold surroundings. To protect against tracking thermal imagery, defensive units use thermal camouflage and offensive units use terrain and inclement weather to conceal their approach. The use of infrared flashlights should be limited. Infrared flashlights, including those used to illuminate night vision goggles, reflect off the snow. The enemy can see the reflection from a great distance with similar night vision capabilities. Units rarely prepare a wooded area by burning because of the created smoke. The enemy can see smoke from a great distance in daylight. Leaders enforce sound discipline when conducting tactical operations in any environment. However, in the cold air, sound carries much farther than in temperate climates. Units keep all sounds to a minimum. Noise caused by motors, troops coughing, and skiers breaking through snow crust may warn the enemy of activity at extreme distances.

9-14. Units operating in arctic operations are especially vulnerable to detection by thermal devices. The environment significantly affects the thermal infrared signatures of targets, enhancing them unless weather conditions are degraded (such as during a snowstorm). High thermal contrasts result when low background temperatures couple with high temperatures produced by internal combustion engines, mechanical friction, and heated areas. In winter, trees usually appear warmer than snow-covered surfaces. This occurs because trees, during the day, absorb much more solar radiation than the surrounding snow. This daytime storage of heat also results in tree trunks and limbs being much warmer than the snow at night. The thermal clutter associated with a wooded area offers significant protection for an individual seeking to hide from infrared surveillance. Units use thermal deception and decoys to confuse enemy surveillance, protect defensive positions, and enable offensive movement. When properly combined with thermal masking and camouflage, thermal deception can improve information advantage.

9-15. Soldiers/Marines are particularly vulnerable to infrared surveillance in winter because of the large difference between body temperature and a cold background. Soldiers/Marines heat their immediate surroundings for comfort or survival. These contrasts increase when background temperatures rapidly decrease because of radiative heat loss. Soldiers/Marines can conceal themselves by constructing a thermal shelter. Anything mechanical (such as a heater or internal combustion engine) also makes Soldiers/Marines susceptible to detection. Camouflage nets can hide tents and heaters from visual detection, but they do little to counteract thermal detection. Snowfall provides the best security from thermal detection. Even light to moderate falling snow can neutralize thermal detection equipment. The obscuring effects of snow, plus the effects of an overcast sky, may significantly reduce the target engagement ranges of infrared sensors. Considering this, snowstorms provide ideal cover to move vehicles and troops or to launch attacks.

9-16. A deep, undisturbed snow cover presents a relatively uniform and clutter-free background to a thermal infrared sensor if the snow is deep enough to completely cover a large area. Snow-covered areas also typically appear as the coldest element in a natural scene. These factors combine to make targets within a snow background more vulnerable to infrared detection. Uncompacted snow emits infrared energy well but conducts heat poorly. At night, undisturbed snow surfaces cool rapidly when cloud cover suddenly decreases. This rapid cooling results since snow cannot conduct heat from the ground rapidly enough to make up for the high radiative losses at the snow surface. Objects in a snowfield contrast with undisturbed snow under such conditions. Patches of ground and objects, such as a log, contrast in the infrared image with the surrounding snow. Such a background creates problems for infrared guided munitions because it generates numerous potential false targets.

SECTION III – CHEMICAL, BIOLOGICAL, RADIOLOGICAL, OR NUCLEAR OPERATIONS

9-17. The principles of CBRN defense in the Arctic are the same as for temperate climates. Commanders adapt these principles to arctic operations, understand the characteristics of the area of operations, and consider the structure and tactics of the operating forces. CBRN represents four unique hazards (chemical, biological, radiological, and nuclear) that react differently at low temperatures. Commanders also consider the unique physical properties of CBRN hazards and the technical properties of CBRN defense materials for operating in the Arctic under CBRN conditions.

9-18. Mitigating CBRN contamination is challenging in the Arctic. Low temperatures make decontaminating personnel more difficult. Wet decontaminants may freeze, so dry decontamination may be required. Immediate decontamination using dry techniques includes removing contamination by vigorous shaking or using brushes or improvised objects such as cloths or shrubbery to remove contamination from surfaces. In a contaminated area, personnel keep clothing completely buttoned to minimize contaminated materials from contacting the skin. Units can minimize cross contamination of contaminated snow into populated areas to include command posts and shelters by establishing stations to remove contamination and monitoring personnel before entry. If practical, units can remove the top layer of contaminated snow within an area to reduce the contamination. (Refer to ATP 3-11.33/MCRP 10-10E.12/NTTP 3-11.26/AFTTP 3-2.60 for contamination mitigation techniques.)

CHEMICAL HAZARDS

9-19. Cold temperatures affect chemical agent behavior. Some agents will have a diminished vapor hazard but persist longer. The diminished vapor hazard may reduce immediate respiratory risk but may also reduce a troop's ability to detect these agents. This may lead to contamination carried unwittingly on clothing or other surfaces. The longer persistence on these surfaces poses an increased contact hazard. CBRN staff study what chemical agents the threat possesses and understand the physical properties of agents to effectively advise the commander. (Refer to TM 3-11.91/MCRP 10-10E.4/NTRP 3-11.32/AFTTP 3-2.55 for more technical information on the impacts of cold weather on chemical hazards.)

9-20. Low temperatures complicate individual protection. Protective masks require winterization and most other protective items must be protected against freezing. In extreme cold, Soldiers/Marines carry their protective masks under their parkas or field jackets to keep them warm. While wearing protective masks, troops use frequent buddy or leader checks to ensure masks do not build up ice, frost, or condensation. When Soldiers/Marines remove masks, they wipe the inside of the mask dry, particularly the area around the outlet valve, to prevent the outlet valve from freezing. The multiple layers of clothing required in cold weather offer good protection against skin absorption of frozen persistent chemical agents. However, there is a danger to personnel wearing contaminated clothing in a heated shelter. Sensors may not detect the chemical threat until heat vaporizes the chemical agent inside the shelter.

9-21. Extreme cold conditions create challenges for detection devices: reagents may freeze and battery life decreases. Units modify SOPs to use detection techniques less affected by weather (such as M8 paper) or periodically moving detectors inside structures. Individual medical chemical defense materiel (such as nerve agent antidote kits) also require protection against freezing. Freezing and thawing do not affect the therapeutic value of atropine, but freezing may rupture the atropine injector. At low temperatures, troops cannot dispense protective ointment from tubes or effectively spread it over the skin.

9-22. Freezing conditions create challenges for decontamination. Leaders consider alternative measures for mitigating risks to exposing personnel to the hazards. (For alternative decontamination materials and methods for contamination mitigation, refer to ATP 3-11.33/MCRP 10-10E.12/NTTP 3-11.26/AFTTP 3-2.60.)

BIOLOGICAL HAZARDS

9-23. Biological hazards, including endemic diseases, can become more persistent and of concern in cold conditions when personnel sleep and congregate in confined, potentially not well-ventilated areas. If there is a contagious biological threat or hazard, leaders may need to consider possible restriction of movement or quarantine.

9-24. Good force health protection measures include personal hygiene practices, and immunizations to defend against diseases. Respiratory protection, including wearing a protective mask, is effective but hard to implement due to the difficulty of identifying biological hazards. Therefore, biological hazards will likely be identified after personnel have been exposed. Good health protection includes a proper diet, rest, avoidance of overexertion, maintaining body temperature, and consumption of at least 2 quarts of water per day. Cold weather hinders proper food, water, rest, and cleanliness at low temperatures, so commanders should emphasize good health practices. Troops suffering from dehydration, or from lack of nourishment or rest, are more vulnerable to biological attack.

RADIOLOGICAL AND NUCLEAR HAZARDS

9-25. Radiation hazards may arise from intentional or accidental release of industrial radioactive material or a nuclear weapon detonation. Aside from the deposition of fallout after a ground burst, weather has no appreciable effect on the location or size of radiological hazards. However, snow or ice cover can delay or prevent the underlying soil from becoming radioactive from neutron capture. CBRN staff and CBRN reconnaissance and surveillance elements can recommend surveying radiologically contaminated areas to limit exposure to levels as low as reasonably achievable. Surveys are normally limited to areas and routes occupied or used. Units can use aerial surveys or unmanned systems to limit exposure to personnel.

9-26. The effect of snow cover and permanently frozen soil on fallout is not completely known. During the winter months in the Arctic, winds at higher altitudes are characterized by high velocities and by rapid changes. Therefore, units in an area of possible fallout should take advantage of the best protection available until the actual fallout pattern on the ground has been determined.

9-27. Units protect themselves from radiation effects with time, distance, and shielding. They minimize time of exposure, maximize the distance between personnel and the radiation source, and place as much shielding material between personnel and source. In the Arctic, troops without specialized equipment are particularly vulnerable to the effects produced by a nuclear detonation. Specialized equipment enables them to dig foxholes and underground fortifications. Shelters offer protection from radiological and nuclear effects. Snow and ice, although not as effective as earth, are readily available and can provide shielding against radiation effects. Hard-packed snow 30 centimeters (12 inches) deep reduces the dose rate by about one half.

9-28. Unfrozen muskeg and tundra provide an average blast-reflecting surface. This surface absorbs some of the shock-wave energy from a nuclear explosion and reduces the distance to which a given over pressure will extend. However, when terrain is frozen or covered with ice or packed snow, this terrain enhances blast effects and increases the distance to which a given over pressure will extend. Units in forested areas are also highly vulnerable to the blast effect from nuclear weapons, turning trees into deadly projectiles. Conversely, newly fallen, loose snow makes a very poor reflecting surface, which decreases blast effects.

9-29. The damage produced by thermal radiation from a nuclear detonation depends on the amount of thermal energy and the susceptibility of the target to damage by thermal energy. Weather conditions affect both variables. Terrain covered with muskeg and tundra, which is wet, is an average reflecting surface and reduces the effectiveness of thermal radiation. Conversely, terrain covered with snow is a good reflecting surface and increases the effectiveness of thermal radiation. At low temperatures, ice fog is more easily generated, which can reduce thermal radiation.

SECTION IV – ELECTROMAGNETIC PROTECTION

9-30. In arctic operations, electromagnetic protection is critical. This involves reducing electromagnetic emissions to avoid detection and jamming. The low temperatures, low visibility, and the lack of ground LOCs in the Arctic impose greater reliance on beyond-line-of-sight communication devices for command and control of ground combat forces. Radio frequency transmissions associated with these command-and-control systems are particularly sensitive to electromagnetic warfare measures. Conversely, the enemy must also rely upon electronic aids. A small electromagnetic warfare unit properly employed can play a decisive role in arctic operations.

SECTION V – EXPLOSIVE ORDNANCE DISPOSAL SUPPORT

9-31. Explosive ordnance disposal operations in an arctic environment are much the same as in more temperate zones. However, the arctic environment presents more planning factors for consideration during each operation. Environmental factors and effects on personnel and equipment increase the difficulty of operations.

9-32. The following environmental considerations adversely affect personnel:

- Extremely low temperatures decrease cognitive thought processing.
- Rapid temperature changes due to donning and doffing personal protective equipment impact personnel.

9-33. The following environmental considerations adversely affect equipment:

- Extreme low temperatures decrease the life of battery-operated equipment.
- Snow and ice reduce manual dexterity and make it more difficult for troops to operate robotic platforms. Snow and ice can also make it more challenging for the robot to operate.

- Extreme low temperatures and permafrost make it more difficult to obtain a safe static electric ground in a high static electric environment.
- Extremely low temperatures impact explosive components used for disruption or disposition.

9-34. Explosive ordnance disposal in an arctic environment poses unique problem sets. When in dry cold temperatures (cold temperature zone 2) and below, nonelectric methods of initiating explosives, such as shock tube shattering, become unreliable and often result in a misfire. Time-fuse calculations can be off by minutes, and there is an increase in misfires as well. Electric demolition procedures that rely on batteries are just as susceptible to the cold. Electric initiation systems are susceptible to static electricity build up in cold dry air. Wires must remain shunted until the last moment. Water-based explosive tools require additional time to build and emplace. Even with additives to lower the freezing point of the water, tools may be at a reduced capability depending on the temperature.

9-35. Many explosives require a warming shelter to keep them malleable. Once in place, initiation systems become more likely to misfire with longer exposure to the elements. Therefore, units should conduct demolition operations as quickly as possible after emplacement. Plans should be in place, and units receive air clearance prior to placing the demolition charge.

SECTION VI – PERSONNEL RECOVERY

9-36. A healthy respect for the arctic and subarctic climates and terrain should be instilled in all personnel. Leaders identify personnel to attend the Isolation Survival (Cold Region) Course or Arctic Survival Training School. Leaders deliberately plan and prepare isolated personnel guidance for every mission. Isolation events are not always related to enemy action. Plans for isolated Soldiers/Marines include individuals having isolated Soldier/Marine guidance and necessary equipment to self-sustain for at least 72 hours. This equipment includes proper clothing, sleeping bags, and rations.

SECTION VII – DETAINEE OPERATIONS

9-37. During winter months, plans to evacuate detainees include their protection from extreme cold, particularly for those captured without sufficient clothing and equipment for survival. Many troops may surrender because of deteriorating morale stemming from ration shortage, sustained exposure to cold, and insufficient protection. Detailed planning and coordination are essential for additional inventories of clothing, rations, and adequate facilities to properly care for and protect detainees from the harsh elements of this operational environment. Prior coordination for detainee back-haul will help ensure the survivability of the detainees so that U.S. forces remain compliant with the standards for humane treatment outlined in the provisions of the Geneva Conventions. See FM 3-63 for more information on detainee operations.

SECTION VIII – FORCE HEALTH PROTECTION

9-38. Force health protection are measures that promote, improve, or conserve the behavioral and physical well-being of Servicemembers that enable a healthy and fit force, prevent injury and illness, and protect the force from health hazards. Force health protection is comprised of preventive and treatment aspects that include five of the ten medical functions:

- Combat and operational stress control.
- Operational public health.
- Dental services.
- Veterinary services.
- Laboratory services.

Note. This manual does not cover dental, veterinary, and laboratory services in detail. Troops can receive satisfactory dental, veterinary, and laboratory services in arctic conditions with modified equipment and materials. Personnel do not require any special qualifications for arctic operations beyond those normally required. Since personnel generally perform these services with bare hands, the most significant consideration for arctic operations is warm clinic shelters. For more information, refer to ATP 4-02.19, ATP 4-02.8, and ATP 4-02.8.

9-39. Paragraphs 9-40 through 9-45 briefly describe each force health protection medical function in support of arctic operations. For more information on each medical function, refer to FM 4-02, ATP 4-02.4, ATP 4-02.5, ATP 4-02.6, ATP 4-02.8, and ATP 4-02.19.

COMBAT AND OPERATIONAL STRESS CONTROL

9-40. Extreme cold and limited hours of light significantly stress individuals. The arctic environment can worsen underlying mental health concerns. Personnel with a history of seasonal affective disorder or other mental health concerns should undergo evaluation before deploying to the Arctic. Behavioral health practitioners conduct preventive training prior to entry into theater, but leaders should also expect increased cases during this time. Leaders must identify such individuals early to prevent mental health concerns.

OPERATIONAL PUBLIC HEALTH SERVICES

9-41. Operational public health is the application of Army public health program concepts and practices during military operations and field training activities. Operational public health aims to provide commanders with healthy and ready forces and to sustain health readiness during military operations. In the operational setting, it is the preservation, maintenance, and restoration of health in Army populations by anticipating, predicting, identifying, surveilling, evaluating, preventing, and controlling disease and nonbattle injuries. (Refer to AR 40-5 for more details on operational public health.) For more information on operational public health, refer to AR 40-5, DA PAM 40-11, ATP 4-02.5, and ATP 4-02.8.

COLD WEATHER INJURIES

9-42. Extreme cold weather imperils the force and can prohibit operations altogether. Units without proper equipment and training quickly become cold weather casualties. For unprepared units, cold weather casualties can outnumber battle casualties. Leaders must take robust protection measures to preserve the effectiveness and survivability of friendly forces from the environment. For more information on CWIs, see Appendix D.

9-43. Preventing a CWI in an Arctic environment starts with proper training, daily checks by leaders, and buddy checks. Leaders can prevent CWIs with training. All personnel receive training in prevention and early identification of CWIs. Soldiers/Marines also train in proper use of clothing and layering principles as dictated by changing weather and current activity or workload. Properly wearing and layering the cold-weather uniform is a simple measure that can prevent numerous CWIs. To further reduce CWIs, leaders implement mandatory daily checks for early identification and treatment of CWIs. To the greatest extent possible, units provide warming tents to provide relief from the cold. Leaders plan frequent rotation of troops into warming tents/areas to reduce the risk of CWIs.

DANGER

CWIs are largely preventable. Failure to train troops for CWI prevention and identification can lead to catastrophically high rates of CWIs or even death.

9-44. All Soldiers and Marines plan for potential isolation. They ensure they carry the isolated Soldier/Marine guidance and a sustainment pack at all times. Arctic conditions make personnel recovery more difficult and emphasize the need for rapid recovery of isolated personnel. Without isolated Soldier/Marine guidance or a sustainment pack for their basic needs, isolated troops can quickly develop a CWI or die from the elements.

ENVIRONMENTAL AND WASTE MANAGEMENT CONSIDERATIONS

9-45. Commanders consider the environment and force health protection during each phase of an operation. Waste management in arctic environments creates unique challenges with limited infrastructure and sustainment operations. Staffs plan extensively to minimize the adverse impact of waste on operational readiness, health of personnel, and the environment. Extreme cold weather increases the potential for degraded materials (metals, rubber, plastics, and other materials). Hence cold weather increases the probability for leaks, hazardous materials spills, and other contamination to the environment. Early planning and coordination help ensure the safe and effective transport of waste throughout the operational area to include the retrograde movement of hazardous and special waste and recoverable items.

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Chapter 10

Training for Arctic Operations

A winter-trained Soldier is also good in the summer, but the reverse is not true.

Arctic Angels Standing Orders

This chapter describes training for arctic operations. Section I – Developing Arctic Training Plans discusses the basic outline for successful arctic training plans. Section II – Other Areas of Training Emphasis explains additional key areas to focus training.

SECTION I – DEVELOPING ARCTIC TRAINING PLANS

10-1. Arctic training requires a well-coordinated program, competent instructors, and knowledgeable administrative staff. Training falls into two categories—winter training and summer training. Because of the special factors introduced by the arctic environment, training differs more widely from that of temperate zones. Leaders carefully select suitable training areas to ensure that Soldiers/Marines can experience all possible conditions of climate and terrain encountered during arctic operations during training. Paragraphs 10-2 through 10-22 talk about the following components of building an arctic training plan:

- Training objective.
- Preliminary training.
- Winter training.
- Summer training.

TRAINING OBJECTIVE

10-2. The training objective aims to train individuals and units to accomplish their combat mission under all conditions of weather, climate, and terrain encountered in arctic operations. Leaders set standards of training high since units will often operate in small groups. Training develops and stresses individual initiative as well as leadership by small unit officers and noncommissioned officers (NCOs).

10-3. Commanders emphasize correct procedures during training to ensure that Soldiers/Marines thoroughly master and correctly apply basic techniques of arctic operations. Even very minor errors must be pointed out, and proper corrective action demanded. If troops receive proper training, they will continue to perform the necessary tasks when confronted with the extreme conditions found in arctic operations. Effective Soldiers, Marines, and DoD Civilians have arctic determination and understand that their job is still "success in combat" and not simply one of survival.

PRELIMINARY TRAINING

10-4. Units selected for deployment to the Arctic complete normal individual and unit training prior to beginning cold weather training. In addition, units conduct preliminary training for—

- Special equipment.
- Instructors.

SPECIAL EQUIPMENT TRAINING

10-5. Units conduct individual training to familiarize troops with special equipment before unit training on arctic operations techniques and tactical principles. Preliminary training on special equipment can occur without snow or cold, which allows time for troops to gain technical and tactical proficiency. Trainers also emphasize training for night operations.

INSTRUCTOR TRAINING

10-6. Units require qualified instructors to prepare a force for arctic operations. The recommended minimum requirements are one officer for each company-sized unit and two NCOs for each platoon or equivalent unit.

Unit instructors must be properly trained and receive practical field experience before the start of arctic operations training. Instructors who are thoroughly experienced in the various techniques specific to arctic operations supervise the train-the-trainer courses. Soldiers can attend the premier train-the-trainer courses at the Northern Warfare Training Center in Fort Wainwright, Alaska. Marines can attend the premier train-the-trainer courses at the Marine Corps Mountain Warfare Training Center in Bridgeport, California.

Guidance For Instructors

10-7. Arctic trainers ensure trainees—

- Avoid fear of the Arctic.
- Train in cold environments.
- Supervise themselves and others.

Avoid Fear of the Arctic

10-8. Most troops have an exaggerated conception of the danger, discomfort, and loneliness of the Arctic. Effective training clearly addresses environmental hazards with respect for their dangers, but Arctic trainers avoid the tendency to overly dramatize them. Arctic trainers ensure that Soldiers/Marines obtain a balanced perspective of arctic operations from the onset. Arctic determination (the will to overcome the challenges of the cold) is a must, and leaders build it through careful training, motivation, and risk mitigation. (For a full description of arctic determination, see the discussion beginning with paragraph 2-113).

Train in Cold Environments

10-9. A principal object of training is to familiarize troops with the cold and living in the field. Arctic trainers develop the training schedule with this goal in mind. As much as possible, instructors require students to complete all work outdoors. To build and maintain acclimatization, Arctic trainers keep training routine and not episodic.

Supervise Themselves and Others

10-10. At the beginning of training, Arctic trainers instruct troops in the buddy system for detecting frostbite. Each Soldier/Marine learns to inspect the face and hands of the buddy periodically. Even with such measures, leaders still need to check troops frequently for frostbite, frozen feet or hands, and overheating, especially during the early stages of training.

10-11. Marches require preparation and certain precautions. Before commencing a march, instructors check to ensure that each Soldier/Marine has mittens, sunglasses or visors, and other essential items of clothing and equipment. Arctic trainers also check all squad equipment, including tents, heaters, and fuel. They ensure that troops are not wearing too much clothing before a march commences. (See Appendix D for information on clothing layer management.) One of the greatest dangers in the Arctic is overheating and perspiring. Wet clothing substantially increases risk for CWIs. Soldiers/Marines make frequent halts of short duration (25 minutes marching and 5-minute breaks) depending on the terrain challenges and conditions of the Soldiers/Marines. Leaders never permit troops to become cold when resting. On strenuous marches or in bad weather, leaders vigilantly watch for signs of exhaustion. When establishing camp, leaders ensure that no Soldier/Marine damp with perspiration or who has wet feet is immediately placed on guard or similar duty before drying off or changing socks.

DANGER

A continual watch must be maintained to ensure that troops do not endanger themselves by fire or expose themselves to carbon monoxide fumes.

WINTER TRAINING

10-12. All leaders in arctic operations have the inherent responsibility to prepare themselves and their troops, both mentally and physically, to operate in the cold weather environment. Units that plan and budget for winter training often find additional advantages, such as a better understanding of the importance of maintaining combat effectiveness, proactive logistic measures, and a better-prepared unit. Winter training aims to train all troops, regardless of job function, in the basic skills required to successfully operate in cold regions. Trainees gain confidence in their cold weather clothing, equipment, and ability to care for themselves in the cold weather environment. Units train to be effective and operate in extreme cold weather, not just to survive. Winter training is critical to ensuring leaders and Soldiers/Marines are trained to fight and win in extreme cold weather conditions.

10-13. Winter training emphasizes developing the following in students:

- Ability to prevent, identify, and treat cold weather injuries.
- Knowledge of the effects of cold on vehicles and weapons.
- Ability to operate and maintain vehicles and weapons in the cold weather.
- Ability to move over snow-covered terrain wearing snowshoes.
- Ability to safely use Army/Marine Corps approved shelters and heaters.
- Ability to survive in temperatures below 10 °F (-12 °C) with only issued cold weather clothing and equipment.
- Ability to apply the risk management process to cold weather training and operations.

10-14. Winter training is classroom and hands-on basic skills instruction that introduces troops to the cold weather environment. The end state is twofold. First, the Soldier/Marine understands the environmental hazards and phenomena. Second, the Soldier/Marine understands their clothing, knows how to properly wear it, knows how to fit it, and can recognize CWIs and act appropriately.

10-15. Table 10-1 provides suggested winter training lessons. They include platform and hands-on classes.

Table 10-1. Suggested lessons for winter training

Task Number	*Task Name*
699-000-8010	Analyze Terrain in Cold Regions
699-000-8011	Analyze Weather in Cold Regions and Mountainous Terrain
699-000-8012	Protect Yourself and Fellow Soldiers in Extreme Cold Weather
699-000-8013	Prevent Cold Weather Injuries
699-000-8016	Evacuate a Hypothermic Casualty
699-000-8017	Manage Risk in Cold Regions Operations
699-000-8018	Plan a Small Unit Movement Over Snow Covered Terrain
699-000-8019	Move Over Snow on Snowshoes
699-000-8020	Employ an Ahkio Group as a Member of a Squad
699-000-8021	Operate a Space Heater, Arctic
699-000-8022*	Employ an Arctic Ten Man Tent as a Member of a Squad
699-000-8023	Operate a Squad Stove
699-000-8034*	Operate a Squad Lantern
699-000-8025	Occupy a Patrol Base in Cold Regions as a Member of a Platoon
699-000-8026	Construct Improvised Shelters in Snow Covered Terrain
699-000-8028	Perform Weapons Maintenance in Extreme Cold Weather
699-000-8029	Employ Individual Camouflage in a Snow Covered Environment
699-000-8030	Engage Targets in a Snow Covered Environment
699-000-8032	Construct a Fighting Position in a Snow Covered Environment
*If a unit does not have equipment assigned, students can train on alternate equipment. For more information on individual tasks, see https://atn.army.mil.	

