Polar Nights, White Nights, and Normal Days and Nights:

Arctic Ground Target Identification and Engagement

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A fundamental concept of contemporary conventional war under nuclear-threatened conditions is that combat will continue uninterrupted in order to deny the enemy the time to restore his combat potential, maneuver his reserves, and resupply. This is conditional on the ability to fight at any time of the day or night and under any climatic condition. Special features of the Polar region challenge the "normal" concept of night and day. Polar nights occur in the northernmost and southernmost parts of the planet when there is night for more than 24 continuous hours. Polar days [Midnight Sun in the U.S. and White Nights in Russia] occur when the sun stays above the horizon for more than 24 continuous hours. In the Russian Arctic, polar nights run from 2 December through 11 January (39 days), while polar days run from 22 May to 22 July (62 days). This leaves 264 days of relatively normal day and night.[1] Polar days support round-the-clock artillery and aviation missions while increasing the need to camouflage the force and conceal its movement. Polar nights complicate orientation, the conduct of accurate fire, limit the effectiveness of weapons at their maximum range of fires, and influence the use of aviation. For example, the engineer capability to build defensive fighting positions falls by 25-40 percent during darkness. Low temperatures, strong winds, and frozen soil further degrade engineer capabilities. Targeting visibility in daylight varies by the time of day, illumination, atmospheric precipitation, fog, terrain relief, smoke from fires, gun smoke, camouflage, vegetation, enemy technical interference with optical-electronic observation, and building density in cities and hamlets.[3] Electronic night-vision systems assist in night target engagement but are not as effective as daylight observation. The stabilized 30mm 2A42 multi-purpose autocannon on the venerable Russian airborne BMD-2 infantry fighting vehicle has a daylight maximum effective range of 1,400 meters but drops to 800 meters at night using night-vision systems.[4] Russia conducted visibility and detection tests on its equipment on the Arctic Kola Peninsula. The peninsula, located between the White and Barents Seas, has mountains, swamps, forest, tundra, and built-up areas (such as Murmansk). The peninsula has a relatively moderate climate for the Arctic. Tests conducted there, aggregated with the local weather and climate, determined the effect of background conditions against which the soldier scout, forward observer, or gunner could detect and destroy targets.

Clearly, the range of day-lit visibility increases with the degree of target exposure and the contrast between the target and its background. Day-lit tests on the Kola Peninsula ranges had more than 2.5 kilometers visibility and measured the time that it took to detect different targets at different ranges over different backgrounds, first without the use of binoculars or other visual assistance and then with. The mathematical expectation was that, under normal circumstances, the unaided eye could detect a tank in a forest 2.5 kilometers away in 7 seconds when the observer and target were at the same altitude. Differences in background contrast, elevation, and terrain breaks affected the visibility findings. The BMD-2 with the 30mm automatic cannon and the PKT 7.62mm co-axial machine gun were used for the fire missions. With an increase in range, the average time expended engaging targets increased 12-35 percent, 10-30 percent for low hills, and 5-20 percent on the plains. Some 40 percent of the test area involved hills and higher elevation. This required that the vehicle commander and gunner carefully select their observation and firing posts. Dug-in targets were difficult to detect and destroy.[5]

The tests determined that observers could detect small targets (anti-tank guided missile [ATGM] and machine-gun crews) without binoculars or other optics up to 900 meters away. The further the target was from the gunner, the less chance of a hit, and the expenditure of ammunition on distant targets increased. When only part of the target was visible, the shots fired were usually high of center mass. The less of the target that was visible reduced the probability of successful target engagement by 1.2 to 1.8 times.[7]

