Ignorance about the MILES system
Denies many good crews
The reward of a kill...

Making MILES Work For You

by Captain James W. Schirmer

After days of careful preparation and planning, the moment of truth finally arrives. The OPFOR enters the engagement area; the gunner carefully lays the reticle on center mass and squeezes off a round. Nothing happens. He reengages, and again, nothing happens. Within seconds, his own belt is hit, and the battle for his crew has ended. Contrary to popular belief, stories like this one are usually not the result of faulty equipment, but the result of a crew that does not understand how the Multiple Integrated Laser Engagement System (MILES) works, and how to make it work for them. Every tank commander and gunner who has ever trained with MILES can tell you a similar story about frustration during a simulated battle.

Making soldiers understand MILES and how to use it is important for three reasons. First, it is important that armor soldiers trust their equipment. Second, in order to maximize the value of training, leaders must level the playing field. If both OPFOR and BLUEFOR utilize the system equally well, the side with the best planning, preparation, and execution will usually win. This helps to reinforce the lessons at the after-action review. Soldiers who undergo an experience like the one described above, are likely to tune out the OC and blame their defeat on MILES. Lastly, many units, and even the U.S. Army as a whole, take data from battles using MILES and at least partially base important decisions on them. For example — switching to the 10-Humvee scout platoon was a decision based heavily on data collected from force-on-force battles at the NTC.[1] Improper use of MILES gear can skew the results of battles and generate misleading data and false lessons.

The purpose of this article is to examine seven major sources of error that specifically affect first-round kill probability with MILES and to suggest techniques for eliminating or reducing those sources:

- System parallax
- Boresight confirmation
- Gunner's parallax during boresighting
- Transmitter movement after boresighting
- Dirty lenses/gun tube obstructions
- Transmitter output
- Transmitter/telescope alignment

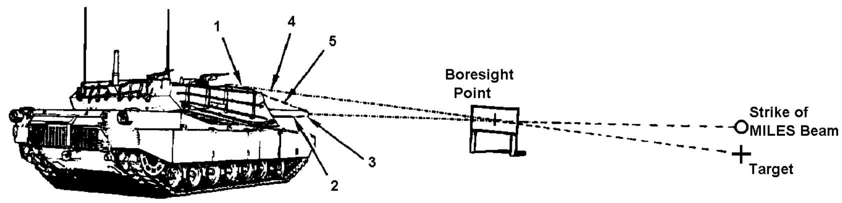
System Parallax. The most important error is the fixed bias known as parallax. This results from the difference between the line from the sight to the target and the Gun-Target line. If the gun is boresighted at 1,000 meters and the reticle is laid on a target at 2,000 meters, the gun is no longer pointing at exactly the same point. The greater the difference between boresight range and engagement range, the more pronounced the error. The following table shows the significant errors that occur based upon different boresighting and engagement ranges. The numbers in the boxes are the distances (in meters up, left, right, or down) from where the reticle is laid to where the MILES beam will strike.[2] The sketch should help you to visualize system parallax.

Most units use one of two methods to correct for system parallax. Many units (to include the OPFOR) boresight at the maximum effective range of the transmitter. The chart below shows that boresighting at longer ranges reduces the amount of error when engaging at close range, and since there is no point in engaging beyond the range of the weapon, there is very little error when shooting long-range targets.

The problem with boresighting at long ranges is that it is very difficult to see the boresight point through the 4X Bushnell rifle sight that is mounted on the M82 tank transmitter.[3] It is very easy to be a couple of mils off in any direction, an error that translates to four meters at maximum range and becomes greater when engaging closer targets. (Most units correct this error with boresight confirmation, which will be discussed below).

Boresight range/ Target range	500m	1000m	2000m
500m	0	.73L/.53D	2.19L/1.59D
1000m	.36R/.26U	0	.73L/.53D
2000m	.49R/.35U	.36R/.26U	0

Figure 1



The second method units employ (a method outlined in *ARMOR* in June 1992)[4] involves boresighting three sights (GPS, GAS, TIS) at three different ranges (usually 500, 1,000, and 2,000) and using whichever sight is closest to the engagement range. This system is not only time-consuming, it can also be difficult to use since the gunner must quickly estimate the range to the target and then remember which sight is closest to that range and rapidly perform the switchology. Furthermore, if a gunner prefers TIS, which he should since it is his primary sight, he must live without it during two of the three engagement ranges. This goes against our train-as-you-fight doctrine.