10-16. Winter training can be done with other training. For example, students can train on weapons maintenance in cold weather as a part of a range; snowshoeing with a land navigation course; and platform classes conducted during leader's time training in the autumn of the year. All students complete winter training first before attempting a cold-weather field training exercise. If students participate in winter training as part of a field training exercise, they should complete winter training during the first four days. Creative scheduling of unit requirements can enhance winter training. The end state is that troops can function in the environment as part of a unit, conducting common skills in a cold weather environment.

10-17. Winter training traditionally has three bivouac lessons. The first bivouac is a heated shelter. This is the tent and heater combination to which the unit is assigned. The purpose is to teach troops how to set up their tent and operate the heater. During training, leaders refine SOPs for fireguards, alert, and security postures. Licensing should also be conducted. The second and third bivouacs are unheated. Unheated bivouacs include—

- A tent assigned to the unit with the heater shut off.
- Any improvised shelter depending on snow availability.
- An open-air bivouac.

Winter training instructors aim to build confidence in their students' ability to take care of themselves without the comfort provided by a heated shelter.

10-18. Winter training traditionally has three over-snow movements. All movements should cover approximately five kilometers. The first movement introduces the snowshoe with a practical exercise covering individual use of snowshoes. The second is a squad-sized movement and the third is a platoon-sized movement. Winter training instructors incorporate other lessons such as Plan a Small Unit Movement Route in Snow Covered Terrain, Individual Movement Techniques, or Battle Drills. The goal is that individuals, teams, squads, and platoons can use their snowshoes effectively in a tactical setting.

10-19. Winter training is traditionally managed at the battalion level. Battalion commanders certify their subordinate companies' training and equipment. There is no limit to time or tasks. Upon completion of winter training, leaders know that tested systems are in place to mitigate risk and allow them to safely and efficiently execute large unit operations in the cold. Commanders can determine if objectives were not met for units or individuals during winter training, and therefore, require additional retraining. Successful commanders exercise patience and accept if their unit requires more training before moving on to more complex and hazardous objectives; this is imperative to mitigating risk. After units complete winter training, they continue with field training exercises, sustainment phase training, and multiple repetitions to refine SOPs and tactics, techniques, and procedures. Leaders use field training to test a unit's ability to operate in the cold to accomplish their mission-essential task list while mitigating CWIs.

10-20. To prepare for winter training, Table 10-2 provides a suggested list of leader professional development subjects. The target audience for this training includes platoon-level leaders and above. Commanders facilitate this training at the battalion level prior to the start of winter training.

Table 10-2. Suggested leader development for winter training

Task Number	***Task Name***
699-000-8000	Manage Physical Readiness Training in Extreme Cold Weather
699-000-8017	Manage Risk in Cold Regions Operations
For more information on individual tasks, see https://atn.army.mil/.	

10-21. Figure 10-1 illustrates a sample winter training program schedule. (Programs of instruction are available on request through the Northern Warfare Training Center.)

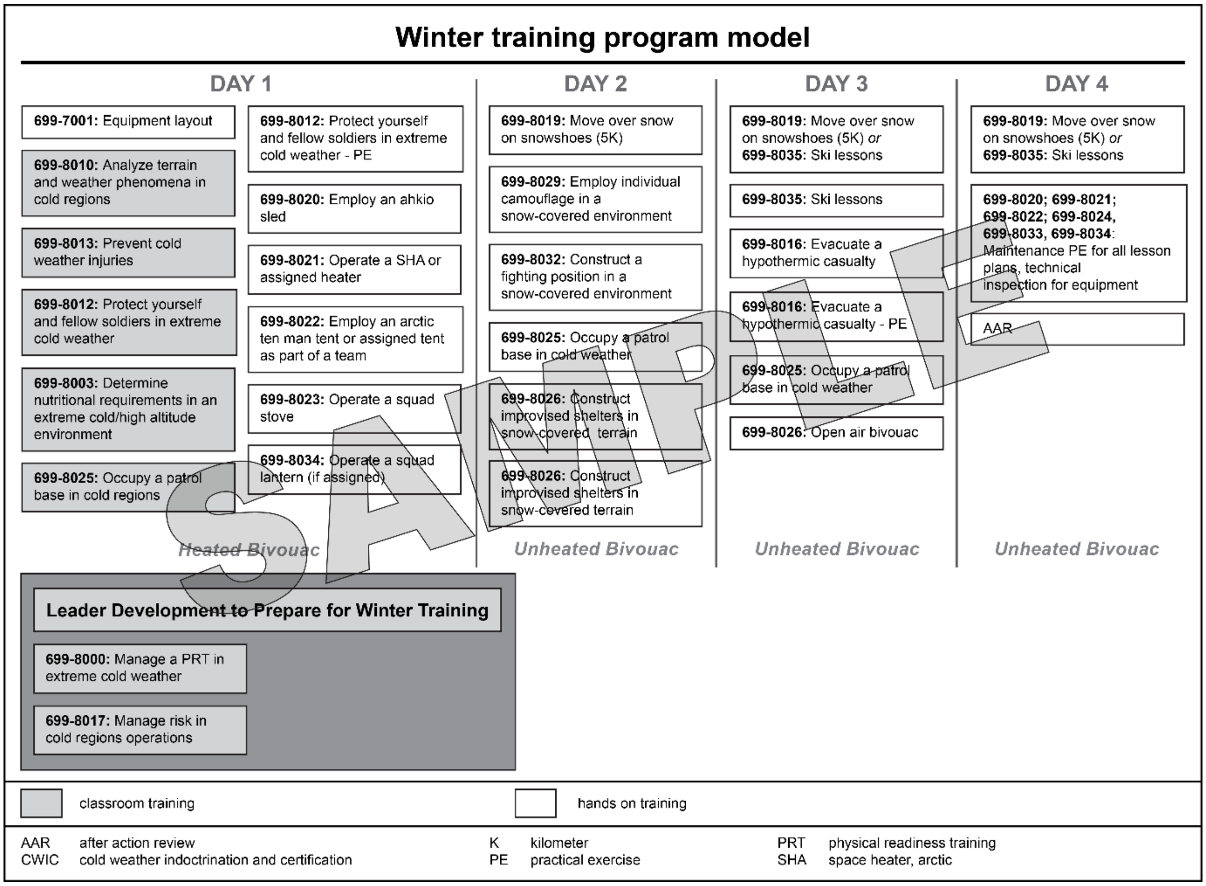

Figure 10-1. Sample of winter training program schedule

SUMMER TRAINING

10-22. From a mobility and sustainment perspective, operating in the summertime can be as problematic as winter, and therefore, requires an equal level of diligence in training. The basic program suggested for winter training is suitable if adjusted by substituting winter-specific activities with those required for summer. This includes training for inland waterway navigation, wet-gap crossing, muskeg, and summer mountaineering. Engineers require additional summer training to address challenges of mobility. Summer training and winter training require the same number of instructors.

SECTION II – OTHER AREAS OF TRAINING EMPHASIS

10-23. When developing an arctic training plan, other areas of emphasis are—

- Physical readiness training.
- Specialized training.
- Officer and NCO training.

PHYSICAL READINESS TRAINING

10-24. Physical readiness training (PRT) for arctic operations demands higher standards of fitness. Arctic trainers conduct as much training as possible outdoors. Over-snow movement with snowshoes, cross-country skiing, and ahkio sled drags are key components of winter PRT events, especially for designated ski mobility units. Troops maintain regular fitness training to sustain the strong hip flexor and lateral stability necessary to maneuver on snowshoes and skis while carrying a load. These activities put troops outdoors during the winter months for PRT, teach them to deal with the cold, and trust their cold weather clothing and equipment.

10-25. Units ensure appropriate risk mitigation controls are in place to mitigate CWIs during PRT. Figure 10-2 displays sample risk mitigation controls and uniform guidelines for PRT based on temperature. (See Appendix A for temperature conversions.)

Temperature °F (including windchill)	Army APFU shirt and shorts with running shoes	APFU jacket and pants	Issued gloves, fleece cap or balaclava	Trigger finger mittens, balaclava, and wool socks (ECWCS Level 1 bottom	ECWCS Level 1 top and bottom, trigger finger gloves, balaclava, wool socks, (with arctic mittens carried)	Arctic field uniform (ECWCS Level 1 & 5, balaclava, trigger finger mittens, arctic mittens, ECWCS Levels 2 & 3 as required)
40 to 33	X	X				
32 to 10	X	X	X			
10 to -10	X	X		X		
-10 to -25	X	X			X	
Below -25					X	X

Temperature ºF (including windchill)	PRT outdoors as normal	Preparation and recovery drills indoors (optional)	Preparation and recovery drills indoors (mandatory)	Units spend no more than four minutes outdoors before or after PRT
Above 10	X			
10 to -10	X	X		
-10 to -25			X	
Below -25				X

APFU Army physical fitness uniform
ECWCS Extended Cold Weather Clothing System
F Fahrenheit
PRT physical readiness training

Figure 10-2. Sample physical readiness training risk mitigation controls based on temperature

Note. Figure 10-2 is a sample to be used with a DD Form 2977. Commanders determine appropriate risk.

SPECIALIZED TRAINING

10-26. Many common, yet essential, tasks require modifications to adapt to arctic operations. Effective units conduct specialized training to prepare their unit for such changes. Tasks that require specialized training include—

- Driving and maintenance.
- Communications.
- Navigation.
- CBRN training.
- Military occupational specialty (known as MOS) specialized training.

Units unfamiliar with arctic operations are prone to overlook specialized training.

DRIVING AND MAINTENANCE

10-27. Units maintain the highest standards of driving and maintenance. To overcome obstacles encountered during winter operations, officers and NCOs closely supervise to ensure that troops maintain these standards. Troops receive special training in the use of winterized equipment, engine heaters, and other special devices;

care of batteries; and treatment of fuel to avoid condensation. (Refer to TM 4-33.31 for cold weather maintenance operations.) Crews must also be proficient in tire chain installation and removal, as well as driving techniques with snow chains. Crews ensure chains are snug or tight at all locations on the tire and are clear of the vehicle wheel well and all other vehicle components. This should be treated as a crew drill, as any unnecessary delays in snow chain installation and removal will postpone movement for the entire convoy. For experienced users, chain installation takes around 20 minutes. If troops are unfamiliar with the chains, this timespan can quickly multiply. Extensive practice in driving under the more difficult conditions of terrain, snow, and ice, as well as in recovery of vehicles, is essential. Drivers train to make on-the-spot emergency repairs and in the use of field expedients. Drivers require additional training and certification to operate and maintain over-the-snow vehicles such as snow machines and CATVs.

10-28. The conditions of arctic operations cause a high rate of damage to all equipment. Unit mechanics will require training to work under these conditions. Units provide either a higher proportion of mechanics than normal, or selected enlisted personnel attend special courses in field equipment repair. Units also train individuals to make minor repairs to the special items of equipment (sleds, skis, and snowshoes) issued for these areas.

COMMUNICATIONS

10-29. Communications challenges are responsible for a significant number of problems in arctic operations. Commanders should be aware of the environmental factors that affect communications and the necessary measures to overcome them. All communications personnel must learn the special techniques necessary to prepare and maintain their equipment and communications systems at operational efficiency under all conditions. Trainers refer to paragraphs 4-21 through 4-73 for training topics related to communications in the Arctic.

NAVIGATION

10-30. Troops must be proficient in dead-reckoning navigation. They thoroughly understand how to use a magnetic compass in the Arctic since it is the most common navigation instrument used by the individual and small unit. Units stand ready to use analog map products for everything from navigation to fires plotting. In certain regions and for certain types of operations, the force may require personnel trained in celestial navigation/astronavigation (navigation by the stars). Commanders enforce cell phone discipline and prevent troops from routinely using them to navigate. Electronic signals from cell phones in the vast arctic wilderness quickly betray unit locations.

CHEMICAL, BIOLOGICAL, RADIOLOGICAL, OR NUCLEAR TRAINING

10-31. Training under CBRN conditions is best accomplished by integrating CBRN threats and hazards into unit training. Since CBRN protection procedures vary in extreme cold from those used in temperate climates, individuals must adapt assessment, protection, first aid, decontamination, and other CBRN defense techniques.

MILITARY OCCUPATIONAL SPECIALTY SPECIALIZED TRAINING

10-32. Above and beyond winter training, commanders give attention to specialized training for a Soldier or Marine of a military occupational specialty to adapt and operate in the Arctic. Winter training allows units to survive in the Arctic, but specialized training allows them to operate and accomplish their mission. Effective units train to overcome mission specific challenges caused by the Arctic. These challenges include reduced mobility, bulky clothing, and equipment malfunctions. Such challenges affect each military occupational specialty differently. Units also learn special techniques. For example, engineers train to use snow for obstacles, and aviators train to use landing skis.

OFFICER AND NONCOMMISSIONED OFFICER TRAINING

10-33. Leader development programs should be conducted regularly to reinforce—

- Arctic leadership.
- Mission command and analog products.
- Weather and terrain analysis.
- Understanding of the arctic environment.

- Ice capacity.

ARCTIC LEADERSHIP

10-34. Arctic operations demand far higher qualities of leadership from officers and NCOs than those normally required. Besides overcoming fear of the Arctic, leaders embrace their responsibility to demonstrate arctic determination and instill it in others. Leaders learn how to reduce risk and address additional safety considerations of the Arctic. For instance, units require leaders at all echelons to make frequent checks to prevent CWIs and maintain force strength. Leaders understand the potentially severe impacts of the arctic environment on personnel, both physically and mentally. See paragraphs 2-120 through 2-121 and paragraphs 4-3 and 4-7 for training topics on leadership. See Appendix D for training topics on CWI prevention.

MISSION COMMAND AND ANALOG PRODUCTS

10-35. Command and control is challenging in arctic operations. Effective units identify friction points and train to accomplish their mission despite them. Arctic leader development reinforces subordinate disciplined initiative and mission command. Leaders exercise the use of analog products and train in their use extensively to overcome problems with communications. Trainers reference Chapter 4 for training topics related to mission command and information systems.

WEATHER AND TERRAIN ANALYSIS

10-36. Officers must be able to interpret meteorological reports and terrain analysis since weather and terrain will be a major influence in the planning and execution of operations. Leaders at all levels must understand the tactical significance of weather and terrain unique to the Arctic. Commanders expose their subordinate leaders to the rigors of arctic operations so they appreciate the challenges troops at the front face. This improves staff estimates and overall judgment.

UNDERSTANDING OF THE ARCTIC ENVIRONMENT

10-37. Commanders and leaders at all levels acknowledge the importance of the Arctic, the importance of their mission, and the importance of realistic challenging training. Leaders continually study the OE and understand the dynamics of the operational variables. (See Chapters 1 and 2 for more information on the arctic OE.) Effective leaders study historical examples from arctic and extreme cold weather battles to better understand arctic operations and learn from the past. Examples include—

- The Battle of the Chosin (Changin) Reservoir, 1950.
- The Battle of Attu, 1943.
- The Lapland War, 1944 to 1945.
- The Continuation War, 1941 to 1944.
- The Winter War, 1939 to 1940.
- The Allied Siberian Intervention, 1918 to 1920.
- The Italian Front, 1915 to 1918.
- The French invasion of Russia, 1812.
- The Great Northern War, 1700 to 1721.
- The Carolean Death March, 1718 to 1719.

ICE AND SNOW PROPERTIES

10-38. Each officer and NCO research ice and snow properties. They study the various factors affecting the strength of ice and the rules or calculations necessary for determining its bearing capacity. Ice assessed as safe affords numerous avenues of approach for movement by mounted and dismounted formations. Officers and NCOs analyze METT-TC (I)/ METT-T to determine when to employ ice avenues of approach versus cross-country navigation. Trainers refer to Appendix C for training topics related to ice. Officers and NCOs also study the various factors affecting the trafficability of snow, the effects of various types of snow on vehicles, and the utility or nonutility of snow as shelter, cover, or for other military purposes. Trainers refer to Appendix B for training topics related to over-snow mobility.

Appendix A
Unit of Measure

This appendix provides conversion charts for units of measurement.

A-1. Table A-1 and Table A-2 display conversions for the metric system, temperature, and angles.

Table A-1. Metric conversion chart

U.S. Units	*Multiplied By*	*Equals Metric Units*	*Metric Units*	*Multiplied By*	*Equals U.S. Units*
			Length		
Inches	2.5400	Centimeters	Centimeters	0.39370	Inches
Inches	25.4001	Millimeters	Millimeters	0.03937	Inches
Feet	0.3048	Meters	Meters	3.28080	Feet
Feet per second	0.3050	Meter per second	Meter per second	3.28100	Feet per second
Miles	1.6093	Kilometers	Kilometers	0.62140	Miles
			Area		
Pounds per square inch	0.0700	Kilogram per square centimeter	Kilogram per square centimeter	14.22300	Pounds per square inch
Square inches	6.4516	Square centimeter	Square centimeter	0.15500	Square inches
Square feet	0.0929	Square meter	Square meter	10.76400	Square feet
Cubic feet	0.0283	Cubic meter	Cubic meter	35.31440	Cubic feet
Cubic inches	16.3900	Cubic centimeters	Cubic centimeters	0.06102	Cubic inches
			Volume		
Gallons	3.7854	Liters	Liters	0.26420	Gallons
			Mass (Weight)		
Pounds	0.4536	Kilograms	Kilograms	2.20460	Pounds

Table A-2. Temperature and angle conversion chart

Units	*Multiplied By*	*Equals*	*Units*	*Multiplied By*	*Equals*
			Temperature		
Degrees Fahrenheit (Subtract 32 then multiply)	0.5556	Degrees Celsius	Degrees Celsius (Add 17.8 then multiply)	1.8000	Degrees Fahrenheit
			Angle		
Degrees (angle)	17.7778	Mils	Mils	0.0562	Degrees (angular)

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Appendix B
Mobility Considerations

Mobility challenges are often overlooked or underestimated in arctic operations. Although extreme cold temperatures are the most notable feature of the Arctic, mobility considerations can have an equal, if not more, impact on success. This appendix provides an in-depth description of movement methods and mobility considerations in arctic operations.

SECTION I – MOVEMENT

B-1. Movement in the Arctic requires specialized equipment to maximize unit mobility and tempo. All motorized transportation has limitations. Individual movement techniques are the most reliable form of transportation in arctic operations. Leaders at all levels adjust plans to accommodate slower moving speeds. (For specifics on how to execute individual movement techniques in a cold weather environment, refer to TC 21-3.)

MOTORIZED MOVEMENT

B-2. Primary means of motorized movement include—

- Helicopter.
- Wheeled vehicles.
- CATV or SUSV.
- Snow machine.

HELICOPTER

B-3. The helicopter works expeditiously to move troops in arctic operations and bypass difficult terrain. However, air mobility has its limitations. Extreme weather patterns can greatly reduce flight time. Aircraft also suffer from periods of reduced visibility due to the lack of daylight and blizzard conditions. Altitude also lessens the capability of helicopters. Troop compartments in aircraft should be kept cool to prevent Soldiers/Marines dressed for cold weather operations from sweating profusely during air movements. Pilots equip helicopters with aviation skis during all seasons to enable landing on snow and muskeg. Figure B-1 depicts a helicopter equipped with landing skis.

Figure B-1. Aviation skis

WHEELED VEHICLES

B-4. Wheeled vehicles have drawbacks due to maintenance and their severe inability to move off-road. Arctic regions generally have very limited road networks. For example, in Alaska there are approximately 14,000 miles of roads. Of these roads, 2,500 miles are paved and, in the winter, only about 60 percent of them are passable. Smaller trails, sometimes no wider than a single lane, are quite prevalent and may become decisive to an operation.

COLD WEATHER ALL-TERRAIN VEHICLE AND SMALL UNIT SUPPORT VEHICLE

B-5. The CATV and SUSV are tracked vehicles that can travel through complex terrains including snow, ice, rock, sand, mud, and mountain environments. Their amphibious capabilities allow them to move through flooded areas, swamps, and bogs. They can move 180 miles on a full tank of fuel. CATVs and SUSVs can each carry up to 13 Soldiers/Marines depending on the front compartment configuration. Available variants of the CATV include general purpose and cargo. Units can change the CATV general purpose (see Figure B-2) into troop carrier, command and control, and casualty evacuation configurations by installing mission kits. The CATV cargo variant rear car has a cargo capacity of 10,000 pounds. The SUSV comes in personnel and cargo variants. The CATV or SUSV can also skijor up to 30 personnel depending on the length of rope in use.

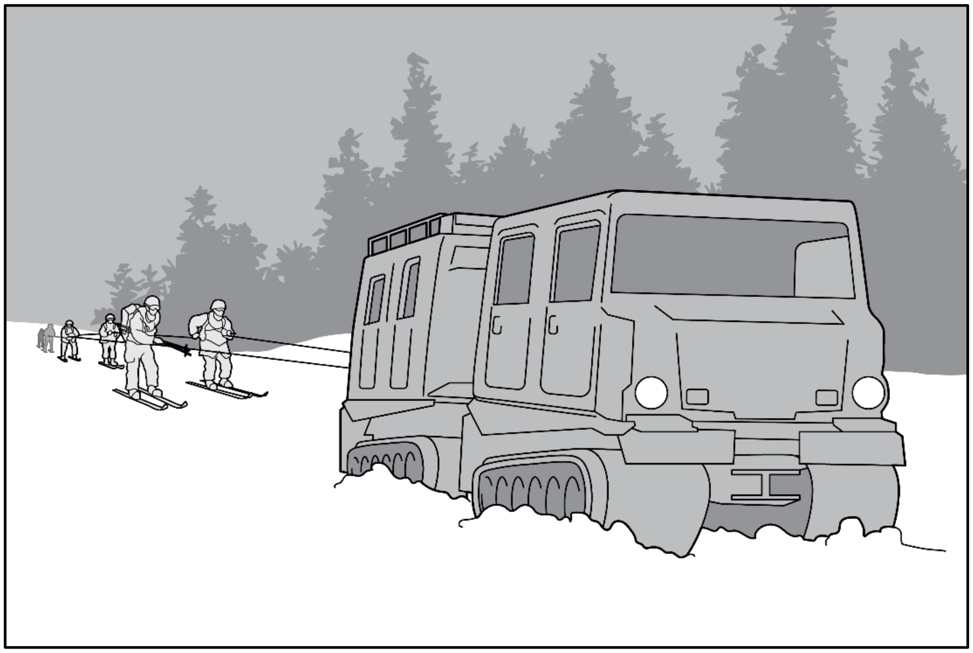


Figure B-2. Cold weather all-terrain vehicle

SNOW MACHINE

B-6. The snow machine (also known as a snowmobile) is a form of winter transportation that can travel over almost any type of snow-covered or frozen terrain. The drawback to a snow machine is the number of personnel it can carry and their exposure to the elements. It is best suited to scout units and light resupply operations. It can skijor up to 3 personnel. The snow machine has an operating radius of approximately 100 miles. Troops can increase that radius by carrying additional fuel cans in a pulled sled.

INDIVIDUAL MOVEMENT

B-7. Means of individual movement include—

- Snowshoes.
- Skis.
- Skijor.
- Cargo sled.

SNOWSHOES

B-8. Snowshoes (see Figure B-3), though slower than skis, require less training. Troops in good physical condition can develop adequate proficiency in a few hours. Snowshoe movement is more practical in confined areas, such as assembly areas, dense forests, field trains, and mortar or artillery positions.

B-9. When walking on snowshoes, individuals pick their feet up and walk with their legs farther apart than normal due to the width of the snowshoe. Because of their size, snowshoes are easier to maneuver through heavy brush. Their ease of use also makes them better suited for rough terrain. Troops leave tails/extensions attached to the snowshoes to maximize surface area for flotation. Leaders consider snowshoeing a minimum skill that all infantry Soldiers/Marines in the unit must possess.

