U.S. Army paratroopers assigned to Chaos Troop, 1st Squadron, 40th Cavalry Regiment (Airborne), 4th Infantry Brigade Combat Team (Airborne) (BTC[A]), 25th Infantry Division (ID), prepare to assault their objective while conducting a joint field training exercise for Yudh Abhyas 21 at Joint Base Elmendorf-Richardson, Alaska, 28 October 2021. On 6 June 2022, the 4th Infantry BCT(A), 25th ID, was reflagged as 2nd BCT under the reactivated 11th Airborne Division as part of the U.S. Army's new arctic strategy. (Photo by Alejandro Peña, U.S. Air Force)

Assured Mobility in the Arctic

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Armies, good or bad, trained or untrained, may find themselves in winter trying to carry on a dragged-out campaign, unwillingly practicing winter warfare.

—George K. Swinzow

With the publication of the *National Strategy for the Arctic Region* and the Army's Arctic strategy—titled *Regaining Arctic Dominance: The U.S. Army in the Arctic*—the 11th

Airborne Division was born with the mission "to not just survive but thrive in [extreme cold weather] and mountainous terrain."[1] For the past eighteen months, the division has expanded training capacity across the state of Alaska, partnered with more cold region allies and partners, issued new extreme cold weather survivable gear and vehicles, and revamped training with a focus on fighting and winning in the Arctic. But what does that really mean?

The focus of the 11th Airborne Division is on operations in extreme cold weather and mountainous terrain. It is not limited by latitude (the Arctic is limited in scope to the area above the Arctic Circle [N 66°32']) but is rather a focus on operating in extreme conditions. The Army defines cold weather categories as 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), and hazardous cold (-40°F and below).[2] Enduring in sustained temperatures below -25° is the benchmark for the soldiers and leaders of the Army's only Arctic division. At those temperatures, batteries fail in minutes, door handles snap off, and frostbite can occur within seconds. More importantly, the effects these temperatures have on the development over time on cold regions provides a terrain challenge that few across the Department of Defense have encountered.

Many leaders in the 11th Airborne Division are presented with case studies and leader development exercises centered on the experiences of the Finnish army in the Winter War of 1939. The Finns, undermanned and severely outgunned by the Russian army, managed to win numerous tactical victories against a far superior force using their knowledge of terrain and understanding of the effects of extreme cold weather. They capitalized on a culture of skiing proficiency and cold weather survival techniques to achieve success in both the offense and the defense. As the Army transforms to division-centric formations and multidomain operations, we must learn to apply these lessons from the past with modern capabilities in an expanding and contested subarctic environment.

For many, the ability to operate in extreme cold weather conditions seems outlandish and nearly impossible. Many tout the equipment limitations in these temperature ranges to focus operations only in temperate regions or in ideal temperatures. But the operational artist must be able to also understand the opportunities presented by extreme cold weather and mountain terrain. As combat engineers, our focus is first and foremost on assured mobility, "a framework—of processes, actions, and capabilities—that assures the ability of a force to deploy, move, and maneuver where and when desired."[3] This study will focus on the macroeffects of terrain on movement and maneuver in extreme cold weather, the strengths and limitations of snow and ice on operations, and modern usage of airborne and air assault operations in subarctic and arctic environments.

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Paratroopers with 6th Brigade Engineer Battalion, 4th Infantry Brigade Combat Team (Airborne) (BTC[A]), 25th Infantry Division (ID), use ground penetrating radar to check the thickness of ice as they prepare to construct a bridge across the Tanana River at Donnelly Training Area, Alaska, 20 January 2021, in preparation for exercise Arctic Warrior 21. On 6 June 2022, the 4th Infantry BCT(A), 25th ID, was reflagged as 2nd BCT under the reactivated 11th Airborne Division as part of the U.S. Army's new arctic strategy. (Photo by Staff Sgt. Alex Skripnichuk, U.S. Army)

Macroeffects of Terrain for Assured Mobility

For many of us, terrain analysis starts with building out the combined obstacle overlay. You lay out your map, place your overlay, and identify restricted and severely restricted terrain. Mountains are impassable, so mark those as severely restricted. Cliffs and steep slopes are undrivable, so mark those as restricted. Rivers, lakes, and other bodies of water clearly cannot support vehicles, so ignore those for now. Then start laying on your mobility corridors. Use roads and highways, some good flat terrain, farm fields, sparsely wooded areas, and the like. You can visualize it and understand the effects of terrain on your operations. As an engineer, you can mark it "Q.E.D." and start emplacing your enemy forces and obstacles.