Both methods are based on the myth that MILES completely bypasses the tank's computer. In fact, with Ammo Subdes 59 entered into the computer control panel (CCP), the ballistic computer will compensate for system parallax, even though it ignores the automatic inputs, manual inputs, and the firing tables. To prove it to unbelievers, boresight at 300 meters with 59 entered into the CCP. Place your hand on the breech and index 2,000 meters.[5] You'll feel the gun move noticeably. This capability gives the M1 tanker a noticeable advantage over his Krasnovian counterpart. He can boresight at 300m where he can see better through the transmitter and ensure an accurate boresight. During an engagement, all he has to do is enter the proper range to the target and let the computer do the math.

With an Eyesafe Laser Filter (ELF) installed, the gunner can utilize the LRF to obtain a correct range to the target. This is the preferred method because it allows the gunner to train using procedures that more closely approximate live fire. If an ELF is unavailable, the platoon leader or platoon sergeant should conduct his own IPB to determine the most likely ranges at which they will encounter the enemy. For example, the platoon leader determines that he will most likely encounter the enemy at 2,000 meters. His platoon crosses the LD with this range indexed. In the event that they must react to an ambush at close ranges, he directs that 500m be entered as the battlesight range for sabot. Looking at the situational template, he realizes that he may be engaged by a Command Surveillance Observation Post (CSOP) at 900 meters as his platoon enters a chokepoint. He directs that 900m be the battlesight range for HEAT and adds a point into coordinating instructions. If ambushed at close range, his TCs simply hit the battlesight button and return fire. As the platoon's tanks approach the chokepoint, the gunners automatically enter battlesight for HEAT and are ready for the CSOP.

Boresight Confirmation. As mentioned above, most units confirm their boresights by firing at the belts of another vehicle to confirm that they can kill it. The problem is that a MILES kill does not necessarily indicate that the boresight was accurate. To understand why, you must know a little more about how MILES works. The MILES laser beam is emitted in a cone that gradually spreads out. The cone is somewhat elliptical (wider than it is tall). As the laser spreads out, there is less laser energy per square inch. When it hits the transmitters on another vehicle, several things happen. First of all, each sensor requires a minimum threshold of energy to set it off. Since all of the sensors on a belt are hooked up in series, if enough total energy hits the sensors, it has the same effect as enough energy striking only one sensor. Getting enough energy to hit the sensors determines a hit.

An easy way to think about the transmitter energy is to imagine it as a number of "words." When the tank transmitter fires, it sends out three pulses of energy. In the first burst, it sends out eight kill words. For each two kill words that strike the target's sensor belt, a hit has been scored. For each hit, the control console in the target vehicle will "roll the dice" to determine whether or not it has been "killed." If all eight kill words hit, the target will roll four times. If only one kill word strikes the sensors, the console will record a near-miss and the Combat Vehicle Kill Indicator (CVKI) light will blink once.

In the second burst, it sends out 120 — "vehicle near-miss." The near-miss pulse has over 17 times more energy than the first pulse. If any one of those "words" strikes the sensor belt, the console will record a near-miss and blink the light. The third pulse contains "man-kill" words that are intended to set off the individual MILES harnesses of exposed crewmen. The obvious conclusion is that it is very easy to get a near-miss, but very difficult to kill.[6]

At three thousand meters, the beam's footprint is intended to be approximately the size of a standard threat tank turret.[7] For ease of calculation, we can say that the cone is approximately one half mil wide. Since the tank has multiple sensors, the last sensor might be hit by the outer edge of the laser cone while the gunner lays center mass. If a company confirms their boresight on a stationary M1 with its flank exposed at 1,000 meters, it is possible to score a kill *even if the boresight is off by two mils*. This error becomes much more pronounced at greater ranges because, although the laser cone gets wider, the center of that cone, where the energy density is great enough to score a kill, gets smaller.

One way to reduce this error is to have the confirmation tank cover all but one sensor, possibly placing a

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white sheet of paper behind the uncovered sensor to give the gunner a better target. While still not perfect, a hit at least guarantees that the boresight is within the footprint of the killing part of the laser beam. To come closer to perfection, a unit could construct a wooden boresight panel with Velcro placed at each of the four corners and one in the center. Using five LTIDS, which could be borrowed from TASC, one sensor from each belt is placed on each of the Velcro patches. The master gunner then monitors the "thumpers" and relays via radio to the gunner which portion of the panel he has hit. When only the center sensor is set off, then the boresight is truly confirmed. Another method might be to simply mount the sensors in the same pattern on a HMMWV. Then the company commander would possess a mobile boresight panel with built-in radio communications.