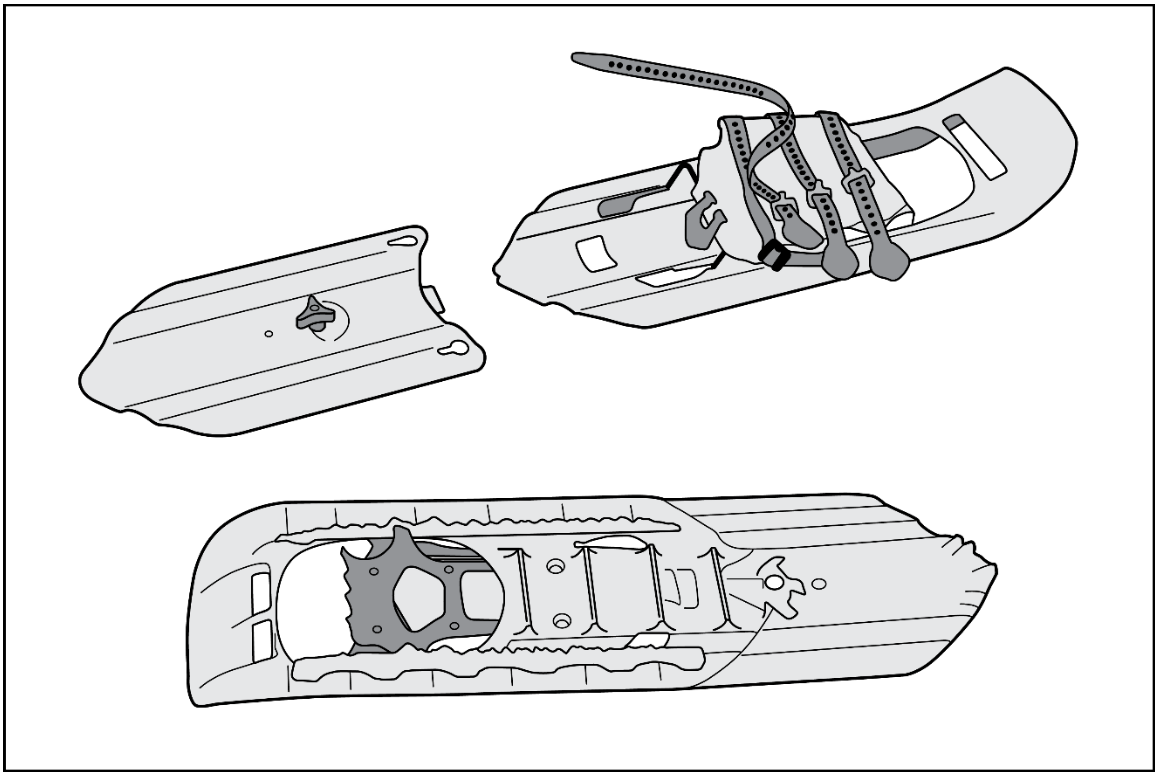


Figure B-3. Snowshoes

SKIS

B-10. Skis provide greater speed, especially over prepared trails, and usually require less physical effort. Snow conditions, such as depth and if a broken trail, affect this speed. Skiing is harder to learn than snowshoeing but requires less work when mastered. Individuals do not pick their feet up or walk with their legs farther apart than normal. Even on flat or moderate uphill sections, a properly trained skier can glide. Downhill skiing requires very little physical work, but the Soldier/Marine has to watch for hazards, especially when pulling, towing, or packing heavy loads. Ski training is very time intensive, and some Soldiers/Marines need significantly more time and effort than others to master this skill. Once mastered, Soldiers/Marines train regularly to maintain the strength and fitness to ski with weight efficiently.

B-11. Table B-1 shows the considerations of when to use skis versus snowshoes.

Table B-1. When to use skis or snowshoes

Use Skis When …	*Use Snowshoes When …*
• Speed is essential. • Traveling long distance. • Stealth is necessary. • Conditions are favorable.	• Moving through heavy brush. • Speed is not essential. • Troops are inexperienced on skis.

SKIJOR

B-12. Skijoring is a method of pulling individuals on skis with a snow machine, CATV, or SUSV (see Figure B-2 on page 195 for an illustration of skijoring). It is a form of individual movement assisted by motorized assets. Skijoring works effectively for rapid cross-country movement where trafficability permits. Troops moving by this means arrive at their destination less fatigued and in better condition to conduct effective operations. It takes little energy to hold onto a rope and be pulled along. Skijoring by CATV or SUSV can move up to 30 Soldiers/Marines at a time.

CAUTION

Ensure all skijoring troops cover all skin to prevent frostbite caused by additional windchill.

B-13. Skijoring requires ski proficiency beyond the fundamentals. Troops must be sufficiently trained in skiing before they attempt skijoring. When planning training events, leaders use written risk assessments to assess skijoring hazards.

CARGO SLEDS

B-14. Cargo sleds are pulled sleds used to transport equipment. Military units most often use the ahkio sled. (See Figure B-4 for an illustration of an ahkio sled.) These sleds can carry 200 pounds (90 kilograms) over difficult terrain to include carrying tents, heaters, fuel, rations, and other necessary items of each tent group. Troops use the ahkio to carry weapons and ammunition. Troops can also use them as firing platforms for machine guns in deep snow and to evacuate casualties. Without ahkios, equipment loads may encumber troops moving through snow.

B-15. Pulling an ahkio is difficult and conducted with rotating teams. It is easiest to pull an ahkio with snowshoes. However, if using skis, Soldiers/Marines wax the bottom runners to provide more grip than glide on the snow. Troops also use climbing skins that attach to the undersides of skis to provide traction. During early winter when little snow lays on the ground, cargo sleds catch on exposed logs and brush and drastically slow movement. Commanders decide when it is best to use cargo sleds and when to leave them behind.

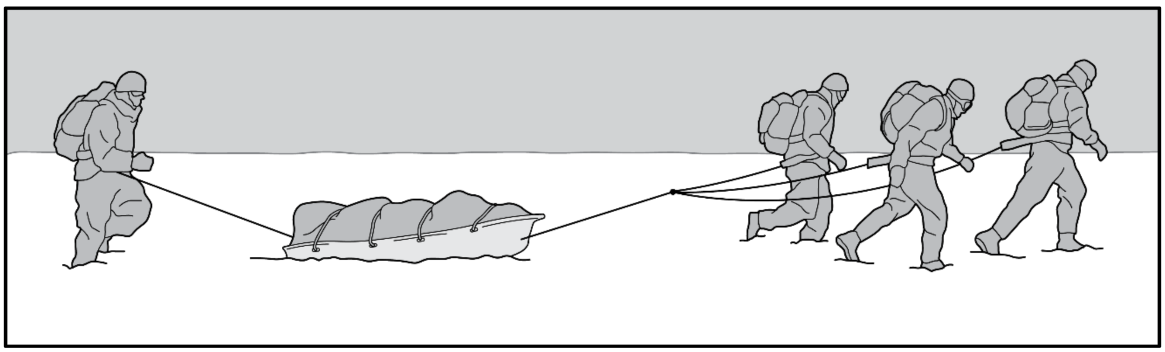


Figure B-4. Ahkio sled

SECTION II – MOBILITY

B-16. Mobility in the Arctic relies on strong roadways and cooperative weather. Inadequate transportation networks affect mobility. During the winter, low temperatures, snow and ice, and difficulties of constructing roads and trails hinder movement. During the breakup season, ice is weakened on lakes and streams, and existing roads become almost impassable. Extensive overland movement drastically slows during the summer because the underlying permafrost prevents effective drainage and extensive swampy areas result. Rotary-wing aircraft equipped with conventional landing gear, skis, amphibious landing gear, or flotation kits can effectively move units in the undeveloped regions of the Arctic.

SEASONAL EFFECTS ON MOBILITY

B-17. Seasons drastically change the arctic terrain and affect mobility. Winter terrain conditions involve snow, ice, freezing or thawing ground, and layered combinations of these conditions. While winter weather conditions hinder maneuvering, the cold temperatures can result in solid and strong soil or ice capable of supporting vehicle traffic in areas not trafficable in summer. In addition, adverse mobility conditions often occur during spring and fall when thaw progression and freezing and thawing cycles can saturate soils with low weight-bearing capacity. Figure B-5 and the following subsections detail mobility considerations by season.

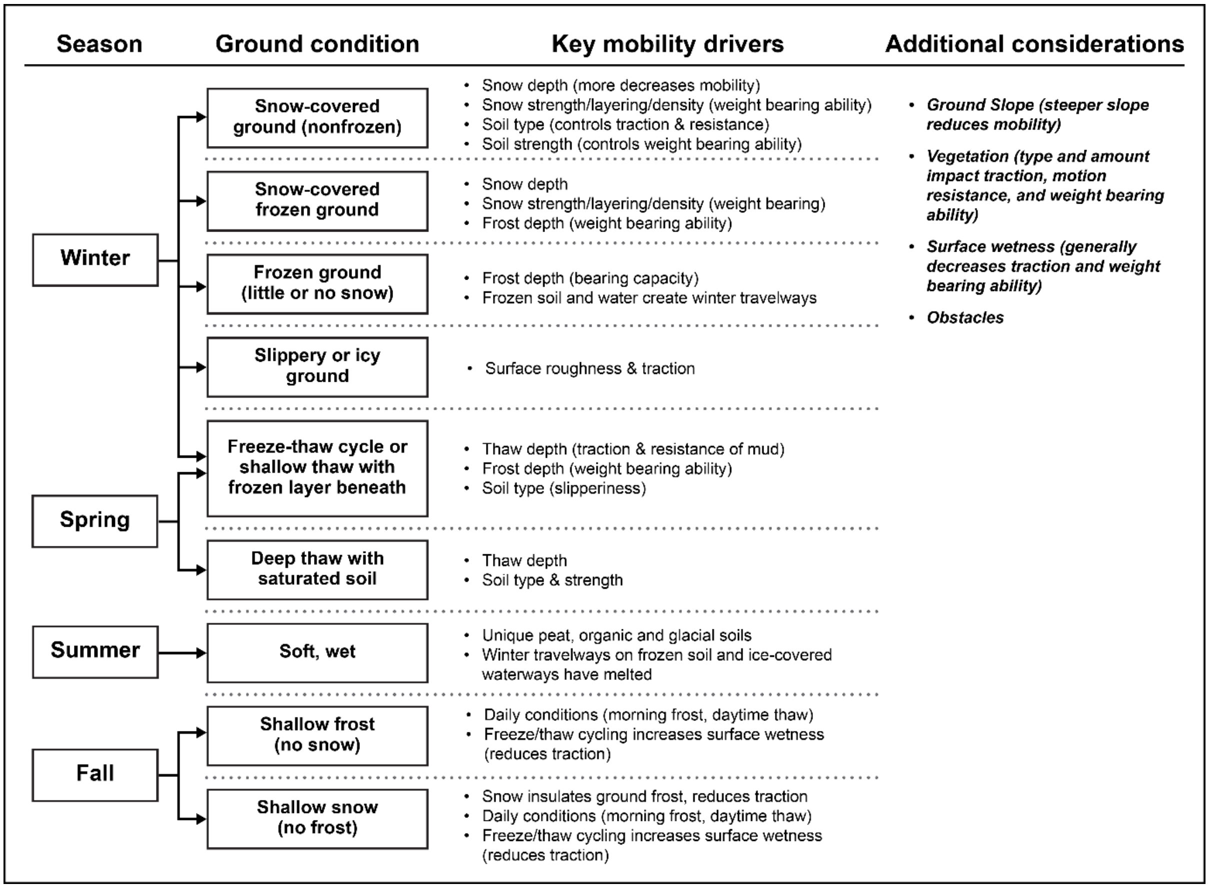


Figure B-5. Seasonal considerations for vehicle mobility for cold regions

WINTER MOBILITY

B-18. Snow hampers the mobility of ground troops. Heavy snow cover by itself impedes movement cross-country and on roads. Snow cover hides many terrain features and obstacles such as stumps, rocks, ditches, small streams, fallen trees, and minefields, and other man-made obstacles. A vehicle may break through a hard ice layer on top of a loose low-density snow and sink in, resulting in high-motion resistance as the vehicle continuously breaks through the ice layer as it travels forward. Conversely, a vehicle may easily travel through loose snow on top of a solid layer near to the ground underneath, or a lightweight vehicle may drive on top of an ice layer without breaking it. Snow cover can also positively impact speed by making rough ground smoother thus reducing surface roughness or obstacle height, especially for small robotic vehicles. Snow cover acts as a thermal insulator, which slows the freezing or thawing of underlying ground. When snow melts, it saturates the ground and often makes it impassable. Snow or ice on roads can make driving difficult and dangerous. On roads and airfields, snow increases maintenance requirements since it requires removal or compaction. Leaders deliberately plan for and maintain snow removal or compaction. Vehicles typically get better traction on compacted snow during extremely cold weather.

B-19. Frozen ground can create an extremely strong layer and provide maneuver corridors during winter that do not exist during summer. Weak and wet soils are significantly stronger when frozen. While frost can provide support for vehicle traffic, frozen ground may also be slippery from ice, recent precipitation, the soil type, and the presence of vegetation. Icy or slippery, frozen ground can support vehicle loadings equally as well as nonslippery frozen ground. Drivers use caution on slopes and corners to avoid losing control of the vehicle because of reduced traction on high ice-content ground. Table B-2 and Figure B-6 depict the frost depth required to support various personnel and equipment. Geospatial intelligence analysts can assist with frost depth estimates. (See Appendix A for weight and distance conversions.)

Table B-2. Estimated frost depth required for vehicle crossing over soft terrain

Standard Mobility Vehicle Bundle	*Representative Vehicle*	*Weight (kg/tons)*	*Required Frost Depth in Meters (Wet/Dry)*
High mobility tracked vehicle	M1A1-Abrams	54,545 / 60	.077 / 1.24
Medium mobility tracked vehicle	M270-MLRS	25,191 / 28	0.53 / 0.85
Low mobility tracked vehicle	M60-AVLB	55,205 / 61	0.78 / 1.25
High mobility wheeled vehicle	M1084-HMMWV	15,078 / 17	0.41 / 0.66
Medium mobility wheeled vehicle	M985-HEMTT	28, 168 / 31	0.56 / 0.89
Low mobility wheeled vehicle	M917-Military Dump Truck	33,070 / 36	0.60 / 0.96
Light ATV	ATV	364 / 0.4	0.1 default minimum

ATV	all-terrain vehicle	HMMWV	high mobility multipurpose wheeled vehicle
AVLB	armored vehicle launched bridge	kg	kilogram
HEMTT	heavy expanded mobility tactical truck	MLRS	multiple launch rocket system

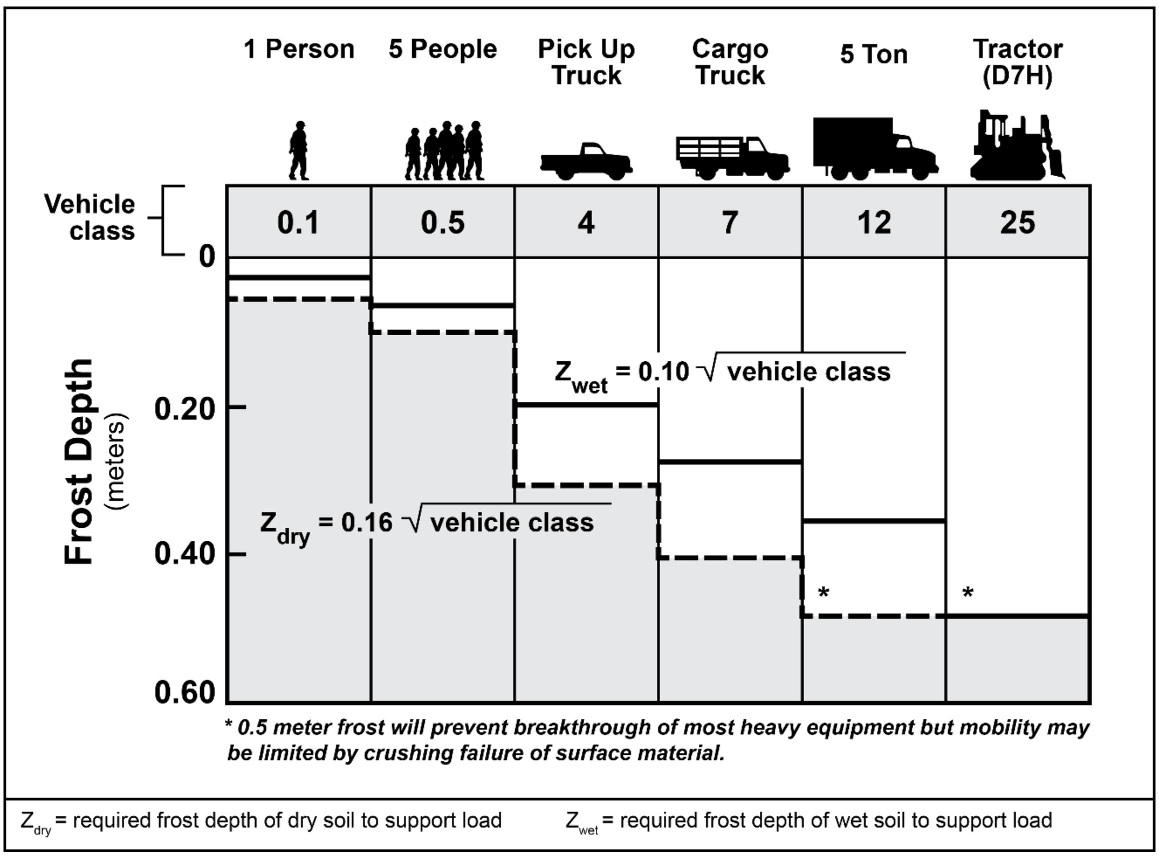


Figure B-6. Frozen ground load bearing capacity over soft terrain

B-20. Freezing rain and measurable snowfall slow mobility. Freezing rain during periods of winter warm spells can cause ice on roads and airfields making them extremely slippery and dangerous. Road sections and passes in mountainous areas are subject to avalanches and should be traversed with caution. Fresh snowfall or deep snow will hide underlying ice, potholes, and debris, which can potentially cause vehicle accidents. Additionally, wind can blow large quantities of snow, which can rapidly fill in drainage ditches, creek bottoms and other low lying or hazardous areas. Snow 8 to 13 inches deep will increase driving time by 20 to 70 percent. At 20 inches of snow, wheeled vehicles cannot move. Vehicles can easily drive into deep snow and become stuck if crews do not pay attention. Units can mitigate this risk by marking routes and assembly areas. Units require winter driver training and snow chains to operate successfully in arctic operations. Table B-3 shows the maximum depth of snow that vehicles can operate in. (See Appendix A for length conversions.)

Table B-3. Vehicle limitations in snow

Vehicle Type	*Snow Depth in Inches*
Wheeled	8
Wheeled 4x4 or greater	15
Wheeled 4x4 or greater with snow chains	20
Tracked	40
Over-snow	Over 40

B-21. Figure B-7 shows vehicle traction in shallow versus deep snow.

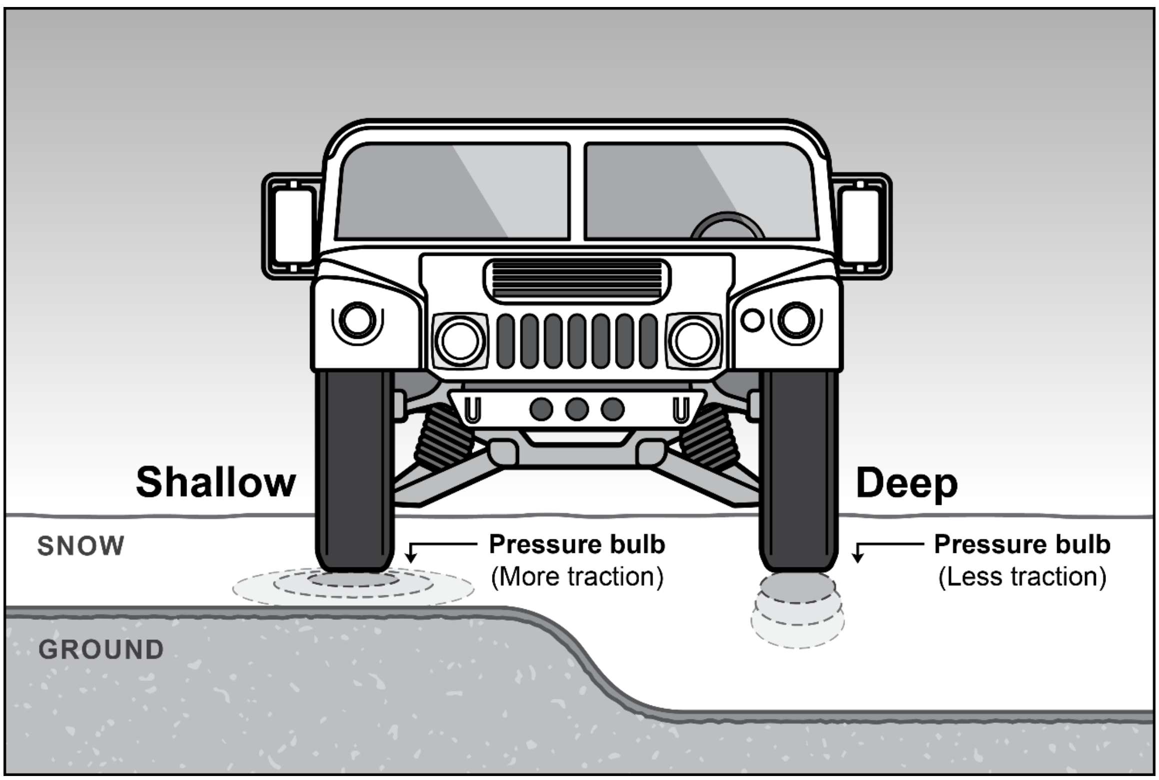


Figure B-7. Illustration of shallow and deep snow conditions

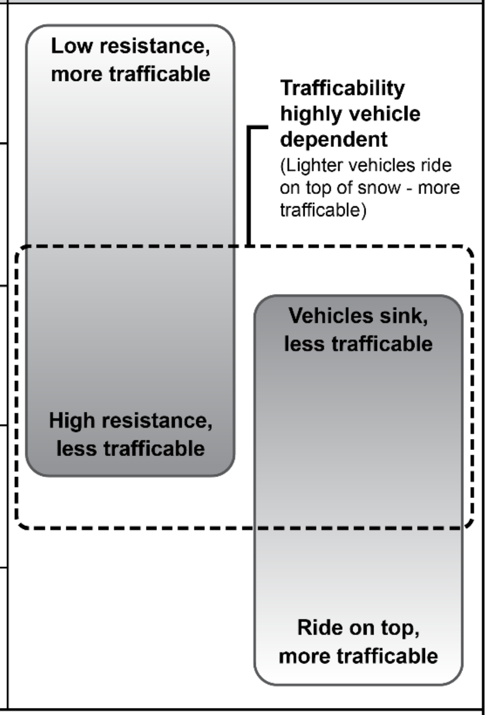
Note. When snow is shallow, pressure from the vehicle reaches through the snow to the ground and provides traction. When snow is deep, vehicle pressure does not reach the ground and provides less or no traction, which can cause the vehicle to become stuck.

B-22. Another significant factor to snow trafficability is snow density. Low density snow exerts less resistance, but personnel and vehicles will sink deeper into it. Higher density snow exerts more resistance, but at a certain point it becomes so dense that personnel and vehicles can travel on top of it, depending on weight and surface area. Temperature and other environmental factors impact snow density and can change in just a short time. For example, snow can become soft at the end of a warm sunny day or hardened after setting through a cold, clear winter night. When time and equipment allow, units improve snow trafficability by mechanical compaction or grooming of the snow surface.

B-23. There are five categories of snow density (very soft, soft, medium, hard, and very hard) as described in paragraph 1-37. Figure B-8 provides a quick means to estimate snow density and its impact on mobility.

Hand hardness test	Class, density, ram hardness
Fist	**Very Soft (1)** • Rounded/Mixed: 70-150 kg/m³ • Faceted: 150-220 kg/m³ • Ram Hardness: 0-50 N
Four Finger	**Soft (2)** • Rounded/Mixed: 100-180 kg/m³ • Faceted: 200-250 kg/m³ • Ram Hardness: 50-175 N
One Finger	**Medium (3)** • Rounded/Mixed: 120-220 kg/m³ • Faceted: 230-260 kg/m³ • Ram Hardness: 175-390 N
Pencil	**Hard (4)** • Rounded/Mixed: 170-280 kg/m³ • Faceted: 260-325 kg/m³ • Ram Hardness: 390-715 N
Knife	**Very Hard (5)** • Rounded/Mixed: 400-415 kg/m³ • Faceted: 350-380 kg/m³ • Ram Hardness: 715-1200 N

Trafficability



kg kilogram m meter N Newtons

Figure B-8. Snow density

Note. Figure B-8 assumes vehicles are traveling on dry snow and in snow depth that does not exceed vehicle limitations.

SPRING (THAW) MOBILITY

B-24. Predicting and understanding the consequences of spring thaw affect any operations planned in areas with seasonal frost. Thawing ground presents maneuver challenges. The thaw season is referred to as mud season. During thaw season, even well-maintained dirt roads may become muddy, rutted, and impassable. The onset of spring thaw, as well as the intensity of mud developed, can vary each year based on specific weather patterns in a region.

B-25. During thaw periods, vehicles should carry reduced loads. Mud and muskeg can completely immobilize vehicles. Units only permit traffic at night when temperatures fall below freezing. Limited traffic allows engineers to perform necessary maintenance without interruption during the day. When nights become so warm that the roads will no longer freeze, heavy traffic may turn unpaved roads into morasses. At times, units may stop all movement on roads because of deep mud. During the spring when rivers begin to thaw, the surrounding country floods and becomes impassable. The thaw is characterized by large ice jams.

SUMMER MOBILITY

B-26. The Arctic in summer is characterized by an abundance of open lakes, streams, and swamps which tend to impede movement. Units can use waterways for military movement if they have equipment or improvised rafts. With detailed reconnaissance, troops can use braided streams, creeks, and graveled riverbeds as routes for vehicles through muskeg or forested areas.