In the spring, summer, and fall, all of this might be true. What is green on a map may be green in reality. Passable terrain may be passable, and restricted terrain likely remains so. But in arctic and subarctic regions, even in summer, the answer is complicated. The tundra is not as conducive to off-road vehicular travel. Muskeg, "a type of bog or wetland found in poorly drained areas underlain with permafrost," abounds.[4] A wrong path or a slip off the roadway can sink a joint light tactical vehicle to the frame. Most of the fighting at the front remains dismounted or limited to prepared roads and trails.

In the mountains, snow becomes unstable, but movement for formations of dismounts becomes more sustainable. Temperature swings and high winds can cause havoc for unprepared formations, but well-trained units can capitalize on mountain routes to maintain the element of surprise by moving stealthily below the tree line or over seemingly impassable terrain to sneak up on an unprepared enemy. For the well-prepared, mountains represent key terrain for any type of operation.

Glaciers present, perhaps, one of the greatest advantages to mountain and cold weather operations. Glaciers are sheets of ice and rock that form over hundreds of years and can serve as a high-speed highway for the truly prepared. Crevasses, moraines, moulins, calving ice walls, and unstable footing present numerous dangers to dismounted troops, but a close study of glaciology along with well-trained troops means swift travel for miles over seemingly impassable terrain.

With the onset of winter, the effects of terrain change dramatically. Snow and ice cover the landscape. Rivers and lakes freeze, and in some of the most northern latitudes, snow builds up for months at a time without a thaw. Formerly passable terrain now becomes problematic. Snowplows, bulldozers, and front-end loaders are needed to open roads and trails. Dismounted movement off-road necessitates the use of skis and snowshoes. The disadvantages of extreme cold weather operations abound, but numerous opportunities present themselves that were not available during the more temperate months.

The 11th Airborne Division has eleven standing orders, and perhaps the hardest learned lesson is number four: "Roads, trails, and cutlines are the enemy's engagement areas; if it is easy, you are walking into a trap; if it is hard, you are winning."[5] All of the seemingly unpassable terrain from your terrain analysis now becomes passable with just a little more work. Muskeg freezes and becomes more stable for use as an off-road corridor. Construction and clearing of combat roads and trails take significantly less work. Tracked vehicles optimized for movement on snow become workhorses. The small-unit support vehicle and the Army's new cold weather all-terrain vehicle are optimized for these conditions. Lightweight, tracked vehicles can carry personnel or equipment over virtually any snow-covered terrain. Similarly, snow machines (or snowmobiles in the lower forty-eight) provide additional sustainment capability for small units operating in the snow.

Excavating frozen ground in the winter to construct protective positions and antitank ditches is extremely challenging even with the strongest pieces of machinery. Digging below ground takes significant time, and exposes the soldiers to direct and indirect fires. Snow becomes the most readily available material in cold climates, and with proper reinforcement and compaction, it can substitute for earthen materials to build trenches and berms for both survivability and man-made obstacles.

Rivers and lakes that served as natural obstacles in the summer freeze over and become high-speed avenues of approach in the winter. Alaska itself has more than 40 percent of the Nation's surface water resources including over twelve thousand rivers, three million lakes greater than five acres, and numerous creeks and ponds.[6] Ice thicknesses as low as two inches provide enough support for an individual on skis, and as cold temperatures continue, ice thicknesses of ten inches and greater provide support for lightweight vehicles.[7] As winter progresses, ice thicknesses in the interior of Alaska regularly approach thirty inches or more with some bodies of water supporting ice thicknesses above sixty inches.[8] The load capacity of the ice sheet is primarily dependent on the weather, thickness, and quality. Reconnaissance engineers equipped with only ice augers, measuring tools, and knowledge can determine whether the frozen river or lake can support heavy equipment for military operations.

