The Live-Fire Accuracy Screening Test: Why Close Enough Isn't Good Enough

by SFC Christopher Coughlin and WO2 Ewan Jack

The U.S. Armored Force employs the Live-Fire Accuracy Screening Test (LFAST) as a means to confirm by fire that the ballistic solution, computer-correction factors (CCF) and the gun/sight relationship established during boresighting are correct and accurate for the type of ammunition being fired for its Abrams main battle tanks. This method of confirming that the tank is firing accurately (able to strike the intended point of aim) was established in 1982 and is referred to as the fleet-calibration method.

For the Armored Force to fight and win the first battle of the next war, we must redefine the current definition of tank accuracy. Our next adversary will undoubtedly require we prove our adage of "one shot, one kill." The Reduced Range Live-Fire Accuracy Screening Test (RRLFAST) will do that.

Determining fleet CCF

Close tolerances in the design and manufacture of the fire-control system and its hardware allow most tanks to use the same ballistic information. This equates to a high probability of hitting the intended strike point when firing several different natures of ammunition.

This ballistic information was gathered by having several tanks fire seven to 10 rounds per gun tube for each nature of ammunition in service. Various other factors were also involved, including range and meteorological data, which the fire-control system considers when calculating a ballistic solution.

The average strike of the rounds is calculated in milliradians, which provides an accurate means of measuring the difference between the intended strike of the rounds and the actual impacts. These standard offsets are then input into the fire-control system as our fleet CCF.

Defining accuracy (Army)

LFAST allows master gunners, experienced tank commanders and gunners to gauge the accuracy of the fleet CCF for each nature of ammunition being fired. This information allows the ballistic computer to apply an offset to the gun to hit close to the intended aiming point.

For instance, an M1A1 Abrams firing M865 target-practice, cone-stabilized, discarding sabot-tracer ammunition at the ST-5 panel (1,500 meters) would miss the intended aiming point (circle in the center of the target) if the azimuth and elevation offsets in the CCF were not applied to the ballistic solution. This circle is 175 centimeters (1.2 mils) in diameter, painted on a large panel at 1,500 meters away from the firing tank.

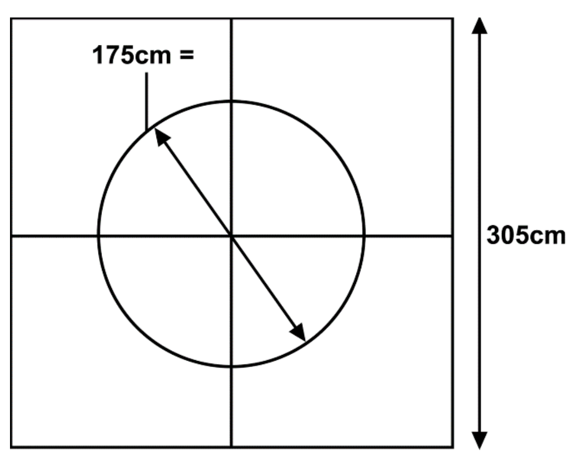

Figure 1. Current U.S. Army LFAST ST-5 panel at 1,500 meters.

The tank is considered screened when one of the first two rounds for each nature of ammunition being fired lands anywhere in the circle. If the ammunition fails this test, measurements are taken of the actual impacts and new offsets are entered and applied to the fire-control system. This is known as a discreet CCF. Once the CCF is entered, the projectile should theoretically impact near the center of the target.

Defining accuracy (Marine Corps)

The U.S. Marine Corps (USMC) incorporates a much more deliberate approach to confirming its tanks' accuracy by way of zeroing. Using the fleet CCF, they reduce the range of the target to 500 meters. (This is the same range used by the Leopard 2 main battle tank from Germany and Canada, which uses the same M256 smoothbore cannon.) Secondly, the USMC incorporates a scaled-down circle of an ST-5 panel at 1,500 meters (still 1.2 mils in diameter but reduced from 175 centimeters to 58.4 centimeters).

In addition to this, the USMC uses a smaller inner circle by which to measure and confirm accuracy. This .5-mil (24.7 centimeters) inner circle ensures that confirmatory projectiles impacting within this circle can impact a smaller target at greater ranges with a higher degree of accuracy.

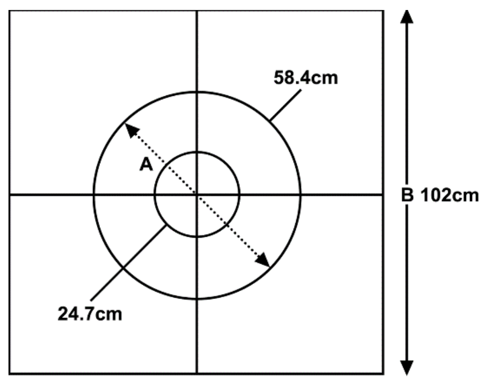

Figure 2. USMC zero panel at 500 meters.

