Paratroopers assigned to Battery A, 2nd Battalion, 377th Parachute Field Artillery Regiment, 4th Infantry Brigade Combat Team (Airborne), 25th Infantry Division, descend over Malemute Drop Zone while conducting airborne and live-fire training at Joint Base Elmendorf-Richardson, Alaska, 22 November 2016. (Photo by Alejandro Pena, U.S. Air Force)

From Heaven to Hell

Fires Employment for the 11th Airborne Division "Arctic Angels"

Lt. Col. Chad W. Fitzgerald, U.S. Army
Lt. Col. Dan Graw, U.S. Army
Capt. Hannah Kuegler, U.S. Army

As the global geopolitical landscape undergoes substantial shifts, the U.S. Army has pivoted its strategic focus toward "Arctic dominance"—a concept that gained prominence following the publication of a seminal strategy document, *Regaining Arctic Dominance: The U.S. Army in the Arctic*, in January 2021.[1] The strategy underscores the necessity for a division designed specifically for multidomain operations and optimized for prolonged engagements in extreme cold weather conditions.[2] Given escalating tensions in both the Arctic and Indo-Pacific regions, it is increasingly evident that contemporary conflict and competition require long-range precision fires, sophisticated fire support (FS) systems, specialized munitions, and rapidly deployable vehicles that adapt to the harsh weather conditions and challenging terrains of the Arctic.[3] In future Arctic combat scenarios, it is unlikely that the primary adversary will utilize ground formations to engage in large-scale combat operations on ice. Instead, climate change will likely exacerbate such conflicts and will focus on controlling critical and sea routes essential for global economic commerce. These potential conflicts may also aim to establish or prevent a foothold to secure vital infrastructure or resources that are under threat from adversaries of the United States and its allies.[4] Airborne and air assault formations provide the operational reach required for the types of Arctic combat scenarios described above. Airborne/air assault forces can move and rapidly concentrate combat power over large distances quicker than land-mobile forces.

Lt. Col. Chad Fitzgerald, U.S. Army, commands the 2nd Battalion, 8th Field Artillery Regiment (AUTOMATIC), located at Fort Wainwright, Alaska. He holds a BA from Texas Christian University, an MA from the Fletcher School of Law and Diplomacy at Tufts University, and an MA in military operations from the School of Advanced Military Studies. Fitzgerald's field artillery experience spans a spectrum of cannon formations including light, Stryker, heavy, and division artillery formations in the 25th Infantry Division, 1st Cavalry Division, 7th Infantry Division, 2nd Infantry Division, 4th Infantry Division, and 11th Airborne Division. Fitzgerald is also a former assistant professor in the Department of Social Sciences, United States Military Academy, West Point, New York.

Arctic Joint Forcible Entry Operations—Fires Focus

The field artillery (FA) branch and the Fires Warfighting Function provide critical capabilities during joint forcible entry operations (JFEOs). However, an institutional gap remains on how best to employ these critical capabilities in intense and extreme cold weather conditions, exacerbated further by the fact that while there are five airborne infantry brigade combat teams (IBCTs) in the U.S. Army, only one specializes in airborne operations in extreme cold weather.[5] Reactivated in 2022, the 11th Airborne Division's 1st and 2nd IBCTs and their two FA battalions—2nd Battalion, 377th Parachute Field Artillery Regiment (2-377 PFAR); and 2nd Battalion, 8th Field Artillery Regiment—are working diligently to assist the U.S. Army in developing and codifying the use of fires and FA in the Arctic, during both airborne and air assault operations.

Lt. Col. Daniel Graw, U.S. Army, commands the 2nd Battalion, 377th Parachute Field Artillery Regiment, located at Joint Base Elmendorf-Richardson, Alaska. He holds a BS in business administration from Susquehanna University, an MBA from Webster University, and an MA in military operations from the School of Advanced Military Studies. Graw has served primarily in light and airborne units within the 11th Airborne Division, 82nd Airborne Division, and 101st Airborne Division. Before command, Graw completed a four-year joint assignment with the U.S. Marine Corps, serving at the 3rd Marine Division in Okinawa, Japan.