The best method is to use one of the boresight panels actually produced by LORAL. This boresight panel will generate data on a laser hit that will indicate where the gunner needs to adjust in order to center the beam on the panel. However, these panels are limited in number and are currently available only at the CTCs.

Gunner's Parallax. Unlike system parallax, gunner's parallax is not a fixed bias that can be compensated for by the computer. It occurs during boresighting when looking down the telescopic sight on the MILES transmitter. If the gunner's eye is not aligned exactly on the transmitter-target axis, the gun may not be properly aligned and an inaccurate boresight will be entered into the computer. For example, suppose the telescope is roughly 15cm (6 inches) long and, because of its location in the breech, it is difficult to get one's eye closer than 10cm (4 inches) to the near side. If a gunner boresights on a target at 1,000 meters and his pupil is just one millimeter (1/25 inch) above the reticle-target axis, the image of the target will appear four meters lower than it really is, causing him to elevate the gun well above the target.

Boresighting at closer ranges does not reduce the magnitude of the effect because it is based on angle — if the above example were conducted at 300m instead of 1,000, the error would be only 1.2m, but it would still be 4 mils at any range. Boresight confirmation as discussed in the paragraph above will eliminate the problem altogether. Another possible solution would be to construct a parallax shield for the transmitter similar to the one some tank gunners used during Canadian Army Trophy gunnery competitions in the 1980s. The parallax shield is simply a metal plate that fits over the GPS eyepiece (it looks like a small aft-cap) with a pinhole in the center of the plate. Because of the pinhole, the gunner can only see the reticle if he looks dead center down the reticle axis. Modified for the MILES transmitter, this would be a sort of extension tube that would fit tightly over the telescope with a pinhole placed dead center on the face. Only when looking straight down the reticle-target axis would enough light be present to allow boresighting.

Transmitter Movement. Another common source of error is transmitter movement. Because the transmitter does not always seat tightly in the breech, traveling over rough terrain often causes it to move, and the tank loses boresight. To combat this, crews need to make every effort to ensure that the transmitter fits snugly into the breech. Some crews wedge pieces of cardboard between the transmitter and the breech. SSG Barner of the Special Forces developed a means of mounting the transmitter on a 120-mm aft cap that fits very snugly into the gun tube.[8] The commander should also attempt to reboresight his company as close as possible to the actual point of expected contact. In the defense, tanks should boresight during the last available light prior to defending and attempt to minimize movement. If there is sufficient time between BMNT and first contact, the company should begin reboresighting. In the offense, it is more difficult since the attack position is often twenty or more kilometers away from the objective and movement usually begins before light. In either case, the crew can check their boresight by laying the reticle on a close target and indexing the range. Since closer targets are easier to see, it is easier to confirm the lay of the transmitter when looking through the telescopic sight. **Caution** — Never boresight or check boresight at less than two hundred meters because the computer does not compensate for parallax inside this range (or beyond 4,000).[9]

Dirty lenses/gun tube obstructions. Many tankers fail to destroy their targets because their laser beam does not reach the enemy's sensor belt with enough power to set off the detector. The number one cause of this is dirty transmitter lenses. A good crew should clean its lenses before each boresighting to take care of particles that came in through the breech and down the tube. It is also wise to take a look through the transmitter scope just before contact is expected. It is a good way to tell if the transmitter has moved since the last boresight, or if mud or leaves entered the barrel.

Transmitter output. As time and rough handling accumulate, some transmitters will inevitably go bad. In many cases, the transmitter will still function, but only at a reduced power output that greatly reduces its effective range. This is a difficult situation because such a transmitter will pass simple tests like holding a man-harness at the end of the barrel to see if it can kill. It may even kill at 400 meters and thus deceive the crew into believing that it is fully functional. Each LORAL (the contractor that manages maintenance of the MILES) site has a calibrated radiometer that they can use to test the output of the transmitter. If it does not meet the minimum standard (which translates roughly to killing at 3,000-3,500 meters) then it is repaired or replaced. Unfortunately, not every site regularly performs such services on its equipment. This test is normally initiated if a crew reports trouble with the transmitter in the field.