Strengths and Limitations of Snow and Ice

Over the past two years, the two brigade engineer battalions (BEB) in the 11th Airborne Division have conducted testing with local partners on the utility of snow and ice to military operations. 6th BEB in Joint Base Elmendorf-Richardson as part of 2nd Brigade (Airborne), 11th Airborne Division; and 70th BEB at Fort Wainwright as part of 1st Brigade (Arctic), 11th Airborne Division, have partnered with 1-52 General Support Aviation Battalion, 212th Rescue Squadron, Cold Region Research and Engineering Laboratory researchers, and the U.S. Coast Guard's Ice Rescue Team to capture data points, ensure the safety of operations, and ensure validity of testing.

6th BEB primarily focused their ice testing on standardizing procedures for airborne operations using frozen lakes. The engineers conducted the test by replicating the weight of a paratrooper and multiple resupply cargo drops. Loads were released from a hovering HH-60 Pave Hawk at specified altitudes to achieve the same rates of descent as the airborne soldier and equipment deploying from a fixed-wing aircraft. The testing determined minimum ice thickness to successfully support aerial drops without breaking through frozen surfaces, codified data points for future reconnaissance teams, and provided a pathway for use of frozen bodies of water for drop zones.

70th BEB's ice testing focus has been on air mobility and air assault operations that included landings of UH-60 Black Hawks and a CH-47 Chinooks on a frozen lake. The engineers sling-loaded a joint light tactical vehicle, a small-unit support vehicle, and various cargo loads to simulate aerial insertions of troops and sustainment missions in areas with no conventional landing and drop zones available. The observed data points gathered during the exercise showed minimal deflection on the ice, illustrating that frozen surfaces are more than capable to receive rotary aircraft and sling-loaded equipment.

For ground-based operations, both battalions continued to refine concepts for reconnaissance and execution of ice bridges where the ice sheet may be too thin to support military vehicle traffic. The bridge is created through a process of pumping water from underneath an ice sheet back onto the top of the ice sheet, keeping the water in place with small snow berms, and allowing the ice to harden in lifts. Ice bridging is critical to ground mobility, especially early in the winter when ice thicknesses can be expected to be suboptimal for sustained river crossings.

Both engineer battalions continue to work with the Army Software Factory to develop an end-user application that will significantly ease the requirements for the ice reconnaissance process. The software is designed to reduce potential calculation errors by automating equations and enabling rapid information sharing through real-time geolocated data points for planners and decision-makers. Once fully developed, the product will provide ease of access to a wide array of data for risk-informed decisions and will considerably increase the generation of crossing site and landing zone candidates for a wide range of combat operations.

As operations in the winter continue for the 11th Airborne Division, engineers are focused on expanding ice testing for larger loads and different purposes. "Forward aviation combat engineering [is] employed to shorten the distance between an aviation unit's objective areas, improve unit sustainment, reduce turnaround times, and enhance the availability and responsiveness of aviation assets."[9] As partnerships continue during extreme cold weather, we expect to test forward arming and refueling point operations and utilize lakes and rivers for forward landing strips for lightweight aircraft and tactical unmanned aircraft systems.

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In addition to ice testing, 70th BEB has begun a series of tests on the strengths and capabilities of snow. One of the primary problems for military operations in extreme cold is sustainment. It takes more fuel, more vehicles, and significantly more time to move materiel across the battlefield. One of the few things that arctic and subarctic environments have in abundance during the winter is snow. We have learned over time that snow is a reliable substitute for everything from antivehicle obstacles to fighting positions, to insulation for equipment. With the hard-packed, frozen ground and amount of snow cover, you have to build up, not dig down.

Snow-berming is one of the primary uses for engineer equipment during extreme cold weather operations. Berms can be tied into eleven-row obstacles or quickly emplaced for antivehicle obstacles kilometers at a time. They are quick and effective barriers, an extremely useful method for hiding vehicles, personnel, or equipment, and they provide a surprising amount of protection.