Background	Type of Target	Limit of Visibility in Kilometers	Background	Type of Target	Limit of Visibility in Kilometers
Forest	Tank	1.9	Grass field	Tank	2.6
	Dug-in tank	1.3		Dug-in tank	1.6
	BMD	1.7		BMD	2.2
	Dug-in BMD	0.8		Dug-in BMD	1.2
	BTR	1.7		BTR	2.2
	Dug-in BTR	0.7		Dug-in BTR	0.9
	ATGM	1.5		ATGM	1.7
	Dug-in ATGM	0.8		Dug-in ATGM	1.2
	ATGM crew	0.65		ATGM crew	0.8
	Machine-gun crew	0.45		Machine-gun crew	0.5
Snow-covered Forest	Tank (white camo)	1.8	Snow	Tank (white camo)	2.2
	Dug-in tank white camo	1.1		Dug-in tank white camo	1.4
	BMD (white camo)	1.5		BMD (white)	2.0
	Dug-in white camo BMD	0.8		Dug-in BMD	1.0
	BTR (white camo)	1.5		BTR (white camo)	2.0
	Dug-in BTR white camo	0.7		Dug-in BTR white camo	0.9
	ATGM white camo	1.4		ATGM white camo	1.9
	Dug-in ATGM white	0.9		Dug-in ATGM white	1.1
	ATGM crew	0.6		ATGM crew	0.7
	Machine-gun crew	0.4		Machine-gun crew	0.5

Abbreviations: BMD (Russian: Боевая Машина Десанта, Boyevaya Mashina Desanta) is an airborne amphibious tracked infantry fighting vehicle; BTR (Russian: бронетранспортёр, Brone¬transportyor) is an armored transport; and AGTM (Russian: Корнет, Cornet) is a second-generation Russian man-portable anti-tank guided missile.

Table 1 — Physical Target Visibility Under Normal Conditions Depending on the Background[2]

The Kola Peninsula has high humidity and is frequently cloud- or fog-covered with overcast up to 180 days a year (20 days a month in winter, 10 days per month in the summer, and 5-10 days a month in the spring and fall). In the summer, daylight continues for 17 hours or more. Winter overcast is less than 8 hours a day.[8]

The tests used Russian weapons systems, which generally have lower silhouettes, less mass, less weight, and wider tracks than their western counterpart systems. Furthermore, the Russians design their equipment to function primarily on Russian terrain. However, the Russians are monitoring western tank developments and their incorporation of optical-electronic suppression systems in current and planned tanks (Table 4).

Target	Background	500m	1,000m	1,500m	2,000m	2,500m
Cannon Target						
Target	**Background**	**Distance by Meters and Seconds**				
		500m	**1,000m**	**1,500m**	**2,000m**	**2,500m**
Tank	Forest	3	4	5	6	7
	Grass field	9	10	11	12	13
BMD	Forest	7	7	8	8	9
	Grass field	10	11	12	14	16
BTR	Forest	11	12	13	15	17
	Grass field	10	11	12	13	15
ATGM launcher	Forest	11	12	13	15	17
	Grass field	10	11	12	13	15
Tank white camo	Snow-covered forest	11	13	17	23	44
	Snow	12	15	19	27	51
BMD white camo	Snow-covered forest	8	9	10	12	13
	Snow	15	21	37	46	66
BTR white camo	Snow covered forest	13	14	19	27	50
	Snow	15	21	37	46	66
ATGM white	Snow-covered forest	13	13	15	19	49
	Snow	22	16	41	50	72
Machine-gun Target						
Infantry ≤ squad	Forest	6	7	8	8	10
	Grass field	5	6	6	7	8
	Snow-covered forest	6	7	7	8	9
	Snow	5	5	6	7	8
ATGM crew	Forest	8	8	9	10	12
	Grass field	6	7	7	8	10
	Snow-covered forest	9	9	11	12	14
	Snow	8	8	9	10	12
Ma-chine-gun crew	Forest	8	9	14	33	.
	Grass field	6	8	12	25	.
	Snow-covered forest	10	9	16	33	.
	Snow	8	9	14	23	.

Table 2 — Mathematical Expectation of the Time to Detect Targets Visually Depending on the Range and Background[6]

Dust and smoke clouds are common on the battlefield. They can be deliberate smoke screens laid as part of the masking effort or incidental to the battle, usually formed by the impact and explosion of artillery rounds and large-caliber machine guns firing on targets, as well as terrain fires sparked by explosion and tracer rounds. These dust and smoke clouds can obscure or completely hide the target, frustrating target tracking and fire corrections. Factors enhancing dust and smoke clouds include varying ground pressures from explosions, the ground composition and type of ground cover, the type of fires employed, and the wind direction of the surface winds.

