

# **Increasing Small Arms Lethality in Afghanistan: Taking Back the Infantry Half-Kilometer**

**A Monograph  
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**AY 2009**

**REPORT DOCUMENTATION PAGE**Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

<b>1. REPORT DATE (DD-MM-YYYY)</b> 30-11-2009		<b>2. REPORT TYPE</b> SAMS Monograph		<b>3. DATES COVERED (From - To)</b> January 2009 - December 2009	
<b>4. TITLE AND SUBTITLE</b>  Increasing small arms lethality in Afghanistan: Taking back the infantry half-kilometer				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> MAJ Thomas P Ehrhart, United States Army				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>  School of Advanced Military Studies (SAMS) 250 Gibbon Avenue Fort Leavenworth, KS 66027-2134				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b>  Approved for public release; Distribution is unlimited					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> Operations in Afghanistan frequently require United States ground forces to engage and destroy the enemy at ranges beyond 300 meters. While the infantryman is ideally suited for combat in Afghanistan, his current weapons, doctrine, and marksmanship training do not provide a precise, lethal fire capability to 500 meters and are therefore inappropriate. Comments from returning soldiers reveal that about fifty percent of engagements occur past 300 meters. Current equipment, training, and doctrine are optimized for engagements under 300 meters and on level terrain. This monograph reviews the small arms capability of the infantry squad from World War I to present. It then discusses current shortfalls with cartridge lethality, weapons and optics configurations, the squad designated marksman concept and finally the rifle qualification course. Potential solutions in each of these areas are discussed.					
<b>15. SUBJECT TERMS</b> Infantry, Arms room concept, Small Arms, Rifle marksmanship, Rifle qualification, Intermediate Cartridge, Cartridge lethality, Squad designated marksman, M4 carbine, Trainfire, Afghanistan.					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>  (U)	<b>18. NUMBER OF PAGES</b>  74	<b>19a. NAME OF RESPONSIBLE PERSON</b> Stefan J. Banach COL, U.S. Army
<b>a. REPORT</b> (U)	<b>b. ABSTRACT</b> (U)	<b>c. THIS PAGE</b> (U)			<b>19b. TELEPHONE NUMBER (include area code)</b>  913-758-3302

# SCHOOL OF ADVANCED MILITARY STUDIES

## MONOGRAPH APPROVAL

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Increasing small arms lethality in Afghanistan: Taking back the Infantry Half-Kilometer

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## Abstract

Increasing small arms lethality in Afghanistan: Taking back the infantry half-kilometer by Major Thomas P. Ehrhart, United States Army, 72 pages.

Operations in Afghanistan frequently require United States ground forces to engage and destroy the enemy at ranges beyond 300 meters. These operations occur in rugged terrain and in situations where traditional supporting fires are limited due to range or risk of collateral damage. With these limitations, the infantry in Afghanistan require a precise, lethal fire capability that exists only in a properly trained and equipped infantryman. While the infantryman is ideally suited for combat in Afghanistan, his current weapons, doctrine, and marksmanship training do not provide a precise, lethal fire capability to 500 meters and are therefore inappropriate.

Comments from returning non-commissioned officers and officers reveal that about fifty percent of engagements occur past 300 meters. The enemy tactics are to engage United States forces from high ground with medium and heavy weapons, often including mortars, knowing that we are restricted by our equipment limitations and the inability of our overburdened soldiers to maneuver at elevations exceeding 6000 feet. Current equipment, training, and doctrine are optimized for engagements under 300 meters and on level terrain

There are several ways to extend the lethality of the infantry. A more effective 5.56-mm bullet can be designed which provides enhanced terminal performance out to 500 meters. A better option to increase incapacitation is to adopt a larger caliber cartridge, which will function using components of the M16/M4. The 2006 study by the Joint Service Wound Ballistics – Integrated Product Team discovered that the ideal caliber seems to be between 6.5 and 7-mm. This was also the general conclusion of all military ballistics studies since the end of World War I.

The reorganization of the infantry squad in 1960 eliminated the M1D sniper rifle and resulted in the loss of the precision mid-range capability of the infantry squad. The modern solution to this problem is the squad designated marksman. The concept of the squad designated marksman is that a soldier receives the training necessary to engage targets beyond the 300-meter range limitation of current marksmanship programs, but below the 600 meter capability of actual snipers. As of June 2009, the equipment and training of the squad designated marksman has yet to be standardized. In field manual 3-22.9 there are only fourteen pages dedicated to training the squad designated marksman.