FALL (FREEZE) MOBILITY

B-27. In some areas, fall rains and freezing rain complicate military movements. Unpaved roads are thawed during the summer, and the fall rains create deep mud. Ruts made in the mud during the day freeze on cold nights and impede vehicle movement. Frozen ruts tear tires and break wheels and axles. Vehicles may break through the thinly frozen crust and may bog down. Under these conditions, vehicles should not overlap the tracks of the preceding vehicle.

B-28. As freeze-up progresses and the ground becomes firm enough for tanks and other vehicles, cross-country movement is facilitated. However, units exercise great care when they use tanks and heavy equipment, such as bulldozers, on streams, lakes, or muskeg. These heavy vehicles may break through thinly frozen ice or ground and sink deeply into the mud or water. Once vehicles become mired, recovery is extremely difficult and time-consuming.

B-29. Another hazard to cross-country movement is groundwater springs, especially when covered with snow. Many of these springs do not freeze, which causes some streams to have little or no ice and some lakes to have only thin ice. The presence of groundwater springs in muskeg areas can cause weak spots in otherwise trafficable terrain.

TERRAIN EFFECTS ON MOBILITY

B-30. The varying types of terrain present different problems. In forested areas, close tree spacing, fallen trees, rocky hummocks, boulders, bogs, rivers, lakes, and swamps present obstacles to summer movement. At times, deep snow cover in forested areas presents an obstacle in winter.

B-31. Non-forested areas include the tundra, ice caps, grassland, semideserts, and the mountains above the tree line. Each of the non-forested areas has unique appearances and seasonal characteristics and affect military operations differently. During summer, large areas of tundra resemble great plains. It is covered with a thick layer of piled moss interspersed with extensive marshes like those of temperate areas but usually not so deep because of the high permafrost table. The depth to the permafrost level will usually vary. Tundra soils are extremely moist and can generally only be crossed with tracked vehicles, often with difficulty. Wheeled vehicles usually cannot traverse through the soft, waterlogged tundra soils. Trafficability of frozen tundra is much better in winter than in any other season.

B-32. Over ice cap terrain and glaciers, the greatest concern is crevasses. Units need to use special crevasse detection equipment when traversing glaciers and ice caps. A trail breaking party selects and marks trails when moving over any area that may contain crevasses. With low temperatures in winter, ice cap surfaces become hard and wind swept. Newly fallen snow blows into snow ridges, which may impede movement. Windblown, compacted snow may harden so much that it can support troops on foot. Mechanized transportation is possible on this surface if snow ridges do not interfere. In many places, light ski-equipped aircraft can land and take off cautiously with minimal surface preparation.

B-33. Ice routes are generally excellent for navigation. Troops can use them as avenues for movement after freeze-up. Units need detailed reconnaissance before attempting to move on ice routes. When moving on ice routes, units treat them as an open area and stay close to the shore. This helps to conceal troops and their tracks. Overflow is a condition common to most bodies of water where the water flows onto the ice. (See Appendix C for detailed information and safety considerations for ice.)

DANGER

Failure to conduct a thorough reconnaissance of a route over ice can lead to loss of life and equipment.

SECTION III – PLANNING FOR MOVEMENT

B-34. Leaders must increase time estimates in all arctic operations to account for slower movement, as well as other time-consuming tasks associated with the region. This includes the time it takes to conduct preparations following a receipt of mission. Units make every possible effort to issue warning orders and fragmentary orders as soon as possible to account for the time lag.

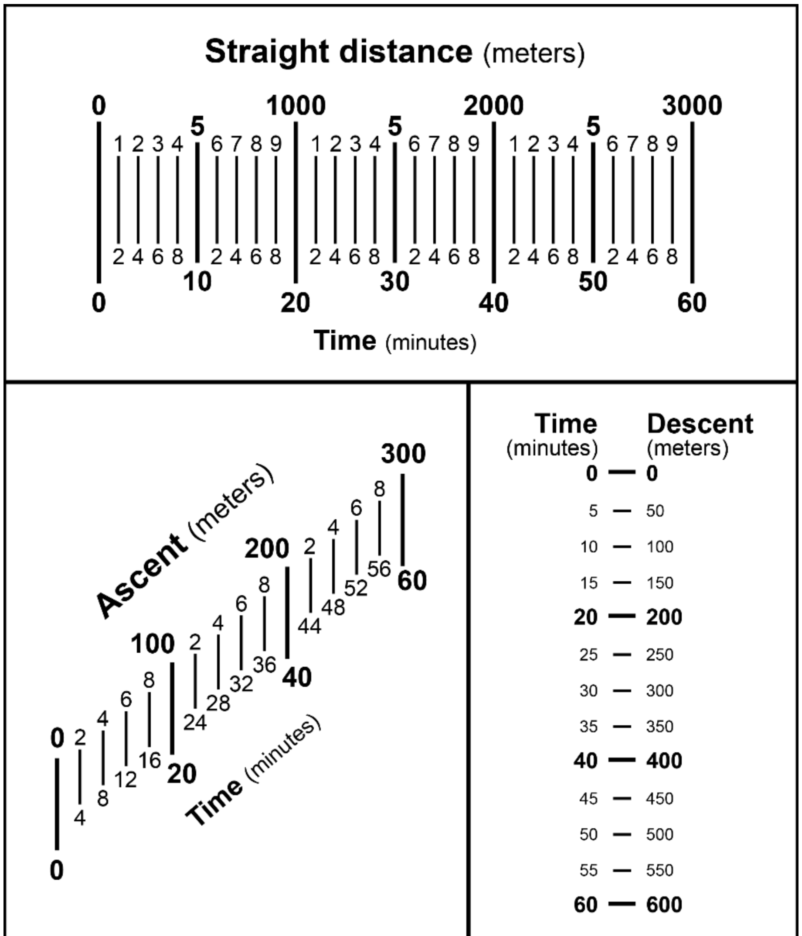
B-35. The normal planning rate for dismounted troops moving on hard packed, gently rolling terrain is 4 kilometers per hour. When crossing snow or hilly terrain, this rate decreases. Table B-4 shows average rates of over-snow movement by mode. The terms unbroken and broken trail have specific meanings. An unbroken trail refers to paths through undisturbed (unbroken) snow. Unbroken trails slow movement and are more physically intense to cross. Broken trails refer to paths over packed or cleared snow. Broken trails are more solid and are easier to walk on. However, initial trail breaking is a time intensive and exhausting effort that requires multiple fire teams or squads to rotate. (See paragraph B-39 for trail breaking procedures). For unbroken trails, the movement rate on foot with less than 1 foot of snow is the same as Soldiers/Marines on snowshoes traveling over more than a foot of snow. Skis are faster than snowshoes because they require less work to use. Finally, skijoring does not give a time for an unbroken trail in the table because Soldiers/Marines are behind a vehicle that is breaking the trail. (See Appendix A for length conversions.)

Table B-4. Planning rates of over-snow movement

Movement Mode	***Unbroken Trail***	***Broken Trail***
On foot – less than 1 foot of snow	1.5 to 3 kph	2 to 3 kph
On foot – more than 1 foot of snow	.5 to 1 kph	2 to 3 kph
Snowshoeing	1.5 to 3 kph	3 to 4 kph
Skiing	1.5 to 5 kph	5 to 6 kph
Skijoring	N/A	8 to 24 kph
kph kilometers per hour	N/A not applicable	

Note. Snowshoeing, skiing, and skijoring rates assume more than 1 foot of snow, which is required to use such equipment effectively.

B-36. Planners add 10 minutes to every kilometer of movement for every 20 pounds of equipment carried over 50 pounds. Planners add one hour for every 300-meter increase in elevation. Planners also consider that temperature generally decreases 3 °F to 5 °F for every 300 meters of elevation gained. When troops climb, it takes longer and requires more halts. When descending, planners add one hour for every 400-to-600-meter decrease in elevation. Figure B-9 shows time-distance factors for dismounted movement. While this is generally accepted for foot or snowshoe movement, proficient skiers take significantly less time to move downhill. More injuries occur descending than ascending, usually affecting the lower leg. (See Appendix A for weight conversions.)



NOTE: Time-distance factor displayed for all scales is 3 kilometers per hour. For ascent, planners add 1 hour of travel time for every 300 meter increase in elevation. For descent, planners add 1 hour of travel time for every 400 to 600 meter decrease in elevation. The descent scale on the lower right depicts a planning factor of 1 additional hour per 600 meters of descent.

Figure B-9. Time-distance factors for dismounted movement

ROUTE SELECTION

B-37. In addition to the normal considerations regarding the tactical situation, leaders ask the following questions when selecting a route across cold or snow-covered terrain:

- Are personnel on skis or snowshoes and how proficient are they? Are they more capable of negotiating the terrain along the route with one or the other?
- Are Soldiers/Marines carrying heavy rucksacks or pulling sleds? What will the temperatures be during movement?
- Are vehicles attached, and if so, what type of terrain or snow depth can they negotiate?
- How will tracks be camouflaged or is it necessary? In barren areas, or areas above the tree line, tracks may be difficult if not impossible to conceal.
- Is the route feasible during conditions of limited visibility?
- Does the route cross any potential avalanche areas?
- What obstacles can troops anticipate? Are streams and other bodies of water sufficiently frozen to support troops or vehicles? Do plowed roads perpendicular to the route have high banks of plowed snow? Are water levels in streams so low that Soldiers/Marines will have to negotiate high banks?

B-38. When conducting a map or imagery reconnaissance in cold or snow-covered terrain, leaders consider—

- Going around terrain features may be faster than going over them.
- Selected routes should involve minimal ascending and descending.
- The time of year and time of flight on imagery affect the way shadows highlight the lay of the land. A photo taken in the winter may have snow covering significant features.
- Areas around population centers usually have trails for many miles in the surrounding countryside. These may not be on any map but can show up on readily available imagery. Control of trails has proven to be decisive in the past.
- The date of a map will affect its accuracy especially regarding built-up areas.
- GPS is affected by terrain masking in deeper valleys or draws. Latitude will also affect GPS due to fewer satellites available or being close to the horizon.
- Old river channels can be used. The vegetation may be less dense or easier to move through. Rivers in arctic regions tend to meander, and this will add distance.
- Vegetation can be estimated by the color. Dark green areas tend to be mature trees such as white spruce, pine, birch, and cottonwood. These trees commonly grow adjacent to river channels. They may have an understory of dense brush, alder, or willow. Light green areas tend to be lower brush such as black spruce, alder, willow, and smaller birch.
- Navigation of wide-open areas with little or no relief can get difficult without landmarks.
- Where the sun is and how the shadows fall. The south side of open areas has longer shadows that will help conceal tracks.

ROUTE PREPARATION

B-39. Units prepare a route by trail breaking and route maintenance. Trail breaking is the preparation of snow surfaces by packing or clearing snow. Packing the snow will increase the density, making it ultimately stronger, but will initially break bonds between snow grains. With time (overnight, or even several hours in the right conditions), the snow will re-sinter and harden, and become much stronger. Individual units usually prepare combat roads and trails by trail breaking because of heavy snowfall or wind drifts. Trail maintenance becomes a task repeated often to maintain LOCs and supply. A significant snowfall or wind event can totally obliterate any trace of a trail. A well-maintained and marked trail is far easier to re-open than breaking a new one. If a unit must break their own trails during movement, then significant additional time must be accounted for (see Table B-4 on page 203).

B-40. Dismounted trail breaking consumes a considerable time, effort, and energy. The first Soldier/Marine in line quickly tires depending on the load carried and depth of snow. One-third of the unit is allocated to trail breaking. The trail breaking party departs one hour earlier for each kilometer to travel. The leader is responsible for—

- Setting a course that maintains tactical security to the larger unit while maintaining ease of movement. Troops set up the general trace using a map and aerial imagery. Leaders make every effort to stay in mature forests and avoid areas choked with brush. Areas with brush make movement excruciatingly slow and risky. Troops can easily alert the enemy from the noise they generate clearing a route or just moving through it.
- Ensure troops adhere to the trail marking SOP. Troops cordon off side trails or back-tracking trails to prevent units from taking a wrong turn.
- Provide guides, if necessary.
- Ensure troops have pioneer tools. The tools in an ahkio group are enough for a squad to cut a trail. If troops use water routes, they carry additional tools such as augers and depth sticks.

B-41. The procedure for the lead squad is as follows:

- The squad leader designates the direction, and the lead Soldier/Marine begins moving, establishing the initial track.
- The second in line does not step into the firsts' tracks but steps opposite and flattens the tracks.
- The third and fourth Soldiers/Marines offset their steps left and right by at least one snowshoe width. This widens the trail to allow troops to bring the ahkios. If necessary, these Soldiers/Marines are also the 'cutters.' Each one carries a machete to clear brush on the sides of the trail. They carefully lop branches close to the main trunk, so stubs do not become spears.

- The squad leader focuses on navigation. This leader keeps a march table to record where the unit is located. The leader relies on more than GPS as batteries are easily drained in the cold. The squad leader ensures the two teams rotate as necessary.
- The trail team fills low spots with snow, straightens the trail if necessary, and provides security for the lead team.
- The lead squad in the platoon generally does not drag its own ahkio group if it needs to break a trail or cut in very thick brush or deep snow. If the lead squad drags its own ahkio, breakers and pullers rotate more frequently in deep snow. Security can lapse very quickly when labor becomes difficult.
- Rotation of the lead team is a significant consideration. The lead fire team or squad moves forward for a set time or certain distance, then it rotates to the trail of their fire team or squad. The same applies to squads within a platoon. Trail breaking is a very demanding enterprise, physically and mentally.

B-42. The CATV or SUSV performs cross-country travel under most snow conditions. The planning procedures are much the same for mounted travel as they are for dismounted. The leader—

- Ensures that at least two vehicles travel together and the crews are well-versed in recovery.
- Ensures that troops top off fuel and carry additional cans.
- Checks that troops have basic issue items or stocklist level-3. Recovery equipment such as winches, tow cables, and snatch blocks are essential. Wheeled vehicles are required to have tire chains.
- Understands and logs route, number of personnel, and time of departure with the command center.
- Ensures that passengers have adequate equipment for sustainment for 72 hours.
- Has navigational equipment, maps, compasses, GPS, overlays, and imagery.

B-43. The procedure for CATV or SUSV trail breaking is as follows:

- The lead vehicle sets the initial track, staying concealed as much as possible.
- The second vehicle offsets its track to flatten out the trail. This keeps a hard ridge from forming in the center of the trail that can hit high center on other vehicles.
- Following vehicles also offset as much as possible to widen the trail. This also hardens the snow and eases the passage for other vehicles.
- Troops set up a series of tripods quickly to mark the trace of a trail through open areas. They space tripods so that troops can easily see from one tripod to the next.

MOVEMENT CONSIDERATIONS

B-44. Leaders weigh the advantages and disadvantages of different movement formations. In snow-free terrain, a column (wedge) formation can maximize fields of fire and allow for greater command and control; however, when operating in a snow-covered environment, the ideal formation is the file formation. File formations are essential for trail breaking and mobility. In a snow-covered environment, troops traveling in a column formation are forced to march through undisturbed snow and move slower. Column formations also create more tracks in the snow and make it easier for the enemy to detect the unit’s location. However, a column formation may be appropriate if enemy contact is imminent.

B-45. In open terrain, troops break only one set of tracks. Aircraft or elevated observation posts can spot several tracks more easily than they can spot a single set of tracks. Troops follow the tree line as much as possible to help conceal them from the ground and hide tracks from the air. The sun stays in the southern sky for most of the winter. Troops can use the very long shadows on the southern side of open areas to conceal tracks.

B-46. In tundra areas, few forested areas exist. Walking through areas with knee high brush conceals trails. Areas with large herds of moving caribou can also conceal tracks. River corridors may have some mature trees to help with concealment, but further north these will dwindle. Troops assume that the enemy knows and observes the locations of these tree lines. In such cases, troops use low ground such as creek beds to mask movements.

B-47. When negotiating hills or mountains, troops use gentle traverses to ascend or descend. This makes it less fatiguing on Soldiers/Marines, so they can fight after reaching an objective. Troops make every effort to avoid avalanche prone slopes. Highly specialized training is required to even come close to negotiating them safely. (For more information on mountain terrain, refer to ATP 3-90.97.)

B-48. During movement, roads and trails depicted on maps or imagery may be completely obscured by heavy snowfall or drifting. A unit can completely miss these features if not careful. Individuals can mitigate this risk by—

- Knowing individual position at all times.
- Plotting azimuths to cross or join roads and trails at easy to identify points.
- Maintaining an accurate log of distance traveled to anticipate times for crossing or joining a road or trail.
- Looking at the tops of the trees in forested areas. There may be a very definite open space in the canopy. Look to the sides as well.

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Appendix C
Ice Considerations

This appendix describes how to measure ice load strength and calculate safe ice thickness for military use. It also details methods of ice reconnaissance, crossing, and demolition.

SECTION I – ICE STRENGTH CALCULATIONS

C-1. Measuring ice thickness and calculating the load bearing capacity of ice can be a matter of life and death. Ice thickness determines safe travel over frozen water sources. Leaders must pay particular attention to ice thickness during seasons of ice thaw and freeze. During thaw periods, ice becomes increasingly weaker. During freeze periods, ice can take several weeks to become thick enough to support troops and vehicles. Leaders consider weather conditions during periods of ice formation. For instance, a heavy snow as the ice is forming can insulate it and prevent thickening.

C-2. Many variables affect ice bearing capacity. These variables include ice thickness, temperature and quality; snow cover; type, speed, spacing, and number of repetitions of moving loads; length of time of stationary loading; depth of water; flow rates; presence of open cracks or zones of pressure buckling; and presence of freshwater, saltwater, springs, seepage inflow, and currents.

C-3. To ensure safe movement of single vehicles crossing freshwater (lake or river) ice at temperatures below 32 °F, the formula $P = h^2/16$ or $h=4\sqrt{P}$ can be used as a rough guide (P is in tons and h is in inches of solid, clear, freshwater ice). Table C-1 provides refined ice thickness standards based on the above formula for short-term loading on solid, clear, freshwater ice. When troops move two loads on the ice, the safe distance between loads is about 100 times the ice thickness at the required minimum thickness. When the two loads differ in weight, planners choose the spacing shown for the larger load. At ice thickness greater than the required minimum, this spacing can be reduced.

Table C-1. Approximate vehicle short-term or moving load capacity of solid, clear, freshwater ice

Vehicle weight	*Required ice thickness (inches = 4√vehicle weight)*		*Distance between vehicles (about 100 x thickness)*	
(tons)	*(inches)*	*(centimeters)*	*(feet)*	*(meters)*
0.1 (200lbs)	2	5	17	5
1	4	11	34	11
2	6	15	48	15
3	7	18	58	18
4	8	21	67	21
6	10	25	82	25
8	12	29	95	29
10	13	33	106	33
20	18	46	149	46
40	26	65	211	65
60	31	79	260	79
80	36	91	300	91
100	40	102	335	102

C-4. Movement of individuals over ice requires a minimum thickness. Table C-2 provides approximate safe ice thickness for troops crossing solid, clear freshwater ice.

Table C-2. Approximate individual short-term or moving load capacity of solid, clear, freshwater ice

Minimum Ice Thickness (Waterborne)			
Load	***One-Time Only Use***	***Normal Repeated Use***	***Distance Between Individuals***
Individuals on skis	1.5 inches / 4 centimeters	2 inches / 5 centimeters	17 feet / 5 meters
Individuals on foot	3 inches / 8 centimeters	4 inches / 11 centimeters	17 feet / 5 meters

DANGER

Tables C-1 and C-2 provide minimum ice thickness guidelines for ideal ice conditions (solid, clear, freshwater). The presence of cracks, white ice, or saltwater degrade ice strength and can make ice conditions unsafe. All ice strength calculations must adjust for the presence of cracks, white ice, or saltwater.

C-5. Planners can use the graph in Figure C-1 as a quick reference to determine minimum ice thickness for solid, clear, freshwater ice. If air temperature has been above freezing for at least six of the past 24 hours, multiply the load by 1.3 before calculating the equation (or use the lower dashed line on Figure C-1), obtaining a larger minimum ice thickness to account for any possible weakening.

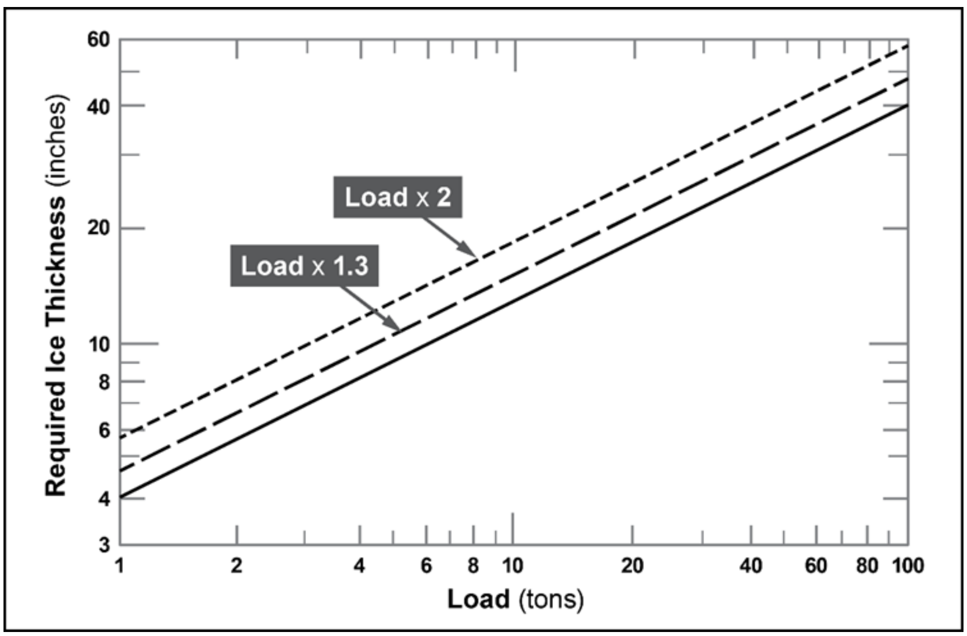


Figure C-1. Thickness chart for short-term or moving load capacity of solid, clear, freshwater ice

C-6. Solid, clear, freshwater ice with no bubbles is the strongest type of ice. Ice containing air bubbles (also called snow ice or white ice) often forms from water-soaked snow and has only half the strength of clear ice. For white ice, multiply the load by 2 (as shown on the upper dashed line of Figure C-1) before calculating to find the required minimum ice thickness.

C-7. The presence of cracks affects the strength of ice. Cracks are either dry or wet. If dry, they do not penetrate ice cover and no corrections are needed. If wet, the ice can only support half the amount of weight; multiply the load by 2 (as shown on the upper dashed line of Figure C-1) before calculating to find the required minimum ice thickness. When driving across wet cracks, choose a path as close to perpendicular to them as possible, instead of parallel to them.

C-8. A loaded ice surface can creep, or deform, over a time without any additional load. For loads left on the ice for more than two hours, multiply the load by 2 (as shown on the upper dashed line of Figure C-1) before calculating to find the required minimum ice thickness. If units have to load an ice surface for a long period, they test the durability by drilling a hole near the load. If water begins to flood the ice through the hole, then the ice is not durable, and they move the load immediately. This also applies to a disabled vehicle. If units leave it for a few days, it may break through the ice from long-term creep. Units plan for vehicle recovery by considering both the minimum ice thickness to support the heaviest vehicle plus the weight of a recovery asset. If a vehicle breaks down during a crossing, troops recon and proof a secondary site unless the bearing capacity supports the recovery asset.

DANGER

For ice that simultaneously contains multiple degrading factors (such as white ice with cracks and a static load), advanced engineer assessment is required.

When the air temperature has been 32 °F or more than 24 hours, ice starts losing strength, and the equations, figures, and tables in this manual no longer represent safe conditions.

Contrary to expectations, a rapid, large air temperature drop makes an ice surface brittle, and the ice may not be safe to use for 24 hours or more.

If ice is not supported by water (waterborne) because the water level has dropped, it is too weak to support heavy loads.

Any large snowstorm creates a new load on the ice. If the snow is heavy enough, the ice surface will sag, and its top surface will be submerged below the water level. Then water will flood the top of the ice through cracks, saturating the lower layers of the snow. Until this slush is completely frozen, stay off the ice. When the saturated snow becomes frozen, it is an added thickness of white ice.

C-9. To determine the required ice thickness or to determine the weight bearing capacity of a frozen body of water for aircraft LZs, units typically use Gold's Formula: $h=\sqrt{(W/A)}$ or $W=Ah^2$ as a rough guide. In this formula, h is in inches of solid, clear, freshwater ice; W is the gross weight of the aircraft in pounds; and A is the flexural strength of the ice in pounds per square inch.

C-10. Troops cannot always assess flexural strength (A). Instead, troops use a constant variable ranging from 50 to 250, selected based on risk. The average flexural strength of ice is 150 psi. Depending on the level of risk that commanders are willing to accept, they can use several A-values which correspond to an associated level of risk. Table C-3 provides values of flexural strength (A) based on associated risk.