Capt. Hannah Kuegler, U.S. Army, commands Avalanche Battery, 2nd Battalion, 8th Field Artillery Regiment (AUTOMATIC), located at Fort Wainwright, Alaska. She holds a BS in athletic training from Boston University. Kuegler previously served in the 2nd Cavalry Regiment. Before command, she served as a fires advisor in the 4th Security Forces Assistance Brigade.

An Alaska Army National Guard UH-60 Black Hawk prepares to lower an M119A2 howitzer to soldiers from Battery A, 2nd Battalion, 377th Parachute Field Artillery Regiment, during an air assault raid in March 2011 at LZ Ranger on Joint Base Elmendorf-Richardson, Alaska. (Photo courtesy of the Department of Defense)

Intense and Extreme Cold Weather Doctrine for Joint Forcible Entry Operations

JFEOs are inherently risky, demanding careful planning and thorough preparation, especially in freezing temperatures. Joint Publication (JP) 3-18, *Joint Forcible Entry Operations*, validated in 2021, discusses the requirement for joint force commanders and subordinate commands to identify and manage the impact of climate and weather. JP 3-18, while reminding staff and commanders that each echelon unit needs to plan for weather, provides no specific guidance regarding operating forces within extreme cold weather areas during JFEOs.[6] Field Manual (FM) 3-99, *Airborne and Air Assault Operations*, closely mirrors JP 3-18 concerning the identification and management of climate.[7] It further details some aspects of cold weather impacting aviation assets.[8] However, it falls short of detailing impacts on ground formation equipment such as FA weapon systems. Published in January 2011, Army Tactics, Techniques, and Procedures (ATTP) 3-97.11, *Cold Region Operations*, was the first major doctrinal revision to cold region operations in forty-three years, replacing the outdated FM 31-70, *Basic Cold Weather Manual* (April 1968), and FM 31-71, *Northern Operations* (June 1971). In this update, the ATTP devotes six paragraphs on fires warfighting function considerations in the cold, with no mention of JFEO.[9] Army Techniques Publication (ATP) 3-90.97, *Mountain Warfare and Cold Weather Operations* (April 2016), was a step in the right direction, combining cold region and mountain warfare manuals (previously FM 3-97.6) into one publication. ATP 3-90.97 devotes an entire chapter to FS and FA operations in extreme cold weather.[10] However, it only briefly touches on air movement considerations and provides no doctrinal reference on FA employment

during JFEOs. FA manuals for certification and training do not consider any variance for air assaults and airborne operations conducted in extreme cold weather. Training Circular 3-09.8, *Fire Support and Field Artillery Certifications*, provides time standards that artillery units must meet as part of the certification process. There are certification standards for derigging a howitzer as part of an airborne operation, establishing firing capability on the drop zone, and in-position ready-to-fire times for airborne and air assault operations.[11] However, for example, there is no adjustment for a drop zone covered in snow at -20ºF.

Artillery Challenges in Extreme Environments

Despite the advancements in modern fires capabilities, the two direct support FA battalions of the 11th Airborne Division face substantial challenges in Arctic operations. Inclement conditions adversely affect the battalions' ability to execute their core functions—shooting, moving, and communicating—with the precision and massing firepower required for modern conflict. The division's artillery enterprise comprises two composite battalions equipped with towed howitzers, including six 155 mm M777A2 and twelve 105 mm M119A3. These units operate independently, without the support of a force field artillery headquarters or division artillery. They are bolstered by joint fires and are required to function in the Arctic, subarctic, and Indo-Pacific theaters.

Recent lessons learned from the Joint Pacific Multinational Readiness Training Center–Alaska 23 (JPRMC–AK 23) reveal some of the many challenges posed by extreme cold conditions and how they substantially compromise the effectiveness of conventional FS and FA equipment that normally operates in more temperate climates. JPRMC–AK 23 witnessed both 11th Airborne brigades (2nd IBCT [Airborne] "Spartan" as the blue force and 1st IBCT "Arctic Wolves" as the opposing force) executing their wartime missions in the extreme cold. The Spartan brigade conducted two sequential airborne operations in March 2023, the first to seize Ladd Army Airfield at Fort Wainwright, Alaska, and the second to seize key terrain in the Yukon Training Area adjacent to Eielson Air Force Base, Alaska.