Soldiers from Company D, 70th Brigade Engineer Battalion, and the Army Test and Evaluation Center conduct snowshoe testing at the Cold Regions Test Center, Donnelly Training Area, Alaska, on 16 March 2023. (Photo courtesy of authors)

Snow itself is different in extreme cold weather. As mentioned above, the Army defines wet cold and dry cold by temperature ranges, but these ranges also affect the type of snow that a region can expect. In the wet cold zone, snow typically adheres to itself and is easily shaped. This is the region of cold where snow can be made into snowballs and snowmen. Snow tends to be drier and lacks adherence below 20°. In the interior of Alaska, most snow tends to be dry and powdery. Those of us who live and operate up here liken it to powdered sugar. It is harder to walk in than the "wet snow" typical of more southern locations and provides a much less stable surface for everything from snowshoes and skis to snow machines and small-unit support vehicles. Because of this, we began looking at whether the powdered snow of the subarctic provides the same level of protection as the more compactable wet snow.

Initial research was surprising. Even for subarctic, dry snow, in almost any act of compaction (shoveling, stomping, placing in a sandbag, snow blowing), essentially doubles the density of the snow.[10] As a starting point, we knew that berming would at least double the density of the snow we were working with. More recent research tested capabilities of snow as protection from direct-fire weapon systems, using modern munitions. The most recent study showed that compacted snow provided protection for every munition up to .50 caliber in less than 1.5 meters of snow. Perhaps most surprising is that first, the bond created by the snow particles causes the rounds to ricochet, and second, that the dry snow almost serves as a self-healing substance, filling in gaps after a round penetrated the snow.[11]

70th BEB validated the protective capabilities of snow berms against small arms and machine gun rounds to effectively build hasty fighting positions using readily available tools and materials on the battlefield. The engineers tested the effectiveness of snow berms by firing 9 mm, 5.56 mm, 7.62 mm, and 12.7 mm (50 caliber) ammunition into berms of varying depths and ages (fresh snow, an eight-hour berm, and a berm that had been emplaced for three weeks). Bullet penetrations were recorded to determine the most effective construction method with the most stopping power. The test results confirmed that a four-and-one-half-foot snow berm compacted every twelve to eighteen inches can stop 95 percent of the ammunition fired from multiple calibers of weapons. Testing will continue this winter with expansion into better understanding the protective capabilities of snow for indirect fire munitions and explosives.

Airborne and Air Assault Considerations in Extreme Cold

The 11th Airborne Division conducts a Joint Pacific Multinational Readiness Center exercise annually to certify its brigades under extreme cold conditions. In March 2023, the 2nd Brigade (Airborne) conducted an airborne assault into the Yukon Training Area before expanding the lodgment and attacking to seize division objectives twenty-five to thirty kilometers away. Airborne assaults and air assaults are difficult to synchronize and execute in even the best conditions. In extreme cold, problems are magnified tenfold. For the soldiers who operate in Alaska, "Rule of the North" number two comes into play over and over: time. In Alaska, everything takes three to four times longer than in the lower forty-eight.[12]

The bread and butter of airborne assaults for engineers is a progression of the light airfield repair package (LARP), field landing strip clearance, and airfield damage repair in sequence to get the engineer equipment to the drop zone, clear for explosive hazards, and then repair a landing strip suitable to marshal in follow-on forces. The engineers dominate the space needed to ensure the rest of the forces have a way into the fight.

The LARP is a series of air-droppable platforms to include blade assets, excavating capabilities, and repair kits needed to fix damages to the airfield so aircraft can air-land. Under normal conditions, these platforms can be dropped, recovered, and begin operation with the first crater repaired in a time standard of under eight hours. In extreme cold, this process looks entirely different. Under extended periods of darkness, with platforms plummeting into feet of snow, engineers must trudge through blankets of snow to even find the equipment before the derigging process can occur. Once the platforms have been found, the equipment then must be recovered out of the snow, derigged, and started under conditions that sometimes reach negative double digits.