DANGER

Troops use Gold's formula for static and dynamic loads. It can be inadequate for impact loads. Troops need additional engineer assessment to determine safe ice thickness when dropping loads on ice.

Table C-3. Associated risk when estimating flexural strength of ice

Risk	*Flexural Strength (A) in psi*
Very Low Risk	50
Low Risk	75
Tolerable Risk	100
Medium Risk	150
High Risk	200
Extremely High Risk	250

C-11. Table C-4 provides a risk assessment tool for landing zones based on gold's formula. It provides several A-values and their associated levels of risk as well as the required ice thicknesses for a range of gross aircraft weights at various levels of risk on solid, clear, freshwater ice.

Table C-4. Required landing zone thickness for solid, clear, freshwater ice

Aircraft Weight (1,000s lbs.)	*Ice Thickness*					
	Very Low Risk (A=50 psi)	*Low Risk (A=75 psi)*	*Tolerable Risk (A=100 psi)*	*Medium Risk (A=150 psi)*	*High Risk (A=200 psi)*	*Extreme Risk (A=250 psi)*
12.00	15.49	12.65	10.95	8.94	7.75	6.93
13.00	16.12	13.17	11.40	9.31	8.06	7.21
14.00	16.73	13.66	11.83	9.66	8.37	7.48
15.00	17.32	14.14	12.25	10.00	8.66	7.75
16.00	17.89	14.61	12.65	10.33	8.94	8.00
17.00	18.44	15.06	13.04	10.65	9.22	8.25
18.00	18.97	15.49	13.42	10.95	9.49	8.49
19.00	19.49	15.92	13.78	11.25	9.75	8.72
20.00	20.00	16.33	14.14	11.55	10.00	8.94
25.00	22.36	18.26	15.81	12.91	11.18	10.00
30.00	24.49	20.00	17.32	14.14	12.25	10.95
35.00	26.46	21.60	18.71	15.28	13.23	11.83
40.00	28.28	23.09	20.00	16.33	14.14	12.65
45.00	30.00	24.49	21.21	17.32	15.00	13.42
50.00	31.62	25.82	22.36	18.26	15.81	14.14
55.00	33.17	27.08	23.45	19.15	16.58	14.83
60.00	34.64	28.28	24.49	20.00	17.32	15.49
65.00	36.06	29.44	25.50	20.82	18.03	16.12
70.00	37.42	30.55	26.46	21.60	18.71	16.73
lbs. pounds		psi pounds per square inch				

SECTION II – ICE RECONNAISSANCE

C-12. Ice thickness can be determined using electronic sensors or by drilling holes in the ice and manually measuring. Movement over thin ice can cause troops and equipment to fall into potentially rapid, chilling waters with deadly consequences. Due to its importance, units train ice reconnaissance personnel to drill and survey the stability of ice formations before units cross. Trained ice reconnaissance personnel complete a detailed recon before units attempt to move on ice routes. When moving on ice routes, units treat them as an open area and stay close to the shore. This helps to conceal troops and tracks. Units never venture out onto a frozen body of water without asking and confirming each of the following questions are negative:

- Stop and look to the far side. Are there signs of low spots or previous collapse?

- If the far bank is visible, is there frost on the trees in spots?
- Can water be heard running under the ice?
- Does the ice sound hollow? (Ski pole testing)

C-13. Overflow occurs to most bodies of water where the water flows onto the ice. Trained ice reconnaissance personnel select ice routes by following these general rules:

- Outside bends of rivers generally have thinner ice due to the faster current.
- Edges of lakes generally have thicker ice as water freezes from outside to inside and top to bottom.
- Inlets, outlets, converging channels, and tributaries are high flow areas prone to thin ice.
- The ice in the middle of lakes and rivers tends to be thinner, and the downwind side of lakes tends to have thicker ice.
- Vapor coming off the surface of the snow indicates open water. Isolated patches of frost form on the trees adjacent to waterways. This indicates that there was open water there, and the ice around that area may be thin.
- Surface hoar (also known as frost flowers) form when water vapor condenses on ice or snow. This comes from exposed water. When an open lead freezes over, surface hoar forms on the ice. This ice is quite thin but may be strong enough to support a load of snow, concealing its presence. Avoid any depression in the snow while on a water route. Listen for the sound of flowing water and any hollow sounds.
- As the winter progresses, water levels under the ice begin to drop. This sometimes leaves an air space where the ice is no longer supported by water and may collapse. Check for hollow sounds and the sound of flowing water.
- Muskeg lakes contain a great deal of vegetation which retards freezing and results in weak ice.

DANGER

Failure to conduct a thorough reconnaissance of a route over ice can lead to loss of life and equipment.

C-14. After leaders select a tentative route, an ice check is necessary. This should be done by at least two Soldiers/Marines. Equipment consists of a 25-meter rope, an auger or heavy ice chipper, and a measuring stick with an angled end. Soldiers/Marines wear personal flotation devices. If the tactical situation permits, they drop their fighting loads or at least lighten it to just a weapon. Gas-powered augers are faster but loud and require a special fuel mixture for two-stroke engines. If available, the Soldiers/Marines use a battery-operated drill with at least a half-inch drive and 18-volt battery. Tactically, hand-powered augers are best. Chippers and axes are excruciatingly slow. (See Appendix A for length conversions.) The following are steps for ice reconnaissance:

- The lead Soldier/Marine ties off to the end of the rope with a bowline just under the armpits. If the rope is around the waist, there is the possibility of being folded in half by a current and having your head submerged. The other Soldier/Marine keeps the rope taut.
- The lead carefully moves onto the ice no more than 10 meters from the shore, 1 to 2 meters downstream from the route (to prevent weakening the route for heavier loads) and drills the first hole. The lead notes the amount of resistance against the auger. The water should flow up out of the hole and be about 1 to 2 inches below the surface of the ice. This shows that the ice is waterborne. The lead measures the thickness of the ice by inserting the stick and hooking the angled portion under the ice shelf. It helps if the shaft has inch or centimeter marks on it.
- If possible, the lead measures the depth of the water underneath the ice. Water depth measurements can help inform risk considerations. Deeper water reduces pressure waves; shallower water increases pressure waves and the risk of ice fractures.
- Both Soldiers/Marines move to the next area not more than 10 meters away and repeat the process.
- The last hole is no closer than 10 meters from the shore.
- The Soldiers/Marines mark the lane.
- Soldiers/Marines continuously monitor the water levels inside the ice holes. Water levels inside the hole can indicate the potential risk of the ice rupturing. The more water that is inside the hole, the

higher the risk of rupture. If water floods overtop the hole and onto the ice, the risk level is extremely high.

- If vehicles use the lane, Soldiers/Marines enforce a speed limit of 5 to 10 miles per hour (mph), especially close to the shore landing. Vehicles can set up a pressure wave and blow out the landing. The heavier and faster the vehicle, the higher the risk. Vehicles enter and exit ice cover at a 45-degree angle so that subsurface waves dissipate along the shoreline (driving vehicles at a 90-degree angle onto and off ice can cause shoreline fractures). If using an enclosed vehicle, Soldiers/Marines always drive with the windows or door open for quick escape.

MAPPING

C-15. Units have several options for mapping terrain. Geospatial intelligence staff can provide historic maps or information from ground penetrating radar. These show the history of ice development from year to year and help set a baseline of expectations. Leaders study historic maps from the past three years. They plot the visible ice surface and note changes of how the ice grows or recedes over the years. Then they review maps of summertime and note any changes in shoreline from winter to summer. Historical maps are particularly useful to analyze rivers. Typically, lakes and ponds will not have much variation yearly. Ground penetrating radar can provide details of ice thickness (for ice at least 7.5 inches thick) and water depth. This radar accurately calculates ice thickness and can create detailed products such as heat maps and profiles of the ice.

ACTIVITIES

C-16. The various activities involved in ice mobility include static, dynamic, impact, rotary-wing, and fixed-wing operations. Each operation has its own unique properties for ice reconnaissance and mission planning.

STATIC

C-17. Static operations involve having a load on waterborne ice for more than 2 hours. These operations can include worksites, sling-load equipment, stockpiling of materials or equipment, and LZs. Figure C-2 illustrates general preparation for a static worksite on freshwater ice. Troops complete a core sampling before a static operation. For freshwater ice, core sampling is recommended at 10 meters between bore holes and 2 meters downstream from desired path to worksite. The coring style ensures the route to the site is strong enough to support the load moving across the area. When calculating load-bearing capacity, troops use the thinnest ice thickness measurement to obtain an overall load-bearing capacity. Static operations cause a circular deflection of the ice, which can increase the risk of rupture over time. To reduce risk, units drill a core site close to the static load to act as a monitoring site. Troops continuously observe the water levels at the monitoring site. The more water that is inside the hole, the higher the risk of rupture. If water floods overtop the hole and onto the ice, the risk level is extremely high. Units monitor static loads to make sure the load does not freeze to the ice. Any load frozen to the ice may take extensive labor to free. (See Appendix A for length conversions.)

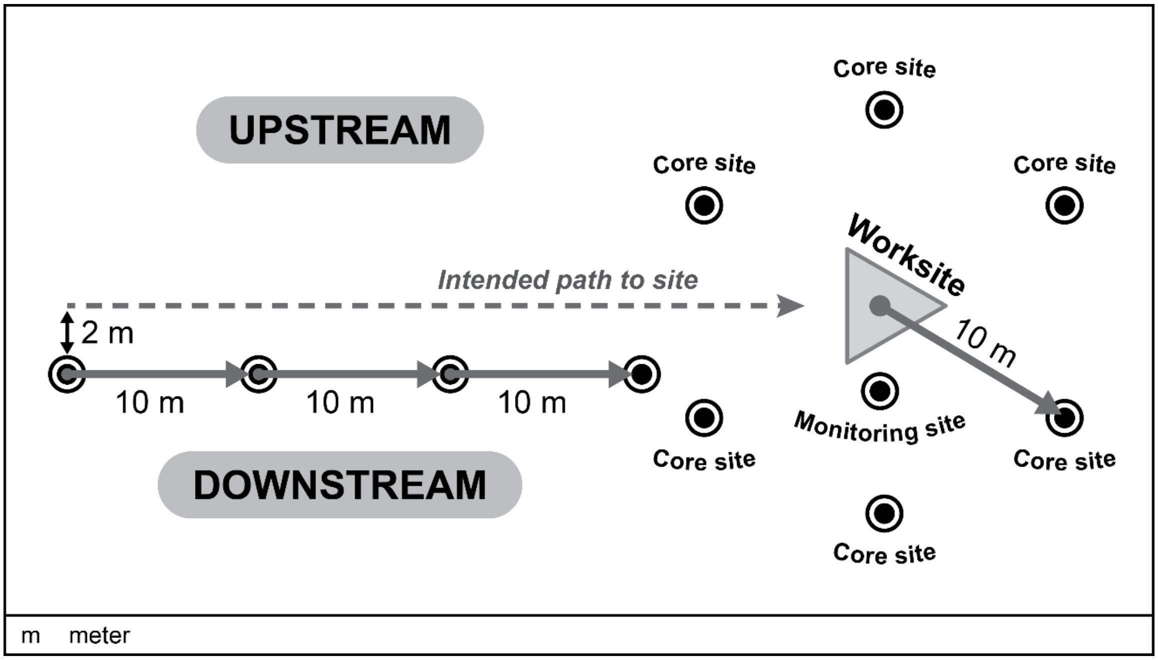


Figure C-2. Static operations ice reconnaissance on freshwater ice

DYNAMIC

C-18. Dynamic operations include any movement across the ice surface. A moving load will cause the ice to deflect in an elliptical pattern and cause a wave to form ahead of and behind the load being moved. This means that units cannot move two loads near each other across the ice. Units move two loads apart from each other so the ice wave deflections by each do not interact. Troops complete a core sampling before a dynamic operation. For freshwater ice, core sampling is recommended at 10 meters between bore holes and 2 meters downstream from the intended route. Troops core sample the entire length of the route. Troops use caution when conducting dynamic operations by maintaining a speed less than 5 to 10 mph. Units keep holes open, and troops continuously monitor the water levels inside the ice holes. Water levels inside the hole can indicate the potential risk of the ice rupturing. The more water that is inside the hole, the higher the risk of rupture. If water floods overtop the hole and onto the ice, the risk level is extremely high. (See Appendix A for length conversions.) Figure C-3 illustrates a basic ice crossing reconnaissance for freshwater ice.

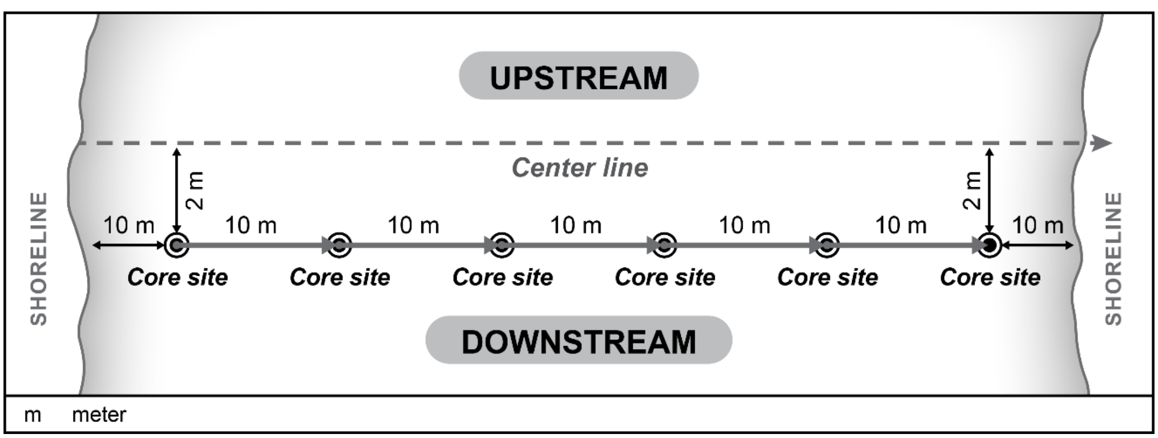


Figure C-3. Dynamic operations ice reconnaissance on freshwater ice

IMPACT

C-19. Impact operations include any airdrop (paratroopers, bundles, and heavy equipment) that causes an impact on the ice cover. Units require a thorough engineer assessment to determine safe ice thickness when dropping loads on ice. When conducting impact operations, leaders consider several key factors to mitigate risks such as obstacles, presence of open water areas, integrity of the ice surface, and gaping cracks. When conducting ice reconnaissance for a personnel or bundle drop, troops survey the entire DZ. They check up to a minimum of 200 meters beyond DZ boundaries to ensure no factors can affect the ice cover in the DZ.

C-20. Soldiers/Marines record the average weight of the bundle or paratrooper rigged with combat equipment before conducting the ice assessment. Core sampling is recommended every 10 meters when encountering any significant terrain variations in the vicinity of the DZ. Additional coring sites depend on assessments. Troops space additional coring sites at no more than 100 meters between core sites in a grid-like layout. (See Appendix A for length conversions.)

ROTARY WING

C-21. Rotary-wing operations on waterborne ice will cause ice deflection by rotor downwash. This intense vibration can potentially fatigue the ice and increase risks of rupture. Therefore, helicopters avoid prolonged hovering above ice landing sites. Leaders also consider the whiteout conditions when an aircraft lands. Troops do not have to clear snow, but doing so gives pilots better visibility when landing and can also thicken the ice.

C-22. Troops can recon an LZ using a similar process as static operations (see paragraph C-17). Additionally, when setting up the LZ for landing or sling-load operations, troops add a bore hole next to the landing zone and clear the snow near the bore hole. Troops notify the flight crew to use the bore hole as a reference point to land. Troops continuously monitor the water levels inside the bore hole. Water levels inside the hole can indicate the potential risk of the ice rupturing. The more water that is inside the hole, the higher the risk of rupture. If water floods overtop the hole and onto the ice, the risk level is extremely high.

FIXED WING

C-23. Variables that affect maximum aircraft operating gross weight include surface roughness, hardness, ice thickness, snow cover, and snow depth. Troops continually monitor and evaluate these characteristics for their effect on allowable aircraft gross weight, particularly when troops leave the LZ unattended or after severe weather conditions.

C-24. Generally, an increased level of surface preparation or grooming allows for increased operating weights. A four-inch elevation change in 20 feet is the threshold for what is considered "smooth." If this threshold is exceeded, structural damage to the aircraft's skis may occur at higher operating weights. (See Appendix A for length conversions.)

CAUTION

The load bearing capacity of ice surfaces varies with thickness, surface temperature, weight of the aircraft and parking time. Always consult with the agency responsible for the aircraft to be landed for the required minimum ice thickness and reconnaissance procedures in accordance with their standard operating procedure.

C-25. For saltwater ice, troops test ice depth at landing and takeoff areas by drilling through the ice at 500-foot intervals on alternated sides for the entire length of the landing area. Minimum depth values do not include surface snow or slush. Troops perform additional drill tests weekly during continuous operations or prior to resuming landings and takeoffs after non-use of more than one week. They check the area regularly for signs of cracking or surface deterioration. For freshwater ice, units consult with the agency responsible for the aircraft to be landed for reconnaissance procedures. See DAFMAN 13-217 for more information on skiway and ski landing area criteria.

> **CAUTION**
>
> Undulating or irregular ice underneath the snow surface, often hidden by the snow cover, can impact the skis during landing or takeoff which may damage skis and other aircraft structure. Ice irregularities can significantly damage skis when struck at any speed. An ice crack or pressure ridge with an edge of more than four inches may do damage at taxi speeds when the ski bridges the crack and applies stress to a point on the ski.
>
> Bare ice with little or no snow cover can impact skis. Snow cover cushions and distributes loads over the skis. Even small irregularities or cracks in bare ice can create stress points along the ski that can cause damage.
>
> Large irregularities in the snow surface (ridges, humps, and surface irregularities created by wind action known as "sastrugi") can impact skis. Ridges, humps, or sastrugi more than four inches can damage skis at taxi speeds as the ski bridges the crack and a stress point is applied to the ski.

C-26. Troops thoroughly analyze the proposed landing location beforehand to rule out any crevassing. They use remote sensing tools. Any crevassing surface is not suitable for fixed-wing operations.

C-27. The agency being supported is responsible for preparing the surface. Surface preparation includes a thorough survey of the landing area to look for ice irregularities and study snow depths and characteristics. Troops remove any unacceptable irregularities. Snow irregularities may be large enough to require troops to drag or grade the entire surface to fill low areas and remove high areas. Troops grade all undulating surfaces to minimize the slope and prevent ski damage. Troops avoid scraping the snow surface down to bare ice because snow cushions and distributes loads during ski takeoffs and landings. If the resulting surface is acceptable, ski operations begin after appropriate marking and certification. Troops consider the following considerations for surface preparation:

- Dragging removes sastrugi, ridges, or humps; grades undulating, uneven, or rough surface areas; and promotes sintering (bonding of snow crystals), which hardens the loose surface snow. Various types of drag devices have demonstrated effectiveness.
- Grooming the cargo loading area improves the surface prior to supporting cargo operations. If possible, troops allow groomed snow to sinter for several hours, or even several days, before use. The longer groomed snow sinters in cold temperatures, the harder the surface becomes.
- Maintaining the skiway requires periodic dragging. Troops drag the skiway immediately after fresh snow accumulation, windstorms, or when ski landings or takeoffs disturb the surface. Regular inspections by the ground party and pilot reports determine if dragging or other maintenance action is required.
- A ski landing area control officer (known as SLACO) certifies ski LZs with a snow surface over an ice substrate.

SECTION III – ICE CROSSING

C-28. Units use caution when crossing ice. Ice deforms under an enduring load. After a load passes over it, the ice recovers, almost to its original shape. This deformation acts like a wave at the beach and can "blow out" as vehicles approach the far side. These waves can reflect (bounce back) from shorelines and other objects, and cause cracks in the ice cover. Therefore, vehicles follow strict adherence to speed limits less than 20 mph. If a unit permits a load to stand still on the ice, the ice surface depresses and may reach the danger point. This "load" is then the critical weight for the strength of the ice at a particular location or in a particular condition. During the thaw period, ice becomes dull and brittle, losing its load-bearing capacity. At such a time, heavy traffic wears through ice quickly. Except during the thaw period, cracks that transverse across ice roads do not indicate weakening of the load-bearing capacity of the ice. Troops can repair transverse cracks by filling them with water, which freezes on standing. Cracks parallel to an ice roadway indicate that troops need to relocate the roadway at once, as the ice can no longer carry the load.

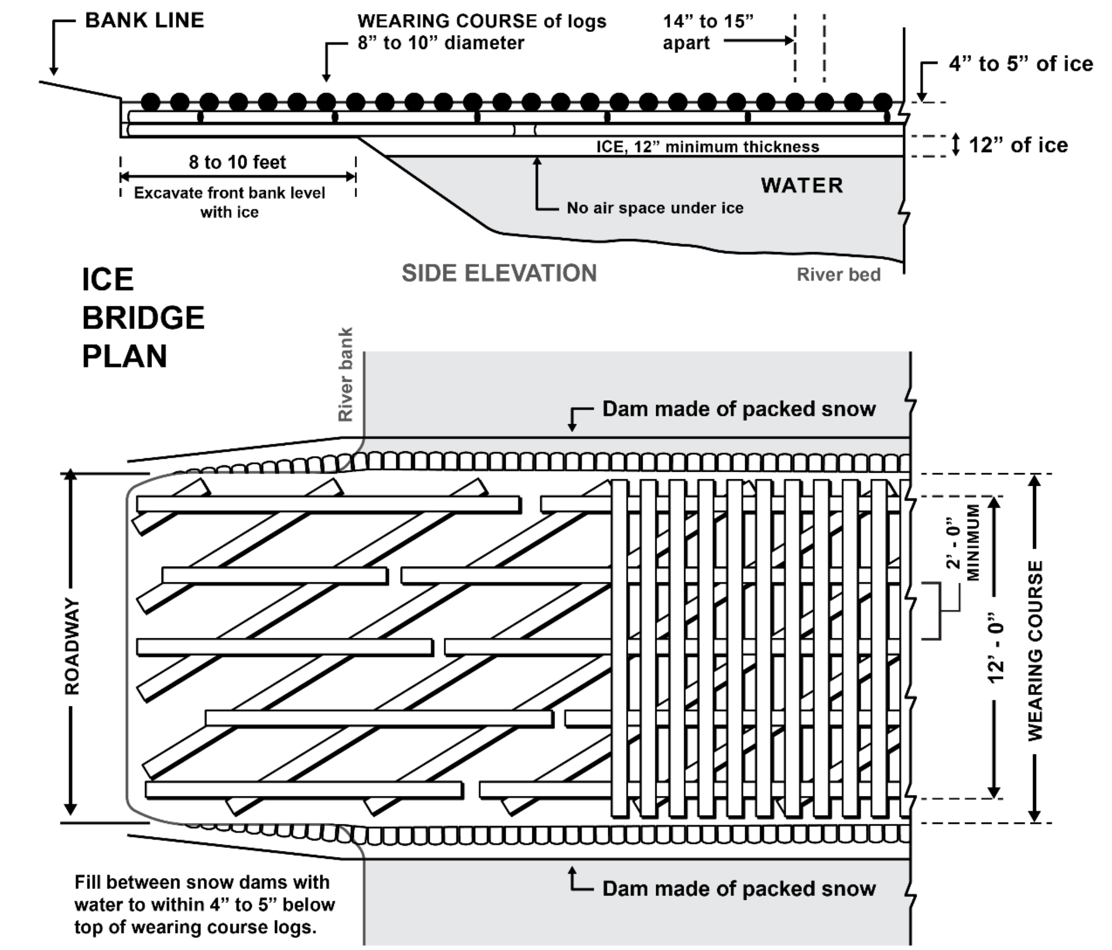
C-29. The strength of ice varies with the structure of the ice; the purity of the water from which it is formed; the cycle of formation, or freezing, thawing, and refreezing; temperature; snow cover; and water currents. The sustaining capacity of ice is not definitely fixed, but experience and tests provide working capacity figures for good quality ice of varying thicknesses. Staffs may need to alter the values given in tables C-3 and C-4 on page 212 regarding ice thickness capacities when climate changes. Generally, the alteration is toward requiring greater thicknesses and intervals. During freezing weather when the ice surface is free of snow, it is usually of good quality. Temperatures above freezing will thaw the ice and deteriorate its quality. Frequent freezing and thawing normally produces ice of poor quality. Snow cover may limit the thickness of the ice formed or may prevent rapid thawing if a thick coat of ice forms and then gets covered with snow. Thaws in the watershed may cause flooding on the ice because of an increased runoff, and freezing may cause the stream water level to drop due to a decrease in runoff. Both conditions affect the quality of the ice.

C-30. Troops can prepare river ice for traffic by flooding the crossing belt between two previously prepared, snow-packed dams. The simplest method of reinforcing ice is to put layers of snow on the surface and pour on water to freeze it. Each layer is frozen before another layer is added. Another way to increase ice capacity is to add several layers of boughs or straw, each about 5 to 10 centimeters thick, and freeze them to the surface. Corduroyed sections increase the ability of the ice to support a crossing load. Troops may also use boards, planks, and small logs to form tracks or runways for vehicles or sleds (see Figure C-4). Each track is at least a meter wide. Sleds made of logs help distribute heavy axle loads. (For a guide in reinforcement of ice, see Table C-5. See Appendix A for length conversions.)