2-377 PFAR established two separate "team fires elements" due to the geographic separation of the drop zones by over 30 km. Each fires element possessed 120 mm and 81 mm mortar systems, towed artillery systems with fire direction, and radar under a single command element, typically the FA battalion commander. This task force concept provided responsive fires to the brigade combat team. The challenge to this concept lies in conducting sustained operations in below-freezing weather while geographically separated from the unit's base of operations.

The airborne operation into the Yukon Training Area resulted in the PFAR's paratroopers and equipment being buried in chest-deep snow at temperatures below freezing upon landing and facing a dug-in opposing force that had been on the ground for four days preparing for the fight. Subsequent heavy equipment drops saw howitzers, radar, and prime movers becoming deeply buried in snow, requiring engineer assistance for equipment removal that would take between four and six hours. The PFAR established airspace control plans with redundancy in satellite internet and high-frequency communication that battled through extreme-cold-induced rapid battery discharge.

The challenges posed by extreme cold conditions substantially compromise the effectiveness of conventional FS and FA equipment that normally operates in more temperate climates. For example, extreme cold leads to increased brittleness and breakage of cables, impaired hydraulic performance, and dysfunctional liquid crystal displays in touchscreen interfaces. Focusing on the M777A2 howitzer, this artillery system is particularly vulnerable in extreme cold environments due to its reliance on a hydraulic suspension system, a hydraulically operated breech, and hydropneumatic recoil system mechanism—all components highly sensitive to low temperatures. Moreover, the system employs a digital fire control interface with an LCD screen prone to freezing, consequently forcing the howitzer into a degraded operational mode.

The M119A3 (105 mm howitzer) is the primary FA platform utilized for airborne assaults because of the added mobility by linking its prime mover on a single thirty-two-foot platform. The M777 requires a thirty-two-foot platform simply for the weapon system, and the prime mover is not certified for airdrop, which impacts the ability to move the weapon system on the ground after a heavy drop operation. The minimum temperature the M119A3 can operate in is -25°F. However,

A military helicopter sits immobilized in muskeg, the swampy terrain rendered treacherous by underlying permafrost, November 2006 on Fort Wainwright, Alaska. The image serves as a stark warning of the deceptive challenges posed by partially frozen ground in transitional seasons. (Photo courtesy of the Northern Warfare Training Center)

degradation in performance and reliability quickly deteriorates below-freezing temperatures. The digital fire control system for the M119A3 is rated to operate at -45°F.

As JPRMC–AK 23 continued, heavy snow, combined with the arrival of additional combat power and limited blade assets, prevented PFAR batteries from accessing subsequent position areas for artillery (PAA). Engineering blade support from the 555th Brigade Engineer Battalion was essential but insufficient for the Spartan brigade's needs. Without a persistent effort toward innovation and collaboration on lessons learned, the two FA battalions of the 11th Airborne Division are bound to experience the same challenges year after year.

Towed Artillery Systems and Arctic Mobility

The 11th Airborne Division's FA battalions navigate a harsh landscape that ranges from the muskeg and swampy marshlands to the thick taiga of northern boreal forests in the summer and wrestle with deep snow drifts overlaying permafrost in the winter. They operate under temperature extremes from lows of -60ºF to highs of 90ºF, although most operations occur in conditions above -40ºF. Currently, Arctic mobility begins with a close partnership with Army aviation.

Looking to the past, artillery units in the Arctic used a combination of helicopter lift techniques and tracked over-the-snow-capable prime movers to drive through fresh snowbanks whereby the friction of the tracks would melt the snow, causing it to refreeze and thereby creating snow roads to access cross-country mobility. The consistency of snow can vary wildly across the Arctic and subarctic regions. Soldiers often encounter hard-packed snow that can be traversed in boots one moment, only to sink into deep drifts the next, akin to wading through hip-deep sand. Despite the aid of snowshoes and skis, these environmental factors prevent cross-country mobility of wheeled vehicles and can slow the speed of a dismounted tactical formation moving over the snow to a pace of one to three kilometers per hour. The current limitations of wheeled prime movers limit over-snow or cross-country capabilities.