Any weapon system designed to perform in various environments will invariably make compromises in order to perform all requirements. The modular nature of the M4/M16 series of weapons lends itself to the arms room concept. Under the arms room concept, each soldier would have multiple weapons and optics combinations available. Commanders would have the flexibility to adjust the capabilities of the infantry squad for the anticipated environment while maintaining commonality of the manual of arms.

Finally, the current qualification course does not accurately depict the enemy on the battlefield. It is based on the 1960's and 70's concept of active defense strategy. Targets come up and depending on their range, remain up for a period of five to ten seconds. The modern battlefield is never this static. Soldiers fire twenty rounds from a prone or foxhole-supported position, then ten rounds from a prone-unsupported position and finally ten rounds from the kneeling position. Soldiers are conditioned to expect that their targets will not move, will only require one shot to incapacitate, and that a hit anywhere will result in that incapacitation.

The Army now has the opportunity to rectify this degradation of marksmanship capability and take back the infantry half kilometer. The ability to engage targets out to 500 meters requires significant revisions to doctrine, training, and equipment. These revisions require emphasis from the highest levels of military leadership.

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## Introduction

Operations in Afghanistan frequently require United States ground forces to engage and destroy the enemy, often at ranges beyond 300 meters. These operations occur in rugged terrain and in situations where traditional supporting fires are limited due to range or risk of collateral damage. With these limitations, the infantry in Afghanistan require a precise, lethal fire capability that exists only in a properly trained and equipped infantryman. The thesis of this paper is that while the infantryman is ideally suited for combat in Afghanistan, his current weapons, doctrine and marksmanship training do not provide a precise, lethal fire capability to 500 meters and are therefore inappropriate.

If the infantryman in Afghanistan is not effective in killing the enemy with small arms fire, what are the problems and how can these problems be fixed? This paper will determine if current small arms, marksmanship training, and doctrine are appropriate for combat in Afghanistan and how changes in these areas can increase small arms lethality.

An examination of past and current equipment, doctrine, training, and organization, reveals where shortcomings originate. Knowing how the Army got to where it is today, identifying current requirements, and discussing potential solutions, the Army can implement changes that will immediately increase small arms lethality of the infantry force in Afghanistan.

The mission of the infantry is to close with the enemy by means of fire and maneuver to defeat or capture him, or to repel his assault by fire, close combat, and counterattack.<sup>1</sup> The way he accomplishes this mission and the means he uses have evolved to keep pace with technological advancements since World War I. Throughout the twentieth century, both during and after each major conflict, different weapons systems and training were adopted based on after action reviews and identified or perceived shortcomings. The first section of this monograph looks at the relationship of changes in organization and

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<sup>1</sup> FM 3-21.8, *The Infantry Rifle Platoon and Squad*. (Washington: Department of the Army, 2007), 1

equipment of the infantry squad and platoon from World War I to present day to identify traditional and current capabilities.

If the role of the infantryman is to kill the enemy, how effective is he? Interviews<sup>2</sup> and open source reports from Afghanistan since 2001 reveal that soldiers are engaging the enemy at ranges from contact distance to beyond the maximum effective range of the M4 carbine.<sup>3</sup> Many comments focus on the ability of the soldier to hit his intended target or a failure of the bullet to achieve the desired effect. Since the adoption of the M16 rifle and its 5.56x45-mm cartridge, there have been complaints by soldiers as to the reliability of the weapon and the effectiveness of the cartridge. Operations in Afghanistan since 2001 and Iraq since 2003 have only added to the controversy. Several congressional studies have attempted to identify the problem, with limited success.<sup>4</sup> The reason for these complaints stems from a lack of education on the capabilities of the weapons systems, improper marksmanship training for the environment, and inherent limitations of the weapon systems.

If the infantrymen are not effective at killing the enemy, what is the problem? The infantryman's ability to engage an enemy successfully is dependent on several factors. These are the capability of the soldier to see the target, (Optics) the capability to hit the target, (Tactical marksmanship) the capability of the weapon to function in the environment,(Reliability) the capability of the weapon to deliver the bullet

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<sup>2</sup> Interview with MAJ (P) Vern Randall, National Police Zone G3 mentor, Afghanistan, August 31, 2009. MAJ Randall stated that "The average small arms engagement range here in RC-East is 500 meters"

<sup>3</sup> Maximum effective range for the M4 carbine is listed as 500 meters for a point target in FM 3-22.9. This range does not take into account the ballistic capability of the 5.56-mm cartridge.