Finally, the USMC doesn't place a restriction on ammunition usage during the zeroing process, opting for higher levels of individual tank accuracy over a one-size-fits-all solution.

Arguably, the USMC has a smaller tank fleet so this extra usage of ammunition will have significantly less cost implications to the overall budget.

Method comparison

If both the USMC zero and U.S Army LFAST were to be conducted at 1,500 meters, the outer circle size would remain the same (175 centimeters diameter). Incorporating the .5-mil inner circle of the USMC zero would create an inner circle of 75 centimeters' diameter. To put those measurements into perspective, a projectile impacting within the inner circle at 1,500 meters would allow that tank to engage a T-72 tank turret of .9 meters in height out to 1,800 meters with an exceptionally high probability of hitting the target.

So why don't we just incorporate an inner circle during the current LFAST process?

Currently, ammunition-lot acceptance has an allowable round-to-round dispersion tolerance of .3 mils. In an ideal world, we would impact subsequent projectiles one on top of the other, replicating Robin Hood's splitting of the arrow several times over. Unfortunately, in the real world, that is not the case. Platform manufacturing irregularities, variations in manufacturing of ammunition, meteorological changes and several other influences prevent this from occurring. The .3-mil round-to-round dispersion tolerance would make it significantly harder for crews to impact consistently within the .5-mil inner circle when you add the possibility of a .25-mil gunner lay error. Adding the two together, a .55-mil (82 centimeters) error would hamper a crew's efforts to consistently impact within the inner circle at 1,500 meters.

In addition to this, the USMC zero allows crews to clearly define their own mean point of impact (the average point at which their projectiles are impacting in relation to the aiming point). This is significantly harder to observe at

1,500 meters, especially when the backdrop to the target is dark and there is heat shimmer obscuring the crew's ability to observe the projectile impacts.

So why don't we just adopt the USMC method and be done with it? The USMC gunnery manual states that if they are using M829A3 armor-piercing, fin-stabilized, discarding sabot-tracer (APFSDS-T) on operations that they will increase the range of their USMC zero out to 1,000 meters. This is to account for the projectile not being fully stabilized. Ammunition studies suggest that initial yaw is not fully dampened on fin-stabilized projectiles such as the M829A2 APFSDS-T until after 800 meters.

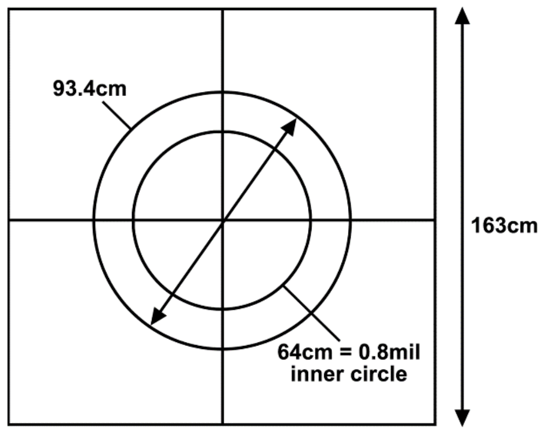

Figure 3. ST-5 panel at 800 meters.

This brings us to a possible solution: the RRLFAST. The RRLFAST incorporates the strengths of the various procedures and mitigates the respective weaknesses.

Redefining accuracy

First, reducing the range of the ST-5 panel to 800 meters enhances the tank commander's and gunner's ability to identify shot impact in relation to aim point. In addition, this reduced range effectively halves the deflection that crosswind could have on the projectile in flight.

Identifying that crosswind can have a significant effect on the projectile is crucial, but also that crosswind is only calculated at the vehicle's position strengthens the reason to reduce the range. Crosswind is unaccounted for from the end of the blast envelope (three meters past the muzzle) to the target, so the further the distance a projectile must travel, the further crosswind can move it off the intended strike point.

Another weakness of the current LFAST procedure observed frequently during LFAST is the flinching of new, inexperienced gunners when firing the main gun. Arguably the most important time for accuracy is the most nerve-racking time for new gunners. To mitigate this issue, the use of manual controls has proven positive. To those who argue "you are not testing the full capability of the fire-control system," what is the purpose of armament accuracy checks? The practical application of this method during testing at Fort Stewart, GA, proved that this method was as accurate as using the powered control handles, and it significantly increased consistency for subsequent rounds fired.

Also, the Army should consider adding an .8-mil inner circle to the current ST-5 panel. The .8-mil inner circle equates to a 1.2-meter high target at 1,500 meters. This coincidentally equates to the same height as the 1.2-meter H1T armor-defilade target listed in Training Circular 25-8, ***Training Ranges***. Further, projectiles impacting within an .8-mil inner circle would replicate the ability to strike an H1T armor-defilade target at 1,500 meters with a considerably higher probability of hitting any fully exposed armor targets at greater ranges.