In Alaska's harsh winter environments, establishing PAAs for artillery and mission command elements becomes a formidable challenge in extreme cold weather operations. Even the most seasoned "Redleg" soldiers face significant difficulties in securing tents or embedding howitzer spades in subzero conditions. Conventional basic issue items render the howitzer emplacement process labor intensive and time consuming, compromising artillery fire responsiveness and overall security. Recent analyses and records kept by the battalion master gunners indicate that in collective training exercises, on average, it takes approximately three hours to dig a M777A2 howitzer to an adequate depth in frozen ground and permafrost. To address this inefficiency, Arctic artillery soldiers and their battalions have adopted off-the-shelf solutions,

incorporating tools such as concrete saws, power drills, pneumatic jackhammers, appropriate fuel, and generators. These innovations have dramatically expedited the emplacement process; a well-trained crew can now complete the emplacement of a howitzer in less than fifteen minutes, significantly enhancing operational agility.

In each 11th Airborne FA battalion, legacy towed artillery systems like the M777A2 and M119A3 are often pulled by some of the Army's oldest chassis such as the M1084 and M1083 Family of Medium Tactical Vehicles (FMTV) and the M1097 high mobility multipurpose wheeled vehicles (HMMWV).[12] Specialized Arctic equipment comes from the Common Table of Allowances, including ten-man Arctic tents, ahkio groups, skis, and snowshoes. Most of these items urgently need modernization, having suffered decades of wear and tear. Currently, the only snowplows available for attachment to Joint Light Tactical Vehicles (JLTV), HMMWVs, and FMTVs are designed for clearing roadways after fresh snowfall. No specialized plows exist for clearing deep snow drifts from potential artillery positioning areas. Consequently, wheeled vehicles and the howitzers they tow are confined to roads due to insufficient assets for snow clearance and cross-country mobility, which compromise security as these roads often lead into designated enemy engagement areas and limit subsequent survivability moves.

These scenarios cause FA leadership to consistently consider tradeoffs, balancing the need for fires with the ability to protect crews and equipment from enemy actions. Frigid temperatures require detailed attention from leaders and soldiers to ensure their Arctic-specific equipment operates as expected. This effort includes seasonal cold weather training that ensures an Arctic artillery soldier learns tasks like maintaining an Arctic tent and stove and attaching required tire chains on wheeled prime movers, essential to moving and surviving in extreme cold weather. Arctic maintenance common operational pictures are essential, considering that an inoperable troop heater in the back of an FMTV will prevent that vehicle from becoming troop transport.

Artillery crewmembers from Battery B, 2nd Battalion, 8th Field Artillery Regiment, sling load a howitzer to a CH-47 helicopter from 1-52 General Support Aviation Battalion to support a two-gun raid. It is not uncommon for a hook-up team to experience temperatures below -50ºF during hook-up procedures under rotor wash. (Photo courtesy of Spc. Samantha Jensen, U.S. Army)

The organic direct support FA battalion becomes challenged to move, strike, and protect with organic assets. As a result, 11th Airborne FA leaders have invested in innovation and Arctic-specific tactics, techniques, and procedures (TTPs) to improve the mobility and lethality of towed artillery formations.

Arctic Artillery Specific Innovations and Tactics, Techniques, and Procedures

In Arctic warfare, mobility is protection, yet the challenging environment presents a formidable barrier to movement. The current cold weather FA doctrine underscores these limitations, noting that artillery units can only navigate the sparse roads and trails available. As one contemplates the dynamics of future Arctic conflicts, it becomes clear that brigades are unlikely to deploy as cohesive units prepared for

Soldiers from 2nd Battalion, 8th Field Artillery Regiment, utilizing a jackhammer to break up frozen soil in preparation for an M777A2 howitzer emplacement. Power tools such as this increase the speed of emplacement from three hours to under fifteen minutes. (Photo by Lt. Col. Chad Fitzgerald, U.S. Army)

large-scale combat operations on icy terrain. Instead, envision an Arctic battalion-sized task force given the mission to secure critical infrastructure or blunt an adversary's power projection over a contested line of communication. The following description of FA battery operations consists of TTPs using current equipment in the 11th Airborne Division and equipment available and in use by allied militaries. The scenario represents what could be an Arctic artillery battalion in the future with a full complement of equipment designed for the harsh extreme cold weather environment. It is a way to improve towed artillery's mobility when operating in the extreme cold in the Arctic and subarctic.