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This brings up an interesting point, especially when one considers that the MILES I equipment exceeded its projected lifetime five years ago and that there is probably no MILES in the Army inventory that is as beat up as the sets at Fort Irwin and other CTCs. (It's also safe to say that the worst ones are not mounted on Sheridans!) One brigade from Fort Stewart that rotated through the NTC in the early '90s paid to bring its home station LORAL contact team with them to test MILES transmitters in the Dust Bowl to ensure that they could kill OPFOR vehicles. In one of the two task force draws, the team identified and repaired 16 vehicle sets (an astonishing 25 percent of combat power) that otherwise would have rolled into the training area unarmed.[10] This demonstrates that command emphasis on the MILES draw can be helpful to units going to the CTCs. Not every unit can afford to pay for civilian TDY, but they can take steps to protect themselves. After carefully boresighting newly drawn equipment, the unit should ensure that each transmitter can kill at extended ranges and swap out those transmitters that do not meet the standard. If resources permit, a unit could also bring MILES from its homestation warehouse (tested for free by their own contact team at home) to replace or supplement equipment drawn at the training site.

Additionally, during MILES draw, each crew should determine at what range their particular transmitter can kill. This can be done by sending a vehicle out with a green key and having the company fire at it on line at progressively greater ranges until no one can kill the vehicle. Each crew then records its maximum range (preferably on a laminated card in the gunner's station). Each leader in the chain of command should know what these ranges are because, more than likely, they will vary enough that they may affect fire planning and position selection in the defense.

Transmitter/telescope alignment. The telescope that is part of the M82 tank transmitter is a standard Bushnell 4X rifle sight. Like most rifle sights, it has two covered knobs to allow the user to adjust the reticle in azimuth and elevation during zeroing. LORAL places each transmitter on a special alignment device and adjusts the knobs so that the axis of the reticle and the center of the laser beam are aligned to be perfectly parallel. This is crucial for boresighting. Mr. Steven Dickert, the LORAL site manager at Fort Knox, stated that the number one cause of "defective" transmitters turned in to him were ignorant crews using the knobs to adjust the reticle. After realignment, the knobs are sealed back on with RTV rubber. Whenever drawing MILES, leaders should immediately check to make certain that this seal is not broken and ensure that all of their soldiers know not to tamper with the knobs.

A unit that knows how to use MILES to its fullest potential will benefit from more realistic training. Any tank crew that reaches a point in the battle where they have a clean shot at an enemy vehicle should be rewarded with a kill. Similarly, any crew that exposes themselves to the enemy for too long should suffer the agony of defeat. We cannot allow MILES ignorance to skew the outcome of our training exercises. Like many problems in the Army, the answer to this one is also training. Too often, MILES training begins and ends with mounting the equipment. Commanders who ensure that their troops know the details will reap great benefits.

Notes

[1]"Applying the National Training Center Experience: Tactical Reconnaissance." Rand Corporation Study, 1987. Data collected by the Rand Corporation over the course of several rotations and published in this study pointed to the need for a stealthier scout platoon with more platforms.

[2]The problem can best be visualized by drawing sets of right triangles, the hypotenuse being the gun-target line, the base being the distance between the gun and the sight, and the third side the line of sight from the doghouse to the target. The sight is .73m right and .53m higher than the gun bore.

[3]TM 9-1265-373-10-1, *Operator's Manual for MILES Simulator System, Firing, Laser: M82 for M1/M1A1 Abrams Tank.*

[4]"MILES Rules the Battlefield," by SFC Richard S. Francis, *ARMOR*, May-June 1992, pp. 42-43.

[5]Much of this data is based on experiments conducted in an LTA by A/2-64 Armor in the summer of 1992.

[6]Information concerning sensor threshold, kill words, and control box probability calculation came from a phone interview with Mr. Larry Tiller, manager of the LORAL engineering site at Pomona, Calif.

[7]From an interview with Mr. Steven J. Dickert, Ft. Knox LORAL Site Manager, 24 April 1995.

[8]"MILES Warfare with the Yugoslavian M84 Tank and the Russian BMP-2," SSG Earl Barner and CW2 Bryan Hinkel, *ARMOR*, Nov-Dec 1994.

[9]TM 9-2350-264-10-1, p. 2-292.

[10]*The Determinants of Effective Performance of Combat Units at the National Training Center*, Army Research Institute, MDA903-86-R-0705, June 1992, p. 2-34.

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