Conducted simultaneously to the derigging of our LARP is our field landing strip clearance conducted by our sapper platoons. This clearing process assesses the status of the drop zone, evaluates the dimensions of damage needing repair, and clears the area of hazards and explosives. This mission set under snowfall increases in time and differs significantly in resources needed. Snow and extreme cold both significantly affect mine detecting and ground penetrating radar to find foreign objects. With this, the team must be much more deliberate. The clearance team must be proficient on skis and snowshoes and develop marking systems specific for snow cover.

Once the field landing strip has been cleared of hazards, the LARP equipment begins the repairing process. Airfield repair under extreme cold conditions is night and day from temperate operations. Just clearing the snow to create routes can take upward of a day for multiple blade teams to execute. The engineer equipment itself faces unique challenges as well. Hydraulic line malfunctions and engine issues begin to interfere as temperatures plummet. Maintenance practices for our equipment must be stellar before heading into the fight. The field landing strip repair itself is also different. Normally these operations would be conducted with dirt, sand, or concrete; engineers use ice-crete (a mixture of snow, water, and gravel that matches the strength of concrete) and water to and make the surface suitable for landing.

Air assault operations are similarly challenging, including whiteout conditions caused by rotor wash, soldiers dropping into feet of snow, loss of space due to loading or sling-loading snow-capable tracked vehicles, and the inability to quickly move off of the "X." As discussed above, though, extreme cold weather also opens previously unheard-of areas for helicopter landing zones. Rivers and lakes can be used for helicopter landing zones as well as drop zones for both people and equipment.

As with airborne operations, getting engineer equipment to the fight and sustaining it remains the biggest challenge for extreme cold weather air assaults. Lightweight excavators can be employed to quickly clear fighting positions. Bobcats can be used to quickly clear pads and routes for troop movement. Sappers with chainsaws and cutting equipment can quickly expand helicopter landing zones, create new ones, or fortify defensive positions. As mentioned previously, though, all things with moving parts require much more care in extreme cold weather.

Conclusion

The majority of soldiers in our Army have not experienced the weather effects of extreme cold, much less been required to execute military operations for sustained periods of time. But the likelihood of fighting in extreme cold remains as high now as it ever was. Russia, China, and North Korea all have climates that meet, if not exceed, those of interior Alaska. For the soldiers of the 11th Airborne Division, our job is to be ready: to fight and win in places no one else can go.

For combat engineers of the Arctic Angels Division, our focus on assured mobility has allowed us to expand our understanding of the risks and opportunities presented by extreme cold weather and mountainous terrain. The macroeffects of terrain provide many restrictions, but opportunities abound in the coldest regions on earth if you understand the use of terrain in the winter. Snow and ice are barriers for some, but for enterprising engineers, they combine to increase usable terrain, lessen the strain on sustainment for class four, and provide significant protection capability if used properly. Airborne and air assault operations in subarctic and arctic environments have significant challenges, but the lack of mobility for road-bound vehicles makes both operations extremely necessary for operations in the subarctic.

To some, the conditions discussed here seem impossible to comprehend, but the Arctic Angels find ways to survive and thrive in these conditions. To paraphrase George K. Swinzow, you can't just choose not to fight a winter war, and sometimes you may be an unwilling participant—but extreme cold becomes "a strategic advantage to the trained, motivated combatant."[13] ■

Notes

Epigraph. George K. Swinzow, *On Winter Warfare*, Special Report 93-12 (Hanover, NH: Cold Regions Research and Engineering Laboratory [CRREL], June 1993), 3, https://apps.dtic.mil/sti/pdfs/ADA270031.pdf.

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11. George L. Blaisdell, Terry D. Melendy, and Marin N. Blaisdell, *Ballistic Protection Using Snow*, ERDC/CRREL MP-22-11 (Hanover, NH: CRREL, May 2022).
12. The rules of the North are as follows: (1) No one is coming to help you. Prepare as if no one is coming. (2) Time. Everything takes three to four times longer than in the lower forty-eight. (3) Never summer. Winter is always coming, so prepare for it before it gets here.
13. Swinzow, *On Winter Warfare*, 3.