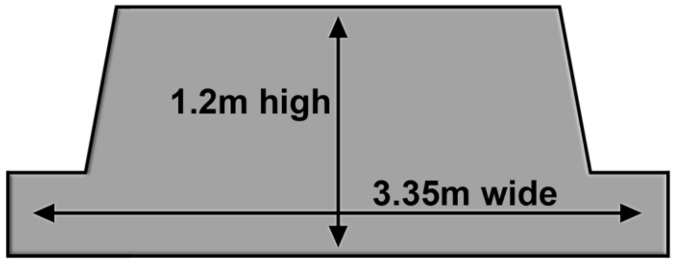

Figure 4. H1T armor-defilade target dimensions.

Furthermore, the use of a significantly larger inner circle (.8 mils/64 centimeters) in comparison to the Marine Corps' zero .5-mil inner circle would reduce the dispensing of discreet CCFs. This would enable company and battalion master gunners to remain within their ammunition allocation for LFAST and reduce the tendency to zero their tanks. It would also lead to ammunition cost-savings due to first-round hit increases and negate the requirement to re-engage missed targets.

Let us take a second to restate what RRLFAST is not. It is ***not*** a zeroing of the main gun. The requirement to pass RRLFAST will be one of the first two rounds striking within the inner circle of the ST-5 panel. The outer circle will remain on the ST-5 panel for aiming purposes to assist the gunner. Should the tank strike within the inner circle of the ST-5 panel, that nature of ammunition will be considered screened and the tank crew will continue to screen other natures of ammunition or test-fire small-arms ammunition. The 120mm ammunition harvested from first-round screening passes will then be cross-leveled to other tanks within the formation that require more screening ammunition.

Case study

Two companies from 2nd Brigade Combat Team, 3rd Infantry Division, from Fort Stewart conducted information-gathering to provide supporting evidence as to why the U.S. Armored Force should modernize and indoctrinate RRLFAST. Results from the two companies showed a significant disparity in relation to accuracy. The company that participated in RRLFAST had an average of 86 percent (71/84) hits on the armor-defilade targets engaged during their Tables IV/V. The company that conducted the standard LFAST had a significantly lower 36 percent (33/91) hits on armor-defilade targets.

It must be noted that both companies' crews were offered a chance to engage targets once re-presented outside of timing restrictions due to acquisition issues.

The brigade master gunner noted that between the two companies, the company that completed RRLFAST had significantly more impacts central to the target, with some targets having the centers shot out. This would be directly reflected in the probability of hits and kills against fully exposed targets at greater ranges and would allow tank crews the ability to fully exploit the capabilities of the fire-control system. Alternatively, the standard LFAST company had impacts in multiple locations, with some likely to have ricocheted off the enemy's turret armor or resulting in only a mobility kill. On the modern battlefield, with such advancements in fire-control systems and ammunition capabilities, the opportunity to re-service a missed or damaged target may not be so easily afforded.

Why does this matter?

This is not a new concept to the master-gunner community. Although various adaptations of RRLFAST have been trialed in the past, research has provided no suitable metric to gauge prior success. The use of armor-defilade targets was the one thing lacking in the previous trials and the one significant issue facing the current method of LFAST. The two companies from Fort Stewart used H1T armor-defilade targets in their lead-up tables (IV/V), replacing all frontal armor targets with the H1T armor-defilade target.

It goes without saying that "the best defense is a good offense!" In the next conflict, to fight and win, American Armored Forces will undoubtedly go on the offense against defended positions. Every T-series tank from the T-72 to the T-14 Armata has its own entrenching blade, allowing it to dig into a hull-defilade position. A target that is harder to see is naturally harder to engage. A target that has extra defenses is going to be harder to kill.

Gunners are taught to aim center of visible mass. If the visible mass is only one meter high, the 175-centimeter circle used to confirm accuracy is woefully ineffective and, most importantly, has the potential to place our tanks and crews in an unnecessary disadvantage on the battlefield.

Conclusion

The one thing that hasn't changed in many decades within the Armored Force is our LFAST procedure. Close enough is certainly not good enough, and given the current climate, operational tempo and recent events globally, tank-on-tank engagements are becoming a realistic prospect. This would suggest that we need to be as accurate as possible in training to build and reinforce the confidence of armored crews.

The Abrams has undergone significant changes and development over the years, from its inception to the latest M1A2 SEP V3 being fielded. The Infantry Branch has developed and adjusted its procedures as a result of lessons-learned – maybe it's time we do the same and implement a procedure that many Abrams master gunners have long advocated.

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Acronym Quick-Scan

APFSDS-T – armor-piercing, fin-stabilized, discarding sabot-tracer
CCF – computer-correction factors
CM – centimeter (figures)
LFAST – Live-Fire Accuracy Screening Test
RRLFAST – Reduced Range Live-Fire Accuracy Screening Test
USMC – U.S. Marine Corps
WOIT – Warrant Officer Instructor Tank (Australian army)