To navigate the Arctic's limited roadways and diverse terrain, an Arctic artillery battery often relies on substantial engineering support in the form of bulldozer blades accompanying reconnaissance, selection, and occupation of a position (RSOP) personnel who utilize snow machines to move to the next potential PAA. Before movement begins, the battery commander utilizes an all-weather unmanned aircraft system (UAS) to scout the next PAA. The aerial view provided by the UAS aids in evaluating approach routes and future security needs by identifying tracks leading to and from the designated PAA.

Additionally, forward observers leverage cost-effective UASs as a primary means for target detection, operating from Arctic observation posts near or within the frontline maneuver units' scouts or from an advantageous terrain-based observation post. Current UASs fielded by the 11th Airborne Division struggle with flight endurance in the extreme cold. However, 1/11 ABN is purchasing off-the-shelf level 1 (under twenty pounds) Department of Defense approved systems primarily utilized for mapping and surveying but can operate to temperature down to -32°F to enable reconnaissance and target identification. Upon target acquisition, joint fires observers or joint terminal attack controllers request engagement from various FS elements such as Army attack aviation, organic mortars, and direct support howitzers, all while enduring temperatures as low as -30ºF.

Drawing from allied insights, the M119A3 battery selects its prime mover based on mission requirements and target considerations. For operations involving snowpacks and off-road terrain, the battery employs an over-the-snow tracked vehicle like a small-unit support vehicle or Cold Weather All-Terrain Vehicle (CATV) and affixes skis to the howitzers. These towed howitzers are equipped with studded tires and spiked snow spades to facilitate movement over icy or hard-packed snow. This configuration also allows for emergency fire missions on hard ground, as the spiked spades provide a stable anchor in the ice. Upon reaching the designated PAA, the battery finds preestablished gun pits prepared by the attached bulldozer team. The howitzer crews then move the gun into its specific position, with crews working diligently to get guns in position ready to fire. The RSOP teams have worked with the engineers to

develop the appropriate dispersion technique based on the enemy threat. Once in position and ready to fire, positions are improved utilizing the ballistic protection of snow and ice. Inside the PAA, the engineers and 13Bs (cannon crewmembers) work to fill HESCO barriers with at least 1.5 meters of snow that provides protection from 5.56, 7.62, and .50 caliber rounds.

The FA battery then coordinates with the engineers to develop a perimeter defense of its PAA, maximizing howitzer dispersion while maintaining mutual support and enabling intersecting fields of fire from crew serve weapon positioning, which is most suited to face an adversary utilizing dismounted maneuver, vertical attack by infantry or UAS loitering munitions. Combat in the Arctic will often present a flankless battlefront, and combined with the vast expanse to be defended, it requires the FA battery to present an all-around defense with its assigned crew-served weapons. This TTP is also true for the gun raid when utilized to increase the brigade's operational reach. Based on the limited manpower of the FA, a mutually beneficial arrangement of an artillery battery in direct support of an infantry battalion in the offense can help protect the PAA and increase the responsiveness of fires via the establishment of a quick-fire radio net. The FA battalion would still provide positioning guidance for the battery to retain the ability to mass the battalion's fires to weight the brigade's main effort.

The task force concept maximizes the infantry-artillery relationship and allows infantry to support the battery's perimeter PAA defense with aggressive patrolling and security operations outside the perimeter. As the task force transitions to the offense, the infantry will move over the snow to find opportunities to attack sustainment or favorable correlation of forces ratios to destroy the enemy. A FA M119A3 battery in direct support and equipped to execute over-the-snow movement can be positioned close to the line of departure to suppress, neutralize, or destroy high-payoff targets or designated objectives. Longer range systems like the M777A2 and general support artillery systems could conduct counterfire and engage deeper targets such as suppression of enemy air defenses. Increasing the FA battery's Arctic mobility enables a doctrinally correct application of FS considerations for the offense by enabling responsiveness and the ability to mass fires.