<sup>4</sup> Andrew Feickert, *The Army's M4 Carbine: Background and issues for Congress*. (Washington: Congressional Research Service, 2008).

accurately to the target, (Mechanical accuracy) and finally the ability of the bullet fired to incapacitate the enemy.<sup>5</sup> (Cartridge Lethality)

In conventional offensive infantry combat, the enemy is located and the elements of combat power are used to kill him, destroy his equipment or force his withdrawal. The enemy in Afghanistan blends into the environment, travels light and fast, and normally controls the high ground. The modern infantryman is burdened with heavy equipment to include weapons, communications gear, and protective armor. Additionally, he is not conditioned, acclimatized, or trained for operations at altitude and his performance in this terrain is reduced. Consequently, once the enemy is located it is difficult to maneuver against him.

Combat in Afghanistan has shown several trends. The enemy takes advantage of the terrain and engages patrols or convoys from high ground. He also combines this advantage with heavy weapons systems and mortars from a distance, typically beyond 300 meters.<sup>6</sup> From the infantryman's perspective, he attempts to fix the enemy, since his equipment limits his ability to maneuver, and attempts to kill the enemy through close air support (CAS), close combat attack, (CCA) or indirect fire.

The infantryman's ability to fix or kill the enemy with organic weapon systems at distances beyond 200 meters is limited by his equipment and training. The incapacitation mechanism of small caliber bullets, such as the 5.56-mm, comes primarily from bullet fragmentation.<sup>7</sup> Bullet fragmentation occurs only at a sufficiently high velocity. All 5.56-mm weapons are most effective when employed

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<sup>5</sup> The term incapacitation best describes the desired effect the infantryman is looking to achieve. If an enemy is shot and dies three minutes after they are shot, he is still capable of affecting the fight for those three minutes. If the shot incapacitates the enemy, he is immediately unable to affect the fight.

<sup>6</sup> Robert D. Clements, "The Designated Marksman Equation." *Infantry*, 2008: 47-50.

<sup>7</sup> Bullet fragmentation occurs when a pointed bullet strikes tissue and begins to yaw. A pointed or spitzer type bullet yaws because the base of the bullet is heavier than the tip and momentum forces the heavier base around to the front. If velocity is sufficiently high, the stresses on the bullet are too great and it fragments into at least two pieces.



within 200 meters due to velocity limitations. Once contact is made, the fight is limited to machine gunners, mortars and designated marksmen. In the table of organization for a light infantry company<sup>8</sup> only the six –M240B 7.62-mm machineguns, two- 60-mm mortars and nine designated marksman armed with either 7.62-mm M14 rifles or accurized 5.56-mm M16A4's rifles are able to effectively engage the enemy. These weapons systems represent 19 percent of the company's firepower. This means that 81 percent of the company has little effect on the fight. This is unacceptable.

The most immediate and cost effective improvements can be made through training and education. Soldiers and leaders need to understand the capabilities and limitations of their organic weapons. They need to understand what is required to maintain their weapons and keep them operational in all environments. This process begins in either basic training, or the basic officer leader course, and should continue through unit marksmanship programs. Equipment and organization need to be modernized.

The current 5.56-mm cartridge has limited application in open or mountainous terrain and should be improved, augmented, or replaced. A move to an intermediate caliber weapon or replacement upper receiver will increase the organic capability of the infantry squad and not substantially increase the soldiers load. By adopting an arms room concept, commanders will be able to choose the right equipment for the type of mission and terrain they face.<sup>9</sup> Finally, doctrine should be reviewed and re-written to incorporate the capability to engage targets out to 500 meters. This doctrine should also include an updated qualification course, which more accurately simulates combat conditions and rewards shot placement. This type of course will give better feedback to the soldier and commander.

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<sup>8</sup> *FMSWeb*.  
[https://webtaads.belvoir.army.mil/protected/WebTAADS/Fram\\_DocTypes.asp?GUID=1705394423](https://webtaads.belvoir.army.mil/protected/WebTAADS/Fram_DocTypes.asp?GUID=1705394423)  
(accessed July 16, 2009).