Atmospheric Conditions	Coefficient of Weakening Emanation	Horizontal Meteorological Visibility Distance, Meters
Heavy fog	86.6	20
Dense fog	85.5	50
Moderate fog	21.4	200
Light fog	8.54	500
Heavy haze	2.14	1,000
Light haze	1.07	4,000
Clear	0.427	10,000
Very clear	0.214	20,000
Exceptionally clear	0.0713	50,000

Table 3 — Visual Distance Is Dependent on Atmospheric Transparency[10]

Technical upgrades	Counter Measures	Effectiveness of OEP
M1A2 and Leopard 2 Tanks		
Camouflage paint patterns to mask signature. Laser illumination detectors. Automatic smoke screen system. Optical-electronic jamming system.	Laser and television fire direction system for cannon and missile armaments with laser rangefinder and television aiming. Semi-active laser placement (GPS and target acquisition). Second generation ATGM with semi-active command system for location and target acquisition.	Reduces probability of hit by 1.2-2.3 times.
Future foreign tank systems		
Laser and radar illumination indicator. Automatic systems to create smoke screens, portray false locations and traps. Active optical and radio-location jamming station. Use of “adaptive” technology.	Thermal and radio-location recce systems, ATGM with laser radial-command placement.	Reduces probability of hit by 2-3.5 times.

Table 4 — Effective Foreign Systems to Hide Tanks and Means of Optical-Electronic Suppression (OEP)[11]

Table 5 shows the common types of ground and ground cover on the Kola Peninsula. In dry weather, it gets very dusty, and a moderate wind can create a dust cloud lasting 3-40 seconds. Explosions of different types of ordnance produce their own dust and smoke clouds. A 152mm or 155mm high explosive-fragmentation round cloud will last from 5-20 seconds and restrict visibility 6-7 times.[9] Table 5 shows the time for a dust-smoke cloud created by the stabilized 30mm 2A42multi-purpose autocannon to disperse. Wind direction is indicated with the weapon laid on 0 degrees of a 360-degree circle and is unrelated to geographic north.

Russia is a northern country, and winter training is normal training. The Russian tests indicate that the ability to detect and destroy enemy targets is often hostage to terrain background, atmospheric conditions, degree of target exposure, enemy optical-electronic suppression, dust, battlefield smoke, and available light. Night-vision devices are effective at close distances but not at longer ranges. Much of the Russian testing was against stationary targets. Movement is always a good indicator of enemy location. Consequently, necessary movement is often restricted to nights or during adverse atmospheric conditions. One-sided illumination markers, direction azimuths, and ground guides are often necessary for nighttime movement. Thermal sensors are a threat to maintaining secrecy as warming tents, generators, and engine warmth can readily give away positions. Radar and radio transmissions also invite enemy counters. Noise carries over long distances of open snow-covered terrain, and acoustic targeting is still part of Russian training. The Arctic adds to normal cold weather challenges, but a study of its special demands and characteristics aids in adapting effectively to the region.

			Time for the cloud to disperse, sec		
Ground at firing position	**Wind speed**	**Wind Direction**	**Minimum**	**Maximum**	**Average**
Dry grassy ground	1.5	270	15	20.5	17.8
Dry ground w/o grass	1.5	180	8.5	12.4	10.2
Dusty ground	0.5 1-2 3-5 3-4	270 45 240 40	24.5 16.5 11.0 3.6	35 23 21.3 4.5	28.3 18.8 15.1 4.0
Sandy ground	2-2.5	100	3.0	3.5	3.25
Grassy ground after rain	1.5	45	6.5	8.3	7.5
Soggy loamy soil	1.0	80	5	7	6
Caked snow 0.4-0.5 meters	2.5	50	3	5.2	4.1

Table 5 — Time for a Dust-smoke Cloud from a 30mm Automatic Cannon to Disperse[12]

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Notes

[1] A. Zelenov, "Ночнью как днем: Факторы влияющие на ведение боевых действий в северных условиях" [Night is like day: Factors influencing military activity in the north], Армейский Сборник [Army Digest], April 2017, 5.
[2] Ibid, 7.
[3] Ibid, 6.
[4] Ibid.
[5] Ibid, 9.
[6] Ibid, 8.
[7] Ibid, 9.
[8] Ibid, 9.
[9] Ibid, 10-11.
[10] Ibid, 10.
[11] Ibid, 11.
[12] Ibid.

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