Soldiers from 29 Commando Regiment (UK) Royal Artillery attach skis to an artillery piece before it is towed behind a tracked over-the-snow-capable prime mover. This configuration could be used by U.S. Arctic artillery battalions to increase mobility. (Photo courtesy of the 29 Commando Regiment Royal Artillery)

Recommendations for the Future

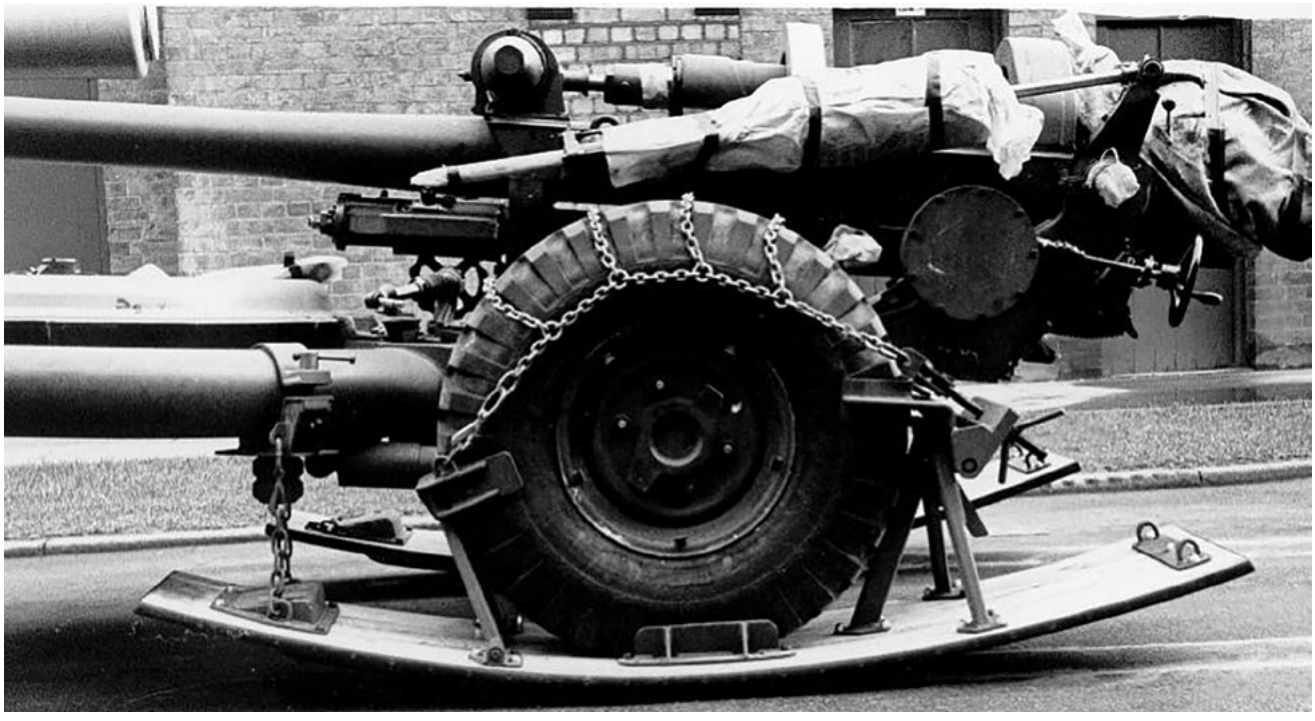
The scenario described above outlines a towed FA battery designed for enhanced mobility and equipped with specialized tools for operation in the Arctic's challenging frozen terrain. At present, Arctic FA battalions rely on off-the-shelf products and tools to enable artillery system occupation and increased mobility but lack access to spare parts for these commercial systems should they fail. To address this, the Arctic FA battalion should have an Arctic-specific list of authorized supplementary equipment. This list should feature items such as studded tires, detachable snow spades equipped with spikes for ice penetration, jackhammers, power drills, concrete saws, and generators—essential tools for the effective winter occupation of a towed howitzer but can only be obtained through unit purchase.