<sup>9</sup> Arms room concept refers to multiple weapons and optics available to the commander to tailor the configuration of the unit for the mission

## Capability of the Infantry – 1917-2003

In order to understand the current problems with small arms lethality, it is necessary to explore the traditional capabilities of the infantry. Requirements of past conflicts have driven changes in equipment, doctrine, organization and training.

### World War I

When the United States entered World War I in 1917, it was an Army schooled in the science of musketry.<sup>10</sup> Its soldiers came from a society that prided itself on its marksmanship skills. Services prided themselves on their marksmanship and conducted numerous marksmanship competitions, such as the national matches held at Camp Perry Ohio starting in 1907.<sup>11</sup> The Army was equipped with modern bolt-action rifles, the M1903 Springfield, and later the bolt action M1917. Both fired a high-powered rifle cartridge, the U.S Caliber .30, model of 1906, hereafter referred to as the .30'06.<sup>12</sup> This cartridge fired a 150-grain spitzer<sup>13</sup> shaped bullet at 2,700 feet per second. This type of round, as originally conceived, allowed the infantryman to engage targets at increased distances, with great effect. The above rifles had sights graduated to 2,700 yards in the case of the M1903 and 1,600 yards for the M1917.<sup>14</sup> U.S Infantrymen of the era were well trained in the application of precision fire at long distances.

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<sup>10</sup> The term reflects the distribution of rifle fires upon an enemy target. *Small Arms firing manual 1913, corrected to March 15 1918*. (Washington: Government printing office, 1918).

<sup>11</sup> Hap Rocketto, "A Short History of Camp Perry and the National Championships." *Shootersjournal.com*. <http://www.shootersjournal.com/Features/Haps/ShortHistoryofPerryandtheNationals.pdf> (accessed August 31, 2009).

<sup>12</sup> Julian S.Hatcher, *Hatcher's Notebook*. (Harrisburg: The Stackpole Company , 1962),19

<sup>13</sup> "Spitzer" refers to a bullets shape. It is derived from the German word Spitzgeschoss. (pointed bullet) It was first introduced in 1898 with the French 8-mm Lebel rifle and adopted by the Germans in 1905. The United States adopted the concept in 1906 with the creation of the .30'06. Combined with smokeless powders, the use of pointed bullets greatly increased the range and lethality of modern cartridges.

<sup>14</sup> *FM 23-6, U.S. Rifle, Caliber .30, M1917*. (Washington: Government Printing Office, 1942)

Marksmanship training for the Infantry during this period consisted of short, mid, and long-range marksmanship respectively, defined as 0-500 yards, 500-800 yards and 800-1,200 yards.<sup>15</sup> This annual training was conducted over a two-month period and consisted of practice and record fire to a distance of 600 yards. Soldiers ranked as sharpshooter or expert in their qualification then proceeded to fire the long-range course consisting of targets from 800 yards to 1,200 yards.<sup>16</sup>

The marksmanship qualification course consisted of two sections. First was a series of slow fire engagements with no time limit. Infantrymen engaged targets from multiple positions to include sitting and kneeling at 300 yards and prone from 600 yards, firing 10 rounds from each position. The second portion of the qualification consisted of rapid-fire engagements from multiple positions. Infantrymen were required to fire 10 rounds from either the sitting or kneeling position in one minute at 200 yards, then 10 rounds from the prone position in seventy seconds from 300 yards and finally 10 rounds from the prone position from 500 yards in eighty seconds. Keep in mind that this course of fire began from the standing position with an unloaded rifle. The shooter had to load the rifle, assume the position for that course of fire, shoot five rounds, reload and fire an additional five rounds within the time limit, all the while manually running the bolt action to reload for every shot.

The expectation of the infantryman was that he could engage targets accurately up to the capability of his rifle. When grouped together, riflemen could engage in volley fire and gain fire superiority on an advancing enemy before being effectively engaged by the enemy. These skills were particularly useful in the positional warfare in Europe during World War I, but they did not translate well to the emerging tactics of 1917/18, which employed small groups of infantrymen to assault enemy

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<sup>15</sup> *Small Arms firing manual 1913, corrected to March 15 1918.* (Washington: Government printing office, 1918).

<sup>16</sup> *Ibid*, 13-17

positions, to penetrate enemy lines. For this type of warfare, soldiers relied on automatic rifles, shotguns, grenades, automatic pistols, revolvers and when available, submachine guns.