Table C-5. Reinforcement of freshwater ice

Material	*Thickness of reinforcing layer*	*Requirement for 13-foot-wide track*	*Increasing in bearing capacity*
Ice and snow	1 ½ inches (packed layers)	N/A	20%
Straw	2 to 4 inches	6 pounds per foot of run	20%
Straw, 3 layers	2 to 4 inches (each layer)	20 pounds	25%
Brush	2 to 4 inches	2 cubic feet per foot of run	25%
Ice block	Dependent on block size	N/A	N/A
Planks, 2 inches	N/A	Two runways 3 foot-wide	50%
*Assumes a minimum ice thickness of 6 inches.			

C-31. Troops must maintain ice crossings. This maintenance includes reinforcement, snow clearance, approach road maintenance, and surface repair and improvement of wearing surface. Troops carry out the snow clearance to make the crossing trafficable to vehicles, to allow inspection of the ice surface, and to influence the freezing or thawing of the surface. Approach road maintenance is the same as that required for bridge and ford approaches. Troops repair badly worn or rutted surfaces by blading and filling or by re-covering the surface with snow and packing and freezing. Ice crossing lanes should be separated by 45 to 60 meters. (See Appendix A for length conversions.)



NOTES.

1. All logs 8” to 10” diameter.
2. Ice and frost must rest upon water with no air pockets under it.
3. Remove snow from logs and ice surface before slushing. Push snow from ice to each side to form a dam.
4. Logs resting upon bank should be free.

Figure C-4. Plank reinforcement of freshwater ice

SECTION IV – ICE CROSSING DEMOLITION

C-32. In some instances, troops destroy crossings to prevent their use by the enemy. The most effective means of destroying ice crossings is to use explosives. To install an explosive in ice, personnel create holes 9 feet apart in staggered rows with axes, chisels, ice augers, thermite grenades, or steam point drilling equipment. Figure C-5 illustrates how to execute this technique.

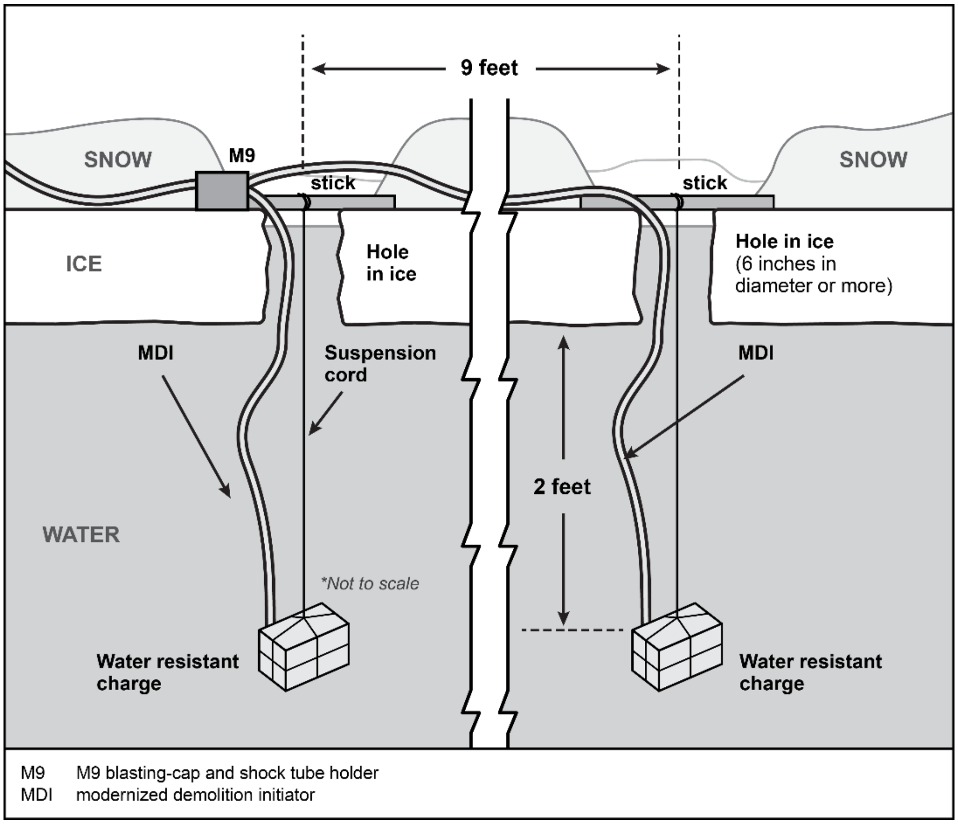


Figure C-5. Method of placing charges in ice

C-33. Soldiers/Marines suspend the charges in the water below the ice with cords tied to sticks bridging the tops of the holes. The charges should consist of explosives that are unaffected by water. Explosives must be protected from water and erosion by waterproofing the constructed charge. Charges should not be emplaced for extended periods to reduce the risk of misfires. Ensure charges are suspended 2 feet below the current or expected depth of the ice.

C-34. The normal thickness of freshwater ice is approximately 4 feet or less. In extremely cold areas, 5 feet of ice is not uncommon. An ice reconnaissance should be conducted prior to charge construction. The size of the charge depends on the thickness and condition of the ice. Test shots are used to find the optimum amount. An ice demolition may consist of several blocks of charges echeloned in width and depth and has at least two rows, each row alternating with the one before it. Detonating charges in this manner creates an obstacle for enemy armor and vehicles for approximately 24 hours at -24 °F. (See Appendix A for weight, length, and temperature conversions.)

Appendix D

Cold Weather Injury Identification and Prevention

This appendix provides information on cold weather injury identification, prevention, and treatment.

COMMON INJURIES AND ILLNESSES IN COLD WEATHER

D-1. When in the field, access to comprehensive medical care can be quite distant from a Soldier's or Marine's location. Knowledge of preventive measures is especially helpful. Should a medical situation arise, knowing the steps to take for immediate relief is important for the individual's well-being. Potential physical problems prevalent in a cold-weather environment include snow blindness, sunburn, tent eye, heat cramps and heat exhaustion, hypothermia, frostbite, dehydration, and carbon monoxide poisoning. A summarized list of symptoms, prevention, and treatment for common injuries/illnesses in cold weather are in Table D-1. For detailed information on cold weather first aid, refer to TC 21-3 or TC 4-02.1.

Table D-1. Common injuries in cold weather

Injury/Illness	*Symptoms*	*Preventive Measures*	*Treatment*
Battle wounds	• Low body temp prevents blood clotting. • Excessive bleeding. • Bleeding increases chance of hypothermia through rapid loss of body heat. • Shock.	• Stop bleeding. • Apply dressing. • Cover with clothing and padding. • Anti-shock treatment with fluids at body temperature (not cold fluids). • Adequate warmth is essential.	• Stop bleeding. • Apply dressing. • Cover with clothing and padding. • Anti-shock treatment with fluids at body temperature (not cold fluids). • Adequate warmth is essential.
Carbon monoxide poisoning	• Headache, dizziness, confusion, yawning, weariness, nausea, and ringing in the ears. • Bright red color on lips and skin. • Drowsiness and sudden collapse. • Unconsciousness. If a victim is found unconscious in an enclosed shelter, carbon monoxide poisoning should be suspected.	• Ensure that stoves and lanterns are functioning properly. • Do not let troops warm themselves by engine exhaust. • Always crack the windows in vehicles when a heater is in use. Do not allow anyone to sleep in a running vehicle. • Use a tent guard or shut the stove off when sleeping.	• Move the troop to open air. • Keep the victim still and warm. • Administer mouth-to-mouth resuscitation if necessary. • Administer cardiopulmonary resuscitation, if necessary. • Immediately evacuate. • Immediately administer oxygen, if available.

Table D-1. Common injuries in cold weather (continued)

Injury/Illness	*Symptoms*	*Preventive Measures*	*Treatment*
Constipation	• Stomach cramps • Dizziness • Headaches	• Eat fresh or canned fruit • Eat regularly. • Drink plenty of liquids. • Adherence to bowel routine.	• Prevention is the best treatment • Medical attention should be sought if constipation persists for more than three days.
Dehydration	• Red skin (indicates a severe condition needing immediate evacuation.) • Lack of appetite. • Dry mouth, tongue, and throat. • Stomach cramps and/or vomiting. • Headaches. • Lethargy. • Disorientation (without feeling or realizing it).	• Adequate hydration. • Drink water whenever possible, particularly during halts. • Ensure that canteens are full before any type of movement and fill with hot water, if possible. • During periods when water is scarce, do not eat snow. It can lower body temperature and the air it contains can cause stomachaches. • Diuretics such as coffee should be avoided. • Check urine spots in the snow. Dark yellow or brown indicates dehydration.	• Keep the patient warm. • Give plenty of liquids. • Make the patient rest.
Sunburn	• Skin redness with slight swelling. • Pain and blistering. • In severe cases, chills, fever, and headaches occur.	• Cover all skin with uniform. • Sunscreen (avoid using lotion-based sunscreen as it can contribute to a CWI). • Lip balm. • Shaving lotions with alcohol content should be avoided (they dissolve the skin's natural oils.)	• Soothing skin creams may be helpful if the swelling is not severe.

Table D-1. Common injuries in cold weather (continued)

Injury/Illness	*Symptoms*	*Preventive Measures*	*Treatment*
Frostbite	Superficial frostbite: • Skin appears white, waxy, and pale in lighter skin types, and red and pale in darker skin types. • There is numbness and the skin moves over the underlying tissue. • When dented, the skin rebounds. Deep frostbite: • Skin discoloration similar to superficial frostbite. There is no tactile sensation at all. • Limb may feel 'wooden.' • Skin does not move over the underlying tissue and when dented, does not rebound. • Skin can feel hard to the touch. After rewarming, a layer of dark-colored skin may form over the affected area.	• Do not wear tight boots and socks. • Use the 'buddy system' to check exposed areas, especially when the wind is blowing. • Carry extra socks and mitten liners. • Do not stay still for long periods of time. • Use caution when cold and wind are combined. • Check feet during halts. Consume good food and hot drinks as often as possible.	• Move the casualty to a warm and sheltered area. • Do not rub snow or apply cold water soaks. • Do not massage or expose to open fire. • Rewarm the face, nose, or ears by placing hands on the frozen area. • Rewarm frostbitten hands by placing them under clothing and against the body. • Close the clothing to prevent further loss of body heat. • Rewarm feet by placing bare feet against the abdomen of a buddy. • Loosen tight clothing and remove jewelry. • Improve circulation by exercising. Protect frozen tissue from further cold or trauma and evacuate the casualty to the nearest medical treatment facility.
Heat exhaustion	• Increased heart rate. • Increased respiratory rate. • Headache. • Dizziness. • Nausea and vomiting. • Thirst. • Fatigue. • Profuse sweating with cool, clammy skin.	• Routine and adequate hydration. • Proper layer management during strenuous activities. • Proper nutrition.	• Drink one canteen of water over the course of 30 to 45 minutes. • Ventilate excess heat but do not allow the patient to become chilled. • Intravenous fluids may be necessary. (Administer in a warm shelter.) • Loosen all tight-fitting clothes. • Elevate feet above the level of the heart. • If the unable to drink water due to an upset stomach or if the symptoms have not improved within 20 minutes, evacuate patient.

Table D-1. Common injuries in cold weather (continued)

Injury/Illness	*Symptoms*	*Preventive Measures*	*Treatment*
Hypothermia	• Mild hypothermia: • Shivering. • Lack of sound judgment; confusion, apathy, and mild mental impairment. • Pale, cool skin. • Increased heart and respiratory rates. • The 'umbles'—fumbles, stumbles, tumbles, grumbles, mumbles. • Moderate hypothermia: • Uncontrollable shivering. • Worsening of the 'umbles.' • Increased confusion. • Increased heart and respiratory rates. • Cold and pale skin. • Severe hypothermia: • Cessation of shivering. • Muscle rigidity. • Stupor progressing to unconsciousness. • Slow or nonpalpable pulse and respiration. • Cold, bluish skin.	• Adequate clothing • Regular meals, hot drinks, and rest • Dry clothing	• Perform first aid for mild and moderate hypothermia. All cases of hypothermia are evacuated to a medical facility for treatment. Follow these procedures: • Change the environment the casualty is in from cold and wet to warm and dry. • Replace damp clothing with dry clothing. • Add a windproof or waterproof layer and/or place the troop in a shelter. • Add extra insulation under and around the casualty. • Provide food and warm liquids. • Exercise mildly hypothermic patients. • Package a moderately hypothermic casualty in a hypothermia wrap.
Snow blindness	• A scratchy, sandy feeling under the eyelids. • Red and watering eyes. • Headache	• Wear issued sunglasses from the approved protective eyewear list • If sunglasses are not available, make glasses with slits from cardboard, thin wood, tree bark, or similar material	• Blindfold the troop using a dark cloth. • Reassure the patient. • Evacuate the casualty to a medical treatment facility.

COLD WEATHER INJURY PREVENTION

D-2. CWIs are always a possibility in cold environments. If allowed to develop, they can be debilitating to troops, diminishing a unit's combat power. However, leaders and their troops can successfully avoid hypothermia, frostbite, and other adverse cold weather-related conditions 24 hours a day by practicing prevention.

D-3. Attentive leadership is essential to ensure troops have, and are using, available cold weather clothing and equipment. A buddy system reinforces attentive leadership and helps troops monitor the fitness of a fellow Soldier/Marine to ensure the buddy is eating properly, drinking adequate amounts of water, dressing warmly, and that individual and unit equipment is maintained and functional. During arctic operations, leaders must continually check the fitness of their troops as well as the adequacy and condition of their clothing and equipment. Leaders frequently rotate troops into warming tents/areas to provide relief from the cold.

D-4. Rapid evacuation of cold weather casualties is essential to minimize long-term effects of CWIs and to save lives. Helicopter evacuation is the preferred method of transport; however, ground evacuation should always be planned. Risks to the patient, the unit, and the mission must be assessed.

Impact of Cold Weather Injuries During World War II

During World War II, CWIs exacted a heavy toll on the U.S. Army. During the winter of 1944 to 1945, the total number of CWI cases on the European western front was more than 23,000 troops (equal to about an infantry division and a half of personnel). Gen. Omar Bradley, the commanding general of the 12th Army, assessed that CWIs had seriously crippled the United States fighting strength in Europe. The injuries caught the armies unaware, partly because the possibility of its occurrence had been ignored. A vast percentage of Soldiers were not issued cold-weather clothing, nor were they trained to prevent CWIs. A survey of CWI casualties revealed that 85 percent of respondents felt they received too little training to prevent the injury, and 74 percent did not take the possibility of cold injury seriously. By the time leaders identified the need for training, CWIs were already overwhelming. At times, the number of CWI hospital admissions exceeded 20 percent of all casualties, which strained hospital bed occupancy, medical attention, nursing, and other care. Medical officers estimated that most of the Soldiers evacuated with a CWI could never return to combat, and that some may be incapacitated for life. It was not unusual for units to lose 10 to 15 percent of their strength to CWIs alone. At times, CWIs exceeded the number of battle casualties. However, more alert commanders who enforced CWI prevention and set up warming tents had drastically lower casualty rates. The impact of CWIs during WWII provides a cautionary tale and illustrates the devastating effect cold weather can have on unprepared units. CWIs are largely preventable with proper equipment and training. However, troops must train prior to the start of operations. Rarely can units effectively train CWI prevention in the midst of battle among too many other life-threatening priorities.

D-5. Early identification of symptoms and issues is key to preventing CWIs. Leaders conduct frequent checks of their troops and their equipment. Table D-2 provides a cold weather wellness checklist that should be conducted daily at a minimum during operations in cold weather.

Table D-2. Daily overall wellness check in cold weather

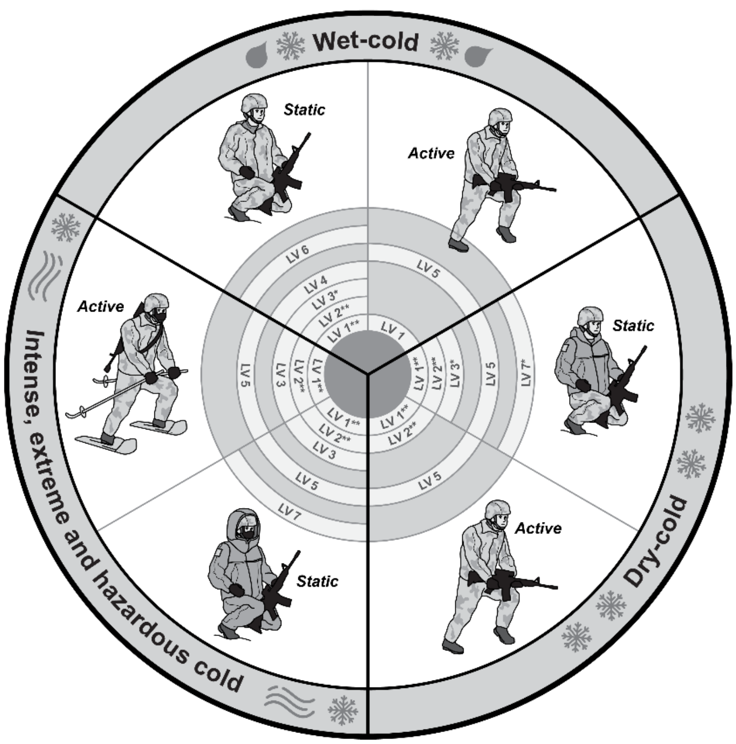
Cold Weather Wellness Checklist		
What	***How***	***Additional Questions***
General condition	• Fluid and nutrition. • Urine and feces. • Freezing/cold, not able to regain warmth.	• Special events? • Is equipment (such as sleeping bag, mittens, boots, etc.) wet or unfunctional?
Face, ears, and neck	• Abnormal color. • Redness. • White spots. • Blisters and/or swelling. • Pain and/or soreness. • Cracked lips. • Capillary refill >2 seconds. • Dry skin.	• Is equipment (such as hat, face mask, goggles, etc.) wet or broken?
Hands and feet	• Abnormal color. • Redness. • White spots. • Blisters and/or swelling. • Pain and/or soreness. • Cracked lips. • Capillary refill >2 seconds. • Dry skin. • Abnormal movement of joints. • Wounds or cuts. • Sensibility.	• Is equipment (such as mittens, shoes, socks, etc.) wet or unserviceable?
Other	• General condition.	• Ask if there are other issues.
Cold, slow capillary refill	Physical activity to increase circulation, rewarm skin to skin and check sensibility.	**With effect:** Frequent rechecks. **No effect:** Possible non-freezing cold injury; confer with medic/corpsman.
Red and swollen skin	**Cold related:** Rewarm skin to skin and cover up. **Non-cold related:** Cover up/tape it/apply ointment.	Be aware of possible negative development.
Blisters	**Cold related:** Cover up, avoid further exposure to cold. **Non-cold related:** Taping, puncturing or protect it with donut-shaped bandage/pad.	Confer with medic/corpsman, possible evacuation.
Damp skin	Air dry, rub gently with sock, sleep/rest with dry socks.	Work wet, sleep dry.
Athletes foot or warts	Be careful with hygiene. Make measures not to spread it.	Confer with medic/corpsman.
Impaired sensibility	Physical activity to increase circulation, rewarm skin to skin.	**With effect:** Frequent rechecks. **No effect:** Evacuation, possible cold weather injury.

Note. Adapted from NATO Centre of Excellence – Cold Weather Operations SIBERIA checklist.

D-6. Clothing plays a critical role in preventing CWIs. The cold weather clothes issued to Soldiers and Marines are effective provided they fit and are worn correctly. Fit of all clothing should be loose. Too much clothing hampers troops, causes them to sweat and dehydrate and then chills them because of wet undergarments. Every Soldier or Marine has a different metabolism and generates body heat at different rates. Therefore, troops may need to dress in different uniforms to achieve proper body temperature regulation. Leaders acknowledge these differences and prioritize safety over uniform standardization. Leaders should also check for small items troops need in cold environments such as lip balm, dark inserts for goggles or sunglasses, waterproof matches, extra socks and glove liners. Inspections and inventories should be conducted, and issues rectified prior to operations in the cold.

D-7. Leaders should understand the design principles of the military cold weather clothing system. These principles are:

- **Insulate.** Insulation allows the creation of a microclimate around the body through which the amount of body heat lost to the environment can be regulated. By varying the amount of insulation, troops can regulate the amount of heat lost or retained.
- **Layer.** Several layers of clothing provide more insulation and flexibility than one heavy garment, even if the heavy garment is as thick as the combined layers. Air pockets trapped between the layers provide insulation and warmth. By adding or removing layers of clothing (insulation), the troop can regulate the amount of heat lost or retained (see Figure D-1).
- **Ventilate.** Ventilation helps maintain a comfortable microclimate around the body, thereby helping control body temperature. By ventilating, troops can release excess heat and minimize sweating which can lower body temperature later as it evaporates.



Clothing layers:

Level 1:	Light-weight cold weather undershirt and drawers
Level 2:	Mid-weight cold weather shirt and drawers
Level 3:	Fleece cold weather jacket
Level 4:	Wind cold weather jacket (w/ soft shell trousers)
Level 5:	Soft shell jacket and trousers
Level 6:	Extreme cold/wet weather jacket and trousers
Level 7:	Extreme cold weather parka and trousers

Temperature zones:

Wet cold: 39°F to 20°F
Dry cold: 19°F to -4°F
Intense cold: -5°F to -24°F
Extreme cold: -25°F to -40°F
Hazardous cold: Below -40°F

NOTE. Depicted layers are *recommended* configurations. Individuals produce and retain heat at different rates and may require more or less layers to regulate body temperature. Uniform guidelines should prioritize safety over uniformity.

* optional ** may wear either level 1, level 2, or both

LV level

Figure D-1. Layer management of cold weather clothing

D-9. There are eight ways to make these principles work, which are listed and explained in Table D-3 with the mnemonic "COLD FEET."

Table D-3. Mnemonic for preventing cold weather injuries

COLD FEET	
C	Keep clothing CLEAN. Dirty clothing will have lower insulation properties.
O	Avoid OVERHEATING. Sweat dampens clothing and chills the body.
L	Wear clothing LOOSE and in LAYERS. Trapped air insulates. When working hard, loosen clothing to allow ventilation and cooling. Take off layers to cool down.
D	Keep clothing DRY. Socks, boots and underclothes will dry in your sleeping bag with you.
F	FIT your clothing properly. Take time to adjust your clothes, make good seals at ankles, waist, neck, head, and wrist.
E	EXERCISE your face, fingers, and toes. Regular exercise of these parts keeps the blood circulating.
E	EAT your rations and drink plenty. NO alcohol. Food gives energy and the body breaks it down to produce heat. Alcohol causes more blood to flow through the skin, thus losing heat.
T	TIGHT boots are TERRIBLE. They constrict the blood flow and stop movement. Look after your feet and keep your boots waterproofed.

Appendix E

Potential Adversary Equipment

This appendix provides descriptions of potential equipment that adversaries can use in arctic operations.

TOR-M2DT AIR DEFENSE SYSTEM

E-1. The TOR-M2DT (see Figure E-1) is a short-range (5 to 12 kilometer) air defense missile system using the TOR-M2 missile launcher. NATO designates it as SA-15 “Gauntlet.” The system is adapted for the arctic region by being mounted on the chassis of the DT-30PM articulated tracked vehicle. The TOR-M2DT was developed by Russia’s JSC Izhevsk Electromechanical Plant Kupol (a subsidiary of the Almaz-Antey Concern). The TOR-M2DT has been deployed in the Russian Arctic from Franz Josef Land to Chukotka.

Figure E-1. TOR-M2DT

BTR-82 ARMORED PERSONNEL CARRIER

E-2. The BTR-82 armored personnel carrier (known as APC) is the latest addition to the BTR-80 family (see Figure E-2). It is an improved version of the BTR-80A/S, which entered service in 1994. It was developed largely as a complement (and a stop-gap) for a BTR-90, whose development has been long, troubled, and expensive. The BTR-82 resembles the BTR-80A/S but has some minor improvements. In 2010, it successfully passed trials. Production commenced that same year. The original BTR-82 entered service with the Russian Army in 2011. However, the original BTR-82 was not produced in large numbers because production soon switched to the up-gunned BTR-82A, which the Russian military uses in large numbers. Its operating temperature range is -58 °F to 122 °F. (See Appendix A for temperature conversions.)

Figure E-2. BTR-82

RUSLAN TTM-4902 PS-10 ALL TERRAIN CARRIER

E-3. The Ruslan TTM-4902 PS-10 carrier is a two-sectioned, tracked, amphibious all-terrain vehicle (see Figure E-3). It has a 300-horsepower engine and can transport up to 22 people as well as provide bed space for five. Manufactured by the CJCS Transport Company, the Ruslan was designed to transport cargo, repair teams, and equipment (up to 4,000 kilograms) in off-road conditions. The first section is a power module (load-carrying capacity 500 kilograms). It can carry six people and has two full beds. The second section is a passenger module (16 people, six beds). Russians tested the vehicle in harsh conditions in the Murmansk region north of the Arctic Circle before entering it into service. These vehicles are currently in use by Russian units in the Arctic. The Ruslan TTM-4902PS-10 has a temperature range of -58 °F to 122 °F.