A fire support specialist from the 2nd Battalion, 8th Field Artillery Regiment, tests a Switchblade 300 precision strike unmanned aircraft system in extreme cold weather. The Army should test all equipment designated for future fielding in arctic conditions to validate capabilities and reveal additional requirements. (Photo courtesy of 1st Lt. Sullivan Delaney, U.S. Army)

A perhaps more pressing issue precedes these challenges: neither Army nor Department of Defense program managers are mandated to conduct extreme cold-weather testing for new equipment in Alaska. This oversight leads to the deployment of equipment ill-suited for Arctic conditions. Take, for instance, the planned introduction of JLTV variants intended to function as fire direction vehicles and howitzer prime movers. These variants come with soft-covered crew compartments and lack troop heaters, making them unsuitable for Arctic operations. In an ideal scenario, Arctic-specific JLTV variants would include such essential features such as hard tops and troop compartment heaters to shield the fire direction center personnel or howitzer crew from the severe cold. Without these adjustments, any future Arctic FA battalion equipped with the current JLTV configuration will find itself unable to move all personnel under extreme cold conditions organically.

Moreover, new equipment should undergo a rigorous engineering verification program as part of the acquisitions process in which it is cold-soaked—operated in temperatures below -20°F for an extended period in the elements. Such a testing regimen would highlight any deficiencies and shed light on the additional requirements necessary for reliability in Arctic operations. The 11th Airborne Division and the Cold Regions Test Center are ideally suited for this type of effort in the future. Furthermore, insights gained from this cold-soak testing could have broader applications. Any modifications or additions to the current modular table of equipment, informed by this specialized testing, could also benefit other Army brigades. This is particularly relevant for units designated for operations in extreme cold or mountainous environments, whether by design or through rotational assignments. Thus, the benefits of implementing a rigorous Arctic-specific verification program would likely extend well beyond the immediate needs of the Arctic FA battalion.

Certainly, existing technology not yet deployed in the Arctic could address current shortcomings. Consider an all-weather, level-one small UAS designed to function at temperatures as low as -32°F and equipped with a light detection and ranging (LiDAR) system that penetrates deep snow drifts to reveal ground composition. LIDAR sends a laser light from a transmitter that is reflected back and detected by a system receiver that utilizes the time of flight to develop a distance map of objects in the area. Such a system could assist FA battalion planners and RSOP personnel in determining not only if a PAA is near an avenue of approach but also if the planned PAA in on permafrost which informs cannon crews the tools needed for emplacement. This could potentially allow units to bypass areas of unstable ground or muskeg. Furthermore, LiDAR technology could gauge the thickness of river ice, offering a more efficient travel



Skis are installed on an artillery piece during a 1987 Cold Regions Test Center Study on arctic mobility. These skis proved laborious to install, were ill-designed, and failed to significantly improve howitzer mobility. (Photo courtesy of the Cold Regions Test Center)

route capable of supporting the weight of both a prime mover and a howitzer, thereby avoiding the challenges of cross-country, over-the-snow movement.

Equipment like this is already available and can be procured through various channels including the Global Combat Support System–Army, GSA purchase card, and military interdepartmental purchase request. However, such purchases would also necessitate a purchase of a stockpile of replacement parts for maintenance and repair. Consequently, the Army should consider incorporating technologies like these into future modified tables of equipment and additional authorized lists. These lists should be tailored for units designated to operate in challenging environments characterized by variable and extreme terrain. Units selected for testing these new concepts should also receive dedicated funding specifically earmarked for testing and evaluation promising programs before new equipment fielding.

It is equally vital to consider lessons from our allies and historical experiences. The Arctic's characteristics, including its military mobility and operations challenges, have been constant even as the geopolitical landscape changes. Historically, dedicated effort and specialized training have been necessary to overcome these challenges. Cold War literature and doctrine emphasized the need for artillery units to possess mobility comparable to the infantry they support.[13] During that period, artillery units employed helicopters, specialized over-the-snow vehicles, and even skis for howitzers to adapt to the terrain. Learning from the past, current FA battalions are eager to continue to improve on previous efforts to increase the FA's Arctic mobility.

Today, our Arctic allies employ specialized equipment like cold-resistant tires, spades, and skis designed explicitly for extreme conditions. Acquisition paths for specialized items such as M119A3 skis and studded spades exist through mechanisms like the Foreign Procurement Test Process and the Army Combat Capabilities Development Command's Technical Information Exchange Agreement with countries like the United Kingdom. The FA battalions of the 11th Airborne Division should also explore these procurement avenues as they continue to innovate using existing resources. Doing so will enhance operational mobility and foster greater interoperability with allies. Therefore, moving forward, the Army must embrace cutting-edge technologies and time-tested solutions to meet the unique demands of Arctic warfare.