One attempt to adapt the standard M1903 bolt-action rifle to semi-automatic fire was the Pedersen device. The Pedersen device consisted of a modified M1903 receiver with an ejection port on its left side and a replacement mechanism for the bolt.<sup>17</sup> A forty round magazine fit into the weapon and the weapon functioned in the semi-automatic mode, firing a round with each pull of the trigger. The cartridge fired by the device was basically a pistol cartridge with a diameter that matched the rifle bore. It consisted of an 80-grain bullet fired at 1,300 feet per second. This was acceptable for the anticipated close range fighting involved when breaching defensive positions. This device was intended to be used in large numbers during a planned spring offensive in 1919 but the war ended and it saw no combat use.

The Pedersen device was tested in France following the armistice. Two squads were equipped with M1903 rifles, one squad had regular rifles and the other squad was equipped with rifles and the Pedersen device. Both squads began at the 1000-yard line firing standard rifle rounds. When the squad achieved the desired amount of hits on a group of targets, they were allowed to proceed to the next closer position. Things were equal until the squad with the Pedersen device reached 500 yards and switched the standard bolt with the Pedersen device. They then unleashed such a volume of fire that they were able to move rapidly to the next yard line and continued to do so until they were on the objective. The squad armed with the standard rifle had barely proceeded closer than the 600-yard line.<sup>18</sup> This test identified the requirement for a weapon that had a long-range capability but also produced a high volume of accurate fire during the assault. Still, the Pedersen device was an interim solution and the infantry needed a more practicable weapon.

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<sup>17</sup> Hatcher, *Hatchers Notebook*, 361.

<sup>18</sup> *Ibid.*, 369.

## The Interwar period

In July 1919, the Chief of Ordnance, General C. C. Williams formed the Ordnance Committee, with representatives of the combat commands and technical services and other interested branch liaisons.<sup>19</sup> Its purpose was to make recommendations to the ordnance technical staff for new weapons. While many senior leaders and ordnance officials lauded the capabilities of the .30'06 cartridge, others felt it was overly powerful for the requirements of the modern battlefield. In April 1923, representatives of the Infantry and Cavalry stated they felt that the .30'06 caliber cartridge was one of the main obstacles in the design of a semi-automatic rifle and invited the board to hear the thoughts of J.D. Pedersen on the matter.

Pedersen was well known in the ordnance community from his earlier work. Unlike other designers, he was more familiar with infantry tactics and knew more than the typical officer. He therefore had an advantage in persuading senior members of the War Department.<sup>20</sup> Pedersen's contention was that the .30'06 cartridge was too powerful and generated too much heat for a self-loading rifle. He cited studies conducted in Europe on the lethality of smaller caliber cartridges and offered to design a new self-loading rifle in caliber .276. He theorized that the smaller caliber cartridge would be more accurate, weigh less and cost less than the current .30'06 cartridge. Subsequent field trials on the Pedersen rifle and his competitor's design, the Garand, concluded that the .276 caliber was indeed more suited for a self-loading rifle, and all developmental research for a .30'06 caliber semi-automatic rifle was suspended.

In 1928, the Army conducted a series of wound ballistics tests at Aberdeen proving ground. The tests were known as the Pig Board tests, as the cartridges were tested on anesthetized pigs.<sup>21</sup> The tests

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<sup>19</sup> William H. Hallahan, *Misfire - The History of how America's small arms have failed our military*. (New York: Pixel Press, 1994), 365.

<sup>20</sup> *Ibid.*, 370.

<sup>21</sup> *Ibid.*, 379.

compared three calibers, .256, .276 and .30'06 calibers. They concluded that the .256 was the most effective at distances under 300 yards, then .276 and finally .30'06. At 600 yards, all three calibers were considered to be equally effective. At 1000 yards, the .30'06 cartridge created the most damaging wounds. The question now was what did the Infantry want in a rifle, short-range or long-range effectiveness?

Over the next several years, tests confirmed that the new caliber would be the .276 Pedersen. The cartridge was standardized as firing a 130-grain bullet at 2,700 feet per second. The only point to decide was which rifle design should be selected, the Pedersen or the Garand? The infantry board semi-automatic rifle tests were conducted at Fort Benning, Georgia in 1931. The two designs went head to head, with the .276 caliber Garand coming out on top. The results and recommendation for adoption of the .276 Garand were passed to the War Department.

Chief of Staff of the Army, Douglas