Figure E-3. TTM-4902 PS-10

DT-10PM AND DT-30PM "VITYAZ" ARTICULATED TRACKED VEHICLES

E-4. The function of the DT series of articulated tracked vehicle (see Figure E-4) is to carry munitions, military equipment, and personnel through difficult terrain and weather conditions (-49 °F to 104 °F degrees). It has excellent off-road capabilities in any season, including swamps, virgin snow, unimproved dirt roads, and water obstacles throughout Russia's Siberia and Far East districts. These are two-unit transport vehicles with all four tracks driving. Because of low ground pressure, the vehicle is theoretically immune to certain types of mines. Articulated tracked vehicles are indispensable as recovery vehicles since they have a high pull ratio and can approach a stuck or damaged vehicle from any direction in bad road conditions. Units can use the DT-30PM transporters for search and rescue teams operating in extreme conditions (bad roads, floods, snow-drifts, land- and snow-slides, or large-scale destruction). Units use it to evacuate people, animals, and various cargoes or to transport rescue teams, medical personnel, equipment, and food to affected areas. The DT-30PM has a fully-enclosed forward-control cab, which provides seating for a driver and four passengers. The engine compartment sits behind the cab. The rear unit can accommodate a variety of bodies. In some variants, the rear unit can vary considerably from the front. It is fully amphibious. On water, it is propelled by its tracks. The Vityaz-family of articulated tracked vehicles can operate in conditions impossible for other all-terrain vehicles, such as—

- Amphibious return to a mother ship.
- Off-road movement with one unit disabled or detached, or without both tracks on one of the units.
- Negotiation of ditches and clefts up to 4.0 meters wide.
- Unloading of a ship offshore if it cannot come close to waterfront (as in the Arctic and Antarctic regions or in flooded regions); negotiating waterways in severe ice conditions.
- Operating in mountains up to an altitude of 4,000 meters.

Figure E-4. DT series of articulated tracked vehicle

TM-140 "CHETRA" ALL-TERRAIN VEHICLE

E-5. The TM-140 "Chetra" is manufactured by Chetra PM (see Figure E-5). It is a commercial arctic vehicle created for oil workers and geologists working in difficult terrain and climatic conditions, adapted for military use. It functions well in snow and swamp environments. It can come equipped with a passenger module, a workshop module, or special purpose modules (pile driving, drilling rig, or crane).

Figure E-5. TM-140

MI-8AMTSH-VA ARCTIC HELICOPTER

E-6. The Mi-8AMTSh-VA (see Figure E-6) is a variant of the Mi-8 HIP multi-role transport helicopter and was first fielded in 2015 to the Russian Air and Space Force (known as RuASF). The Russian Navy received its first version in 2016. Produced by the Ulan-Ude Aviation Plant (known as U-UAP) in southeastern Siberia, it has been modified for arctic conditions. With an additional power unit, the helicopter can start up in temperatures down to -75 °F and remain in the open air without a hangar for up to five hours in a ready for take-off state. Designed as a transport helicopter, the Mi-8 proved to be a multi-purpose machine. The cable external suspension, equipped with the weight measuring device, makes it possible to carry large-size cargoes weighing up to three tons. If required, it can serve as either a combat, rescue, or artillery observation helicopter. The Mi-8AMTSh-VA is deployed to Kotelny Island, Tiksi, Nagurskaya, Anadyr, and Mys Schmidt. Russian forces use it for resupply, reconnaissance, and search and rescue operations in the Northern Sea Route.

Figure E-6. Mi-8AMTSh-VA

FIRE SUPPORT VEHICLE TOROS

E-7. The Toros is an arctic-adapted vehicle developed by Muromteplovoz based on the MT-LBu chassis (see Figure E-7). It is used for carrying personnel, transporting loads, infantry fire support, and escort and guard missions in arctic conditions. In addition to deep cold, this vehicle can operate in mountainous areas up to 3,000 meters above sea level as well as up to 4,000 meters above sea level with some modifications.

Figure E-7. Toros tracked armored vehicle.

TTM 1901 BERKUT SNOW MOBILE

E-8. The TTM-1901 Berkut is a snowmobile with a two-person heated cab and a rear cargo platform (see Figure E-8). It has skis in the front and tracks in the rear. The cab resembles an automobile interior with bucket seats, standard foot pedals, and a steering wheel instead of handlebars. Designed to transport personnel and tow skiers, it is built to order by the Nizhny Novgorod-based "NPO Transport" company using Oka car bodies and Lada engines. The cab's heating system maintains a temperature of 65 °F even if it is -60 °F outside. The vehicle drives on snow regardless of its thickness at a speed of 35 to 40 kilometers per hour. There is a combat station for a machine gunner. The Russian ministry of defense purchased 40 of these in November 2016. This vehicle is currently in use by Russia's arctic brigades (80th Independent Motor Rifle Brigade in Alakurtti and the 200th Independent Motor Rifle Brigade in Pechenga). The vehicle has also been used by the Russian border guards as well as the Ministry of Emergency Situations.

Figure E-8. TTM 1901 Berkut snowmobile

T-80BV MAIN BATTLE TANK

E-9. The T-80B main battle tank is a variant of the T-80, which was produced only in small numbers (see Figure E-9). The T-80B is the first variant produced in quantity. Small-scale production commenced in 1978. The T-80BV improves on the T-80B, adding Kontakt-1 explosive reactive armor (ERA). The T-80BV smoke grenade launchers were moved from either side of the main armament back to either side of the turret and positioned between the turret side and the ERA panels. On the turret of the T-80BV, the panels join to form a shallow chevron shape. ERA is also fitted to the forward part of the turret roof to provide protection against attacks from above. The ERA provides a high degree of protection against antitank guided missiles which rely on a high-explosive antitank warhead to penetrate armor. Over the frontal arc, it does not provide any added protection against armor-piercing discarding sabot or armor-piercing, fin-stabilized, discarding sabot rounds. Some T-80BV tanks have a dust flap under the glacis plate and some of them have been equipped with single line of ERA along the top of the hull. The T-80BV engine has a gas turbine, allowing the tank to be started in one minute at -20 °F compared to 45 minutes with an unheated diesel engine.

Figure E-9. T-80 main battle tank

ARMORED VEHICLE MT-LB

E-10. The wide track of the MT-LB makes it an effective light armored vehicle for ice, snow, and marshes (see Figure E-10). The MT-LB is a general-purpose carrier and prime mover developed from an unarmored civilian tractor. Some versions are used as an APC with a maximum capacity of 11 dismounted soldiers. It is armed with two PKT 7.62-millimeter machine guns. Units can mount other weapons systems on the vehicle for a variety of purposes. It has 7 to 14 millimeters of armor; has a collective nuclear, biological, and chemical protection system; and comes with a self-entrenching blade. The MT-LB has many variants.

Figure E-10. Armored vehicle MT-LB

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Appendix F

Planning Factors for Cold Weather Training and Operations

This appendix provides clothing and equipment planning factors by temperature zone for conventional equipment and Flame-Resistant Environmental Ensemble (FREE) Equipment. (See Appendix A for temperature conversions.)

SECTION I – CONVENTIONAL EQUIPMENT

F-1. This section provides clothing and equipment recommendations for conventional gear in cold temperature zone 1 (Table F-1) through cold temperature zone 5 (Table F-5).

Table F-1. Safety recommendations for cold temperature zone 1

Cold Temperature Zone 1: 39 to 20 ºF Wet Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**ECWCS Generation III:**
	Base Layer	Level I Lightweight cold weather undershirt/drawers and/or
		Level II Mid-weight cold weather shirt/drawers
	Insulating Layer	Level III Fleece jacket (Available/Optional)
	Outer Shell	Level IV Wind cold weather jacket
		Level VI Extreme cold/wet weather jacket
		Level VI Extreme cold/wet weather trousers
	Other: • Issued wool socks with synthetic liner sock • Temperate boots; cold weather boots recommended • Balaclava and neck gaiter • Issued GORE-TEX® gloves with liners • Knife • Arctic necklace (lighter and chap-stick worn around neck)	
Training	• Knowledge of cold weather environmental hazards • Knowledge of cold weather clothing capabilities and limitations • Skill to use cold weather clothing and equipment to provide protection from the elements • Skill to prevent, recognize, and treat cold weather injuries • Winter training is required for all personnel	
Food and Water	• MREs, MCW or FSR. Supplement with MORE, High altitude/cold weather (Type I) as available • One hot meal daily as mission dictates. UGR arctic Supplements as available • Requirement of 3.5 to 5 quarts of water per day	
Shelter and Heat	• Patrol Bag • GORE-TEX® bivouac cover • Sleeping mat • Poncho • Poncho liner (optional)	

Table F-1. Safety recommendations for cold temperature zone 1 (*continued*)

<table>
<tr><th colspan="2">Cold Temperature Zone 1: 39 to 20 ºF Wet Cold</th></tr>
<tr><th>Area of Consideration</th><th>Special Requirements and Recommended Actions</th></tr>
<tr><td>Additional Control Measures</td><td>• Water resupply plan
• Sanitation plan
• Leader/Medic checks at least daily
• No skin camouflage below 32 ºF</td></tr>
<tr><td colspan="2">ECWCS extended cold weather clothing system
F Fahrenheit
FSR First Strike Ration ®
MCW meal, cold weather
MRE meal, ready-to-eat
MORE modular operational rations enhancement
UGR unitized group ration</td></tr>
</table>

Table F-2. Safety recommendations for cold temperature zone 2

<table>
<tr><th colspan="3">Cold Temperature Zone 2: 19 to -4 ºF Dry Cold</th></tr>
<tr><th>Area of Consideration</th><th colspan="2">Special Requirements and Recommended Actions</th></tr>
<tr><td rowspan="9">Available Personal Clothing and Equipment</td><td>Clothing Layer:</td><td>ECWCS Generation III:</td></tr>
<tr><td rowspan="2">Base Layer</td><td>Level I Lightweight cold weather undershirt/drawers and/or</td></tr>
<tr><td>Level II Mid-weight cold weather shirt/drawers</td></tr>
<tr><td>Insulating Layer</td><td>Level III Fleece cold weather jacket (Available/Optional)</td></tr>
<tr><td rowspan="3">Outer Shell</td><td>Level VI Extreme cold/wet weather jacket for warmer range or Level V Soft shell jacket for colder range.</td></tr>
<tr><td>Level VI Extreme cold/wet weather trousers for warmer range or Level V Soft shell trousers for colder range.</td></tr>
<tr><td>Level VII Extreme cold weather parka (Available/Optional)</td></tr>
<tr><td colspan="2">Other:
• Issued wool socks with synthetic liner sock
• Cold weather boots
• Balaclava and neck gaiter
• Contact gloves
• White vapor barrier boots available
• Issued GORE-TEX® gloves with liners
• Trigger finger mittens with extra liners
• Knife
• Arctic necklace (lighter and chap-stick worn around neck)
• Double pane ski goggles</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Training</td><td colspan="2">• Winter training required for all personnel
• Cold weather field training for TO&E Units</td></tr>
<tr><td>Food and Water</td><td colspan="2">• MREs, MCW or FSR. Supplement with MORE, High altitude/cold weather (Type I) as available
• 1 hot meal daily as mission dictates. UGR arctic supplements as available
• Requirement of 3.5 to 5 quarts of water per day
• Increase caloric intake</td></tr>
</table>

Table F-2. Safety recommendations for cold temperature zone 2 (*continued*)

Cold Temperature Zone 2: 19 to -4 ºF Dry Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Shelter and Heat	Individual: • MSS, all components • sleeping mat, poncho and poncho liner • Open air bivouac possible Squad: • Ahkio group complete • Arctic 10-person tent • Space heater, arctic
Additional Control Measures	• Leader/medic CWI checks for cold weather injuries 2 to 3 times daily at minimum for exposed troops. Detailed check once daily • All troops checked upon entering shelter • Water resupply and storage plan (to prevent water from freezing) • Sanitation plan • Contact gloves must be worn when working outdoors • POL gloves must be worn when working with fuel • Consider 4 season, 2 to 4 person shelters for personnel that work away from support base • Level V Soft shell available for lower end of temperature range

CWI	cold weather injury	MRE	meal, ready-to-eat
ECWCS	extended cold weather clothing system	MSS	modular sleep system
F	Fahrenheit	POL	petroleum, oil, and lubricants
FSR	First Strike Ration ®	TO&E	table of organization and equipment
MCW	meal, cold weather	UGR	unitized group ration
MORE	modular operational rations enhancement		

Table F-3. Safety recommendations for cold temperature zone 3

Cold Temperature Zone 3: -5 to -24 ºF Intense Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**ECWCS Generation III:**
	Base Layer	Level I Lightweight cold weather undershirt/drawers and/or
		Level II Mid-weight cold weather shirt/drawers
	Insulating Layer	Level III Fleece cold weather jacket
	Outer Shell	Level V Soft shell jacket
		Level V Soft shell trousers
		Level VII Extreme cold weather parka (Worn in static positions; Available during movements)
		Level VII Extreme cold weather trousers (Worn in static positions; Available during movements)

Table F-3. Safety recommendations for cold temperature zone 3 (*continued*)

Cold Temperature Zone 3: -5 to -24 ºF Intense Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Available Personal Clothing and Equipment (continued)	Other: • Issued wool socks with synthetic liner sock • Cold weather boots • White vapor barrier boots • Balaclava and neck gaiter • Double pane ski goggles • Spare balaclava, neck gaiter, mitten liners, socks available • Contact gloves • Issued intermediate cold gloves with liners • Trigger finger mittens • Arctic mittens • Knife • Arctic necklace (lighter and chap-stick worn around neck)
Training	• Winter training required for all personnel • Cold weather field training for TO&E units
Food and Water	• MCW, supplement with MORE, high altitude/cold weather (Type I) as available • One hot meal daily as mission dictates. UGR arctic supplements as available • Requirement of 3.5 to 5 quarts of water per day. Transport bulk water in heated truck. Fill cans with hot water. Water trailer in heated tents. • MRE/FSR are not preferred. • Calorie intake 4,600 for males; 3,150 for females depending on workload
Shelter and Heat	Individual: • MSS, all components • Sleeping mat, poncho, and poncho liner • Open air bivouac for well-trained units Squad: • Ahkio Group complete • Arctic 10-person tent • Space heater, arctic
Additional Control Measures	Implement all control measures from temperature zone 2 and change/add: • Leader/medic CWI checks for cold weather injuries every 2 hours; Buddy checks 1 hour for exposed troops. Detailed check once daily • Rotate troops in static positions frequently • Warm tents and/or vehicles available for troops • 4 season shelters for personnel that work away from support base are mandatory • All troops checked upon entering shelter • Mandatory sock change daily

CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
F	Fahrenheit	MSS	modular sleep system
FSR	First Strike Ration ®	TO&E	table of organization and equipment
MCW	meal, cold weather	UGR	unitized group ration

Table F-4. Safety recommendations for cold temperature zone 4

<table>
<tr><th colspan="3">Cold Temperature Zone 4: -25 to -40 ºF Extreme Cold</th></tr>
<tr><th>Area of Consideration</th><th colspan="2">Special Requirements and Recommended Actions</th></tr>
<tr><td rowspan="9">Available Personal Clothing and Equipment</td><td>Clothing Layer:</td><td>ECWCS Generation III:</td></tr>
<tr><td rowspan="2">Base Layer</td><td>Level I Lightweight cold weather undershirt/drawers and/or</td></tr>
<tr><td>Level II Mid-weight cold weather shirt/drawers</td></tr>
<tr><td>Insulating Layer</td><td>Level III Fleece cold weather jacket</td></tr>
<tr><td rowspan="4">Outer Shell</td><td>Level V Soft shell jacket</td></tr>
<tr><td>Level V Soft shell trousers</td></tr>
<tr><td>Level VII Extreme cold weather parka (Worn in static positions; Available during movements)</td></tr>
<tr><td>Level VII Extreme cold weather trousers (Worn in static positions; Available during movements)</td></tr>
<tr><td colspan="2">Other:
• Issued wool socks with synthetic liner sock
• Cold weather boots
• White vapor barrier boots
• Balaclava and neck gaiter
• Double pane ski goggles
• Spare balaclava, neck gaiter, mitten liners, socks available
• Contact gloves
• Issued intermediate cold gloves with liners
• Trigger finger mittens
• Arctic mittens
• Knife
• Arctic necklace (lighter and chap-stick worn around neck)</td></tr>
<tr><td>Training</td><td colspan="2">• Winter training required for all personnel
• Cold weather field training for TO&E Units</td></tr>
<tr><td>Food and Water</td><td colspan="2">• MCW, supplement with MORE, high altitude/cold weather (Type I) as available
• 1 hot meal daily as mission dictates. UGR arctic supplements as available
• Requirement of 3.5 to 5 quarts of water per day. Transport bulk water in heated truck. Fill cans with hot water. Water trailer in heated tents.
• MRE/FSR are not preferred.
• Calorie intake 4,600 for males; 3,150 for females depending on workload</td></tr>
</table>

Table F-4. Safety recommendations for cold temperature zone 4 (*continued*)

Cold Temperature Zone 4: -25 to -40 ºF Extreme Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Shelter and Heat	Individual: • MSS, all components • Sleeping mat, poncho, and poncho liner • **Open air or unheated bivouac for very highly skilled units** Squad: • Ahkio group complete • Arctic 10-person tent • Space heater, arctic
Additional Control Measures	Implement all control measures from temperature zone 3 and change/add: • All troops checked upon entering shelter; Risk Level is high • Limit outdoor operations and training; close scrutiny of operations/training by leaders is required • Hourly leader/medic CWI checks. Detailed check once daily • Buddy checks 30 to 45 mins for exposed troops • Cover all exposed skin • Static duty not recommended; rotate minimum 2 to 3 hours • Mandatory sock change daily

CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
F	Fahrenheit	MSS	modular sleep system
FSR	First Strike Ration ®	TO&E	table of organization and equipment
MCW	meal, cold weather	UGR	unitized group ration

Table F-5. Safety recommendations for cold temperature zone 5

Cold Temperature Zone 5: Below -40 ºF Hazardous Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**ECWCS Generation III:**
	Base Layer	Level I Lightweight cold weather undershirt/drawers and/or
		Level II Mid-weight cold weather shirt/drawers
	Insulating Layer	Level III Fleece cold weather jacket
	Outer Shell	Level V Soft shell jacket
		Level V Soft shell trousers
		Level VII Extreme cold weather parka (Worn in static positions; Available during movements)
		Level VII Extreme cold weather trousers (Worn in static positions; Available during movements)

Table F-5. Safety recommendations for cold temperature zone 5 (*continued*)

Cold Temperature Zone 5: Below -40 ºF Hazardous Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Available Personal Clothing and Equipment (continued)	Other: • Issued wool socks with synthetic liner sock • Cold weather boots • White vapor barrier boots in the field and outdoor work • Balaclava and neck gaiter • Double pane ski goggles • All skin covered • Spare balaclava, neck gaiter, mitten liners, socks available • Contact gloves mandatory • Issued intermediate cold gloves with liners • Trigger finger mittens • Arctic mittens with liner gloves • Knife • Arctic necklace (lighter and chap-stick worn around neck)
Training	• Winter training required for all personnel • Cold weather field training for TO&E Units
Food and Water	• MCW, supplement with MORE, high altitude/cold weather (Type I) as available • One or two hot meals daily as mission dictates. UGR arctic supplements as available • Requirement of 3.5 to 5 quarts of water per day. Transport bulk water in heated truck. Fill cans with hot water. Water trailer in heated tents. • MRE/FSR are not preferred. • Calorie intake 4,600 for males; 3,150 for females depending on workload
Shelter and Heat	Individual: • MSS, all components • sleeping mat, poncho, and poncho liner • **Open air or unheated bivouac not recommended** Squad: • Ahkio Group complete • Arctic 10-person tent • Space heater, arctic
Additional Control Measures	Implement all control measures from Temperature Zone 4 and change/add: • Risk level is extremely high • Buddy checks 30 to 45 minutes, Leader/medic CWI checks minimum hourly for exposed troops, Detailed check once daily. • Mandatory sock change daily • Limit outdoor operations and training to critical life support tasks • Warm tents and/or vehicles mandatory for all personnel • All troops checked upon entering shelter

CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
F	Fahrenheit	MSS	modular sleep system
FSR	First Strike Ration ®	TO&E	table of organization and equipment
MCW	meal, cold weather	UGR	unitized group ration

SECTION II – FLAME RESISTANT ENVIRONMENTAL ENSEMBLE (FREE) EQUIPMENT

F-2. This section provides clothing and equipment recommendations for FREE equipment in cold temperature zone 1 (Table F-6) through cold temperature zone 5 (Table F-10).

Table F-6. FREE safety recommendations for cold temperature zone 1

Cold Temperature Zone 1: 39 to 20 ºF Wet Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**Fire Resistant Environmental Ensemble (FREE):**
	Base Layer	Layer I Under Layer, Layer II Base Layer
	Insulating Layer	Layer III Mid Weight
	Outer Shell	Layer IV A2CU, Layer V LWOL
	Other: • FREE socks • Temperate boots; cold weather boots recommended • Balaclava and neck gaiter • Issued Nomex gloves, FREE liners • Knife • Arctic necklace (lighter and chap-stick worn around neck)	
Training	• Knowledge of cold weather environmental hazards • Knowledge of cold weather clothing capabilities and limitations • Skill to use cold weather clothing and equipment to provide protection from the elements • Skill to prevent, recognize and treat cold weather injuries • Winter training is required for all personnel	
Food and Water	• MREs, MCW or FSR. Supplement with MORE, High altitude/cold weather (Type I) as available • One hot meal daily as mission dictates. UGR arctic supplements as available • Calorie intake 4,600 for males; 3,150 for females depending on workload	
Shelter and Heat	• MSS, all components • GORE-TEX® bivouac cover • Sleeping mat • Poncho • Poncho liner (optional)	
Additional Control Measures	• Water resupply plan • Heavier layers must be available for aircrew and fuelers around running aircraft. POL gloves mandatory for fuelers • Layer VII EWOL is the outer shell in rainy conditions. • Leader/medic checks at least daily • No skin camouflage below 32 ºF	

A2CU	Army aircrew combat uniform	MCW	meal, cold weather
CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
EWOL	extreme weather outer layer	MSS	modular sleep system
F	Fahrenheit	POL	petroleum, oil, and lubricants
FSR	First Strike Ration ®	TO&E	table of organization and equipment
LWOL	light weather outer layer	UGR	unitized group ration

Table F-7. FREE safety recommendations for cold temperature zone 2

<table>
<tr><th colspan="3">Cold Temperature Zone 2: 19 to -4 ºF Dry Cold</th></tr>
<tr><th>Area of Consideration</th><th colspan="2">Special Requirements and Recommended Actions</th></tr>
<tr><td rowspan="5">Available Personal Clothing and Equipment</td><td>Clothing Layer:</td><td>Fire Resistant Environmental Ensemble (FREE):</td></tr>
<tr><td>Base Layer</td><td>Layer I Under Layer, Layer II Base Layer</td></tr>
<tr><td>Insulating Layer</td><td>Layer III Mid Weight, Layer IV A2CU</td></tr>
<tr><td>Outer Shell</td><td>Layer V LWOL or Layer VI IWOL</td></tr>
<tr><td colspan="2">Other:
• FREE socks
• Cold weather boots
• Balaclava and neck gaiter
• White vapor barrier boots available
• Mukluks with standard or upgraded liners
• Issued Nomex gloves, FREE liners
• Arctic mittens available
• Knife
• Arctic necklace (lighter and chap-stick worn around neck)
• Double pane ski goggles</td></tr>
<tr><td>Training</td><td colspan="2">• Winter training required for all personnel
• Cold weather field training for TO&E Units</td></tr>
<tr><td>Food and Water</td><td colspan="2">• MREs, MCW or FSR. Supplement with MORE, high altitude/cold weather (Type I) as available
• One hot meal daily as mission dictates. UGR arctic supplements as available
• Requirement of 3.5 to 5 quarts of water per day
• Increase caloric intake</td></tr>
<tr><td>Shelter and Heat</td><td colspan="2">Individual:
• MSS, all components
• Sleeping mat, poncho, and poncho liner
• Open air bivouac possible
Squad:
• Ahkio group complete
• Arctic 10-person tent
• Space heater, arctic</td></tr>
<tr><td>Additional Control Measures</td><td colspan="2">• Leader/medic CWI checks for cold weather injuries; 2 to 3 times daily at minimum for exposed troops. Detailed check once daily
• All troops checked upon entering shelter
• Water resupply and storage plan (to prevent water from freezing)
• Sanitation plan
• Contact gloves must be worn when working outdoors
• POL gloves must be worn when working with fuel
• Consider 4 season, 2 to 4 person shelters for personnel that work away from support base
• Heavier layers must be available for aircrew and fuelers around running aircraft. POL gloves mandatory for fuelers</td></tr>
</table>

Table F-7. FREE safety recommendations for cold temperature zone 2 (*continued*)

Cold Temperature Zone 2: 19 to -4 ºF Dry Cold			
A2CU	Army aircrew combat uniform	MCW	meal, cold weather
CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
EWOL	extreme weather outer layer	MSS	modular sleep system
F	Fahrenheit	POL	petroleum, oil, and lubricants
FSR	First Strike Ration ®	TO&E	table of organization and equipment
IWOL	intermediate weather outer layer	UGR	unitized group ration
LWOL	light weather outer layer		

Table F-8. FREE safety recommendations for cold temperature zone 3

Cold Temperature Zone 3: -5 to -24 ºF Intense Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**Fire Resistant Environmental Ensemble (FREE):**
	Base Layer	Layer I Under Layer, Layer II Base Layer, Layer III Mid Weight
	Insulating Layer	Layer IV A2CU, Layer VII EWOL fleece
	Outer Shell	Layer V LWOL or Layer VI IWOL with vest and Layer VII EWOL
	Other: • FREE socks • Balaclava and neck gaiter • White vapor barrier boots • Mukluks with standard or upgraded liners • Issued Nomex gloves, FREE liners • Arctic mittens with glove liner • Contact gloves/POL gloves mandatory • Spare balaclava, neck gaiter, mitten liners, socks available • Knife • Arctic necklace (lighter and chap-stick worn around neck) • Double pane ski goggles	
Training	• Winter training required for all personnel • Cold weather field training for TO&E Units	
Food and Water	• MCW, supplement with MORE, high altitude/cold weather (Type I) as available • One hot meal daily as mission dictates. UGR arctic supplements as available • Requirement of 3.5 to 5 quarts of water per day. Transport bulk water in heated truck. Fill cans with hot water. Water trailer in heated tents. • MRE/FSR are not preferred. • Calorie intake 4,600 for males; 3,150 for females depending on workload	
Shelter and Heat	Individual: • MSS, all components • Sleeping mat, poncho and poncho liner • Open air bivouac for well-trained units Squad: • Ahkio group complete • Arctic 10-person tent • Space heater, arctic	

Table F-8. FREE safety recommendations for cold temperature zone 3 (*continued*)

Cold Temperature Zone 3: -5 to -24 ºF Intense Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Additional Control Measures	Implement all control measures from temperature zone 2 and change/add: • Leader/medic CWI checks for cold weather injuries every 2 hours; Buddy checks 1 hour for exposed troops. Detailed check once daily • Rotate troops in static positions frequently • Warm tents and/or vehicles available for troops • 4 season shelters for personnel that work away from support base are mandatory • Heavier layers must be worn by aircrew and fuelers around running aircraft. POL gloves mandatory for fuelers • Mandatory sock change daily

A2CU	Army aircrew combat uniform	MCW	meal, cold weather
CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
EWOL	extreme weather outer layer	MSS	modular sleep system
F	Fahrenheit	POL	petroleum, oil, and lubricants
FSR	First Strike Ration ®	TO&E	table of organization and equipment
IWOL	intermediate weather outer layer	UGR	unitized group ration
LWOL	light weather outer layer		

Table F-9. FREE safety recommendations for cold temperature zone 4

Cold Temperature Zone 4: -25 to -40 ºF Extreme Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**Fire Resistant Environmental Ensemble (FREE):**
	Base Layer	Layer I Under Layer, Layer II Base Layer, Layer III Mid Weight
	Insulating Layer	Layer VI A2CU, Layer V LWOL or Layer VI IWOL
	Outer Shell	Layer VII EWOL with fleece liner
	Other: • FREE socks • Balaclava and neck gaiter • White vapor barrier boots • Mukluks with standard or upgraded liners • Issued Nomex gloves, FREE liners • Arctic mittens with glove liner • Contact gloves/POL gloves mandatory • Spare balaclava, neck gaiter, mitten liners, socks available • Knife • Arctic necklace (lighter and chap-stick worn around neck) • Double pane ski goggles	
Training	• Winter training required for all personnel • Cold weather field training for TO&E Units	

Table F-9. FREE safety recommendations for cold temperature zone 4 (*continued*)

Cold Temperature Zone 4: -25 to -40 ºF Extreme Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Food and Water	• MCW, supplement with MORE, high altitude/cold weather (Type I) as available • One hot meal daily as mission dictates. UGR arctic supplements as available • Requirement of 3.5 to 5 quarts of water per day. Transport bulk water in heated truck. Fill cans with hot water. Water trailer in heated tents. • MRE/FSR are not preferred. • Calorie intake 4,600 for males; 3,150 for females depending on workload
Shelter and Heat	Individual: • MSS, all components • Sleeping mat, poncho, and poncho liner • **Open air or unheated bivouac for very highly skilled units** Squad: • Ahkio group complete • Arctic 10-person tent • Space heater, arctic
Additional Control Measures	Implement all control measures from temperature zone 3 and change/add: • All troops checked upon entering shelter; Risk Level is high • Limit outdoor operations and training; close scrutiny of operations/training by leaders is required • Hourly leader/medic CWI checks. Detailed check once daily • Buddy checks 30 to 45 mins for exposed troops • Cover all exposed skin • Static duty not recommended; rotate minimum 2 to 3 hours • Mandatory sock change daily

A2CU	Army aircrew combat uniform	MCW	meal, cold weather
CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
EWOL	extreme weather outer layer	MSS	modular sleep system
F	Fahrenheit	POL	petroleum, oil, and lubricants
FSR	First Strike Ration ®	TO&E	table of organization and equipment
IWOL	intermediate weather outer layer	UGR	unitized group ration
LWOL	light weather outer layer		

Table F-10. FREE safety recommendations for cold temperature zone 5

Cold Temperature Zone 5: Below -40 ºF Hazardous Cold		
Area of Consideration	***Special Requirements and Recommended Actions***	
Available Personal Clothing and Equipment	**Clothing Layer:**	**Fire Resistant Environmental Ensemble (FREE):**
	Base Layer	Layer I Under Layer, Layer II Base Layer, Layer III Mid Weight
	Insulating Layer	Layer IV A2CU, Layer V LWOL or Layer VI IWOL
	Outer Shell	Layer VII EWOL with fleece liner

Table F-10. FREE safety recommendations for cold temperature zone 5 (*continued*)

Cold Temperature Zone 5: Below -40 ºF Hazardous Cold	
Area of Consideration	***Special Requirements and Recommended Actions***
Available Personal Clothing and Equipment (*continued*)	Other: • FREE socks • Balaclava and neck gaiter • White vapor barrier boots • Mukluks with standard or upgraded liners • Issued Nomex gloves, FREE liners • Arctic mittens with glove liner • Contact gloves/POL gloves mandatory • Spare balaclava, neck gaiter, mitten liners, socks available • Knife • Arctic necklace (lighter and chap-stick worn around neck) • Double pane ski goggles
Training	• Winter training required for all personnel • Cold weather field training for TO&E Units
Food and Water	• MCW, Supplement with MORE, High altitude/cold weather (Type I) as available • One or two hot meals daily as mission dictates. UGR arctic supplements as available • Requirement of 3.5 to 5 quarts of water per day. Transport bulk water in heated truck. Fill cans with hot water. Water trailer in heated tents. • MRE/FSR are not preferred. • Calorie intake 4,600 for males; 3,150 for females depending on workload
Shelter and Heat	Individual: • MSS, all components • sleeping mat, poncho and poncho liner • **Open air or unheated bivouac not recommended** Squad: • Ahkio Group complete • Arctic 10-person tent • Space heater, arctic
Additional Control Measures	Implement all control measures from temperature zone 4 and change/add: • Risk level is extremely high • Buddy checks 30 to 45 minutes, Leader/medic CWI checks minimum hourly for exposed troops, Detailed check once daily. • Mandatory sock change daily • Limit outdoor operations and training to critical life support tasks • Warm tents and/or vehicles mandatory for all personnel • All troops checked upon entering shelter

A2CU	Army aircrew combat uniform	MCW	meal, cold weather
CWI	cold weather injury	MORE	modular operational rations enhancement
ECWCS	extended cold weather clothing system	MRE	meal, ready-to-eat
EWOL	extreme weather outer layer	MSS	modular sleep system
F	Fahrenheit	POL	petroleum, oil, and lubricants
FSR	First Strike Ration ®	TO&E	table of organization and equipment
IWOL	intermediate weather outer layer	UGR	unitized group ration
LWOL	light weather outer layer		

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Appendix G

Sample Risk Assessment Considerations for Arctic Operations

This appendix provides sample risk assessment considerations for various arctic training and operations.

G-1. Table G-1 thorough Table G-4 provide examples of hazards and controls for the following:

- Training using firearms (Table G-1).
- Training with possibility of a fire hazard (Table G-2).
- Training over-snow movement (Table G-3).
- Training with possibility of avalanche hazard (Table G-4).

G-2. Units create a DD Form 2977 to perform their own thorough assessment of risk based on present conditions, hazards, and the training level of their Soldiers/Marines.

Table G-1. Example of risk assessment involving firearms

Hazard	*Control*
Cold weather injuries while engaging targets in a snow covered environment	All individuals wear contact gloves at a minimum while outside.
	Individuals do not place nose against stock or charging handle.
	All individuals use neck gaiter or balaclava to prevent contact frostbite.
	Clothing is appropriate to temperature zone.
	Medical personnel take refresher class on signs of frostbite.
	Evacuation platform is on site during the entire occupation.
Negligent Discharge	All individuals briefed on range procedures prior to occupying firing line.
	All individuals attend preliminary marksmanship instruction prior to occupying range.
	Unit issues ammunition just prior to occupying the firing line.
	All individuals rod weapons on and off the firing line.
Weapons malfunction due to frozen condensation	Store and guard weapons outside in extreme cold temperatures to prevent condensation. Avoid exposing weapons to extreme temperature shifts.

Table G-2. Example of risk assessment involving fire hazard

Hazard	*Control*
Tent fire while operating a space heater, arctic	Operational fire extinguisher and smoke detector are in the center of the tent.
	Stove is placed on stove board to prevent stove from touching ground.
	Only licensed personnel are authorized to operate stove.
	Fireguard required when stove is in use. Fireguard must be licensed to operate the stove.
	When lighting the stove, all individuals must be awake, doors open to the outside.
	Individuals ensure that flaps on stove pipe opening closure flap are tied open and do not touch the stove pipe.
	Individuals ensure that drip interceptor loop is in fuel supply hose to prevent fuel from running down the hose onto the tent.
	Individuals tie lines from the stack cap assembly directly to the tent to allow stack to move with tent in windy conditions.
	Individuals ensure that snow flaps are positioned to the outside of tent and are not frozen to the ground to allow individuals to roll out.
	Tent pole is 6 to 8 feet in height to prevent tent from coming in contact with stove.

Table G-2. Example of risk assessment involving fire hazard (*continued*)

Hazard	Control
Carbon monoxide poisoning while operating a space heater, arctic	Individuals ensure all ventilators are open when operating stove.
	Individuals use all sections of the stack assembly to allow the stove to draft properly.
	Individuals ensure that the seams on the stove pipes are in line with each other.
Frostbite while handling fuel	At least 1 pair of petroleum handler gloves is in each ahkio group. Individuals wear petroleum handler gloves when handling fuel.
Environmental damage from fuel spills	Fuel absorbent pads are in each ahkio group. Individuals place fuel absorbent pads beneath fuel cans.

Table G-3. Example of risk assessment for over-snow movement

Hazard	Control
Cold weather injuries while conducting over-snow movement	Clothing is appropriate to temperature zone and activity level.
	Squad leader checks each individual's pack to ensure appropriate equipment is available.
	Buddy teams are assigned.
	Medical personnel check all individuals at conclusion of event in a warm shelter.
	Medics/corpsmen monitor checkpoints along the route with radio and evacuation vehicle with separate driver (not the medic/corpsman).
Dehydration	Each individual departs starting area with at least 2 liters of water. Water is positioned along route.
	Individuals ensure the pace is kept at a level that reduces the chances of sweating.
Lost troops	Individuals briefed on route.
	Trail is well marked.
	Squad leaders have maps and navigation equipment.
Slips and falls	Individuals use ski poles for balance for ski or snowshoe movement.
	Individuals are trained to use snowshoes prior to execution.
Equipment malfunctions due to cold weather conditions	Use purpose-built equipment or modify equipment to be winterized using adapters and modification kits in accordance with TM 4-33-31.
Encounter with wildlife predator	Follow commander's established rules of engagement if threatened by wildlife predator.

Table G-4. Example of risk assessment involving avalanche hazard

Hazard	Control
Avalanche	Training area will be reconned prior to occupation. Medical personnel with evacuation vehicle present.
	Qualified personnel will evaluate snowpack and slope angles prior to occupation.
	Minimum equipment will include shovels per 2 individuals; probe per 2 individuals.
	Individuals minimize number of personnel in slide path.
	Individuals rehearse recovery of buried personnel before entering avalanche terrain.
	Individuals recon through map and imagery prior to movement.
	Individuals submit route overlay and timeline to higher headquarters.

Source Notes

This division lists sources by page number. Vignettes are bolded.

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69 Sample historical data collected from Point Barrow, Alaska.

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81 **Mission Command and Motti Tactics**. Vignette adapted from Chew, Allen F. *Leavenworth Papers No. 5: Fighting the Russians in Winter: Three Case Studies*. (Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, 1981). Figure 3-1. Battle of Suomussalmi recreated from Esposito, Vincent. The West Point Atlas of American Wars, Vol. II, 1900 – 1953. (West Point, New York: United States Military Academy, 1959).

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Glossary

The glossary lists acronyms and terms with Army, joint, and Marine Corps definitions. Where Army definitions differ from Marine Corps, (Army) or (Marine Corps amplification) precedes the definition. The proponent publication for terms is listed in parentheses after the definition.

SECTION I – ACRONYMS AND ABBREVIATIONS

AFDP	Air Force doctrine publication
AR	Army regulation
ATP	Army techniques publication
C	Celsius
CATV	cold weather all-terrain vehicle
CBRN	chemical, biological, radiological, or nuclear
CWI	cold weather injury
DA	Department of the Army
DD	Department of Defense (form)
DoD	Department of Defense
DZ	drop zone
ECWCS	extended cold weather system
ERA	explosive reactive armor
F	Fahrenheit
FM	field manual
FREE	Flame-Resistant Environmental Ensemble
GPS	Global Positioning System
HF	high frequency
JP	joint publication
LARC	lighter, amphibious resupply, cargo
LCAC	landing craft, air cushion
LOC	line of communications
LZ	landing zone
MCDP	Marine Corps doctrinal publication
MCRP	Marine Corps reference publication
MCTP	Marine Corps tactical publication
MCWP	Marine Corps warfighting publication
METOC	meteorology and oceanography
METT-T	mission, enemy, terrain and weather, troops and support available - time available
METT-TC (I)	mission, enemy, terrain and weather, troops and support available, time available, civil considerations, and informational considerations

NATO	North Atlantic Treaty Organization
NCO	noncommissioned officer
OE	operational environment
PAA	position area for artillery
PAM	pamphlet
PMCS	preventive maintenance checks and services
POL	petroleum, oils, and lubricants
PRT	physical readiness training
RAIPON	Russian Association of Indigenous Peoples of the North
RSOI	reception, staging, onward movement, and integration
SATCOM	satellite communications
SHA	space heater, arctic
SOF	special operations forces
SOP	standard operating procedure
SUSV	Small unit support vehicle
SWO	staff weather officer
TB MED	technical bulletin medical
TC	training circular
TEWT	tactical exercise without troops
TO&E	table of organization and equipment
U.S.	United States
UAS	unmanned aircraft system
UGR	unitized group ration
USMC	United States Marine Corps
UW	unconventional warfare

SECTION II –TERMS

air interdiction

Air operations to perform interdiction conducted at such distances from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required. (JP 3-03)

airdrop

The unloading of personnel or materiel from aircraft in flight. (JP 3-36)

airland

Movement by air and disembarkment, or unloading, on the ground after the aircraft has landed or while an aircraft is hovering. (JP 3-36)

***arctic determination**

An individual's mental and physical tenacity to accomplish the mission by leveraging confidence in personal skills to overcome extreme cold weather and other arctic challenges.

***arctic operations**

Actions executed in ice cap, tundra, and boreal terrain that require special techniques and equipment.

area defense

(Army) A type of defensive operation that concentrates on denying enemy forces access to designated terrain for a specific time rather than destroying the enemy outright. (ADP 3-90)
(Marine Corps amplification) A type of defense in which the bulk of the defending force is deployed on selected terrain. Principal reliance is placed on the ability of the defending forces to maintain their positions and to control the terrain between them. The reserve is used to add depth, to block, or restore the battle position by counterattack. (USMC Dictionary; see also MCWP 3-01)

breach

(Army) A tactical mission task in which a unit breaks through or establishes a passage through an enemy obstacle. (FM 3-90)

(Marine Corps amplification) To break through or secure a passage through an obstacle (USMC Dictionary)

clearing

A mobility (focused on movement) task performed by follow-on engineers and explosive ordnance disposal that involves the total elimination or neutralization of an obstacle. (ATP 3-90.4/MCTP 3-34A; USMC Dictionary)

close air support

Air action by aircraft against hostile targets that are in close proximity to friendly forces and that require detailed integration of each air mission with the fire and movement of those forces. (JP 3-09.3)

***cold weather capability**

The ability to survive and operate in cold environments without being significantly degraded by the elements.

counterland operations

Airpower operations against enemy land force capabilities to create effects that achieve joint force commander objectives. (AFDP 3-03)

countermobility

A set of combined arms activities that use or enhance the effects of natural and man-made obstacles to prevent the enemy freedom of movement and maneuver. (ATP 3-90.8/MCTP 3-34B; USMC Dictionary)

defensive operations

(Army) Operations to defeat an enemy attack, gain time, economize forces, and develop conditions favorable for offensive or stability operations. (ADP 3-0)
(Marine Corps amplification) Operations conducted to defeat an enemy attack, gain time, economize forces, and develop conditions favorable to offensive and stability operations. The three types of defensive operations are area, mobile, and retrograde. (USMC Dictionary; see also MCWP 3-01)

direct action

Short-duration strikes and other small-scale offensive actions conducted as a special operation in hostile, denied, or diplomatically sensitive environments and which employ specialized military capabilities to seize, destroy, capture, exploit, recover, or damage designated targets. (JP 3-05)

enabling operation

An operation that sets the friendly conditions required for mission accomplishment. (FM 3-90)

envelopment

(Army) A form of maneuver in which an attacking force avoids an enemy's principal defense by attacking along an assailable flank. (FM 3-90)
(Marine Corps amplification) An offensive maneuver in which the main attacking force passes around or over the enemy's principal defensive positions to secure objectives to the enemy's rear. (USMC Dictionary; see also MCWP 3-01)

exploitation

(Army) A type of offensive operation following a successful attack to disorganize the enemy in depth. (FM 3-90)

(Marine Corps amplification) An offensive operation, following a successful attack, designed to disorganize the enemy in depth and extend the initial success of the attack by preventing the enemy from disengaging, withdrawing, and reestablishing an effective defense. (USMC Dictionary; see also MCWP 3-01)

***extreme cold weather operations**

Actions executed at -25 °F or below.

flanking attack

An offensive maneuver directed at the flank of an enemy. (USMC Dictionary; see also MCWP 3-01)

frontal attack

(Army) A form of maneuver in which an attacking force seeks to destroy a weaker enemy force or fix a larger enemy force in place over a broad front. (FM 3-90)

(Marine Corps amplification) An offensive maneuver in which the main action is directed against the front of the enemy forces. (USMC Dictionary; see also MCWP 3-01)

gap crossing

The projection of combat power across a linear obstacle (wet or dry gap). (ATP 3-90.4/MCTP 3-34A; USMC Dictionary)

infiltration

(Army) A form of maneuver in which an attacking force conducts undetected movement through or into an area occupied by enemy forces. (FM 3-90)

(Marine Corps amplification) The movement through or into an area or territory occupied by either friendly or enemy troops or organizations. The movement is made, either by small groups or by individuals at extended or irregular intervals. When used in connection with the enemy, it implies that contact is avoided. (USMC Dictionary; see also MCWP 3-01)

information

The material and actions taken to generate, preserve, deny, and project informational power to increase and protect competitive advantage or combat power potential within all domains of the operational environment. (USMC Dictionary; see also MCWP 8-10, MCDP 8)

information advantage

A condition when a force holds the initiative in terms of situational understanding, decision making, and relevant actor behavior. (ADP 3-13)

linkup

(Army) A type of enabling operation that involves the meeting of friendly ground forces, which occurs in a variety of circumstances. (FM 3-90)

(Marine Corps amplification). An operation wherein two friendly ground forces join together in a hostile area. (USMC Dictionary)

logistics

(Army) Planning and executing the movement and support of forces. It includes those aspects of military operations that deal with: design and development; acquisition, storage, movement, distribution, maintenance, and disposition of materiel; acquisition or construction, maintenance, operation, and disposition of facilities; and acquisition or furnishing of services. (ADP 4-0)

(Marine Corps amplification). 1. The science of planning and executing the movement and support of forces. 2. All activities required to move and sustain military forces. Logistics is one of the seven warfighting functions. (USMC Dictionary)

mission command

The Army's approach to command and control that empowers subordinate decision making and decentralized execution appropriate to the situation. (ADP 6-0)

mission orders

Directives that emphasize to subordinates the results to be attained, not how they are to achieve them. (ADP 6-0)

mobile defense

(Army) A type of defensive operation that concentrates on the destruction or defeat of the enemy through a decisive attack by a striking force. (ADP 3-90)

(Marine Corps amplification). Defense of an area or position in which maneuver is used with organization of fire and utilization of terrain to seize the initiative from the enemy. (USMC Dictionary)

mobility

A quality or capability of military forces which permits them to move from place to place while retaining the ability to fulfill their primary mission. (JP 3-36)

mobility tasks

Combined arms activities that mitigate the effects of obstacles to enable freedom of movement and maneuver. (ATP 3-90.4/MCTP 3-34A; USMC Dictionary)

offensive operation

(Army) An operation to defeat or destroy enemy forces and gain control of terrain, resources, and population centers. (ADP 3-0)
(Marine Corps amplification) Operations conducted to take the initiative from the enemy, gain freedom of action, and generate effects to achieve objectives. The four types of offensive operations are movement to contact, attack, exploitation, and pursuit. (USMC Dictionary; see also MCWP 3-01)

passage of lines

An operation in which a force moves forward or rearward through another force's combat positions with the intention of moving into or out of contact with the enemy. (JP 3-18)

penetration

(Army) A form of maneuver in which a force attacks on a narrow front. (FM 3-90)
(Marine Corps amplification) A form of maneuver in which an attacking force seeks to rupture enemy defenses on a narrow front to disrupt the defensive system. (USMC Dictionary; see also MCWP 3-01)

pursuit

(Army) A type of offensive operation to catch or cut off a disorganized hostile force attempting to escape, with the aim of destroying it. (FM 3-90)
(Marine Corps amplification) An offensive operation designed to catch or cut off a hostile force attempting to escape, with the aim of destroying it. (USMC Dictionary; see also MCWP 3-01).

reconnaissance

A mission undertaken to obtain information about the activities and resources of an enemy or adversary, or to secure data concerning the meteorological, hydrographic, geographic or other characteristics of a particular area, by visual observation or other detection methods. (JP 2-0)

relative advantage

A location or condition, in any domain, relative to an adversary or enemy that provides an opportunity to progress towards or achieve an objective. (FM 3-0)

retrograde

A type of defensive operation that involves organized movement away from the enemy. (ADP 3-90)

(Marine Corps amplification) Anymovement or maneuver of a command to the rear, or away from the enemy. (USMC Dictionary)

security operations

Those operations performed by commanders to provide early and accurate warning of enemy operations, to provide the forces being protected with time and maneuver space within which to react to the enemy, and to develop the situation to allow commanders to effectively use their protected forces. (ADP 3-90)

special reconnaissance

Reconnaissance and surveillance actions conducted as a special operation in hostile, denied, or diplomatically and/or politically sensitive environments to collect or verify information of strategic or operational significance, employing military capabilities not normally found in conventional forces. (JP 3-05)

stability operation

An operation conducted outside the United States in coordination with other instruments of national power to establish or maintain a secure environment and provide essential governmental services, emergency infrastructure reconstruction, and humanitarian relief. (ADP 3-0)

sustainment warfighting function

The related tasks and systems that provide support and services to ensure freedom of action, extend operational reach, and prolong endurance. (ADP 3-0)

tactical deception

A friendly activity that causes enemy commanders to take action or cause inaction detrimental to their objectives. (FM 3-90)

tempo

The relative speed and rhythm of military operations over time with respect to the enemy. (ADP 3-0; USMC Dictionary)

troop movement

The movement of Soldiers and units from one place to another by any available means. (FM 3-90)

turning movement

A form of maneuver in which the attacking force seeks to avoid the enemy's principal defensive positions by attacking to the rear of their current positions forcing them to move or divert forces to meet the threat. (FM 3-90)

unconventional warfare

Activities conducted to enable a resistance movement or insurgency to coerce, disrupt, or overthrow a government or occupying power by operating through or with an underground, auxiliary, and guerrilla force in a denied area. (JP 3-05)

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RELATED PUBLICATIONS

These documents contain relevant supplemental information.

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31 March 2025

By Order of the Secretary of the Army:

RANDY A. GEORGE
General, United States Army
Chief of Staff

Official:

MARK F. AVERILL
Administrative Assistant
to the Secretary of the Army
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Colonel, United States Marine Corps
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