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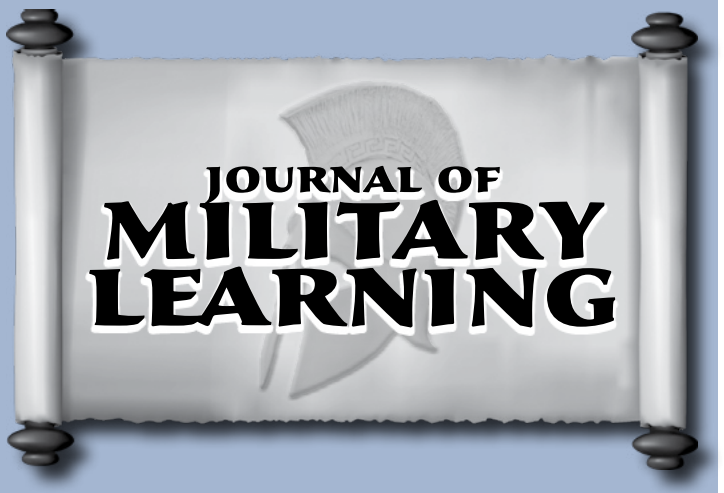

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This article has endeavored to thoroughly examine the challenges constraining the efficient deployment of artillery in the Arctic's severe conditions. It has evaluated ongoing technological and tactical advancements designed to mitigate these challenges. Moreover, it has put forth forward-looking solutions that have the potential to significantly advance the U.S. Army's capabilities in Arctic operations. Through these contributions, this article aimed to enrich discussions related to the evolving demands of contemporary military operations. ■

Notes

1. James C. McConville, *Regaining Arctic Dominance: The U.S. Army in the Arctic*, Chief of Staff Paper #3 (Washington, DC: Headquarters, Department of the Army, January 2021), https://www.army.mil/e2/downloads/rv7/about/2021_army_arctic_strategy.pdf.
2. Ibid., 26.
3. Throughout this article, observations and performance estimates of equipment are derived from a systemic empirical approach, based on collective training exercises conducted over the past five years by multiple leaders across both field artillery battalions.
4. The commander's vision of the 1st Infantry Brigade, 11th Airborne Division, is to be the "world's premier Arctic Fighting Force, capable of seizing and holding key terrain and critical infrastructure where no one else can while simultaneously conducting theater support operations in the Arctic region and U.S. Indo-Pacific Command area of responsibility."
5. Army Techniques Publication (ATP) 3-90.97, *Mountain Warfare and Cold Weather Operations* (Washington, DC: U.S. Government Publishing Office [GPO], 2016), 1-8. The Army defines intense cold weather as between -5° and -25°F, and extreme cold weather as between -25° and -40°F.
6. "The U.S. Army's First Parachute Combat Assault," U.S Army Airborne and Special Operations Museum, accessed 28 September 2023, https://www.asomf.org/the-u-s-armys-first-parachute-combat-assault/.
7. Joint Publication 3-18, *Joint Forcible Entry Operations* (Washington, DC: U.S. GPO, 2017), I-1.
8. Field Manual (FM) 3-99, *Airborne and Air Assault Operations* (Washington, DC: U.S. GPO, 2015), I-4.
9. Army Tactics and Techniques Publication 3-97.11, *Cold Region Operations* (Washington, DC: U.S. Government Printing Office, 2011), 6-2–6-3.
10. ATP 3-90.97, *Mountain Warfare and Cold Weather Operations* (Washington, DC: U.S. GPO, 2016), 4-1.
11. Training Circular 3-09.8, *Fire Support and Field Artillery Certifications* (Washington, DC: U.S. GPO, 2020).
12. The 2nd Battalion, 8th Field Artillery Regiment, will be the first active duty field artillery battalion to utilize the Joint Light Tactical Vehicle as a prime mover for the M119A3.
13. FM 31-71, *Northern Operations* (Washington, DC: U.S. Government Printing Office, 1971), 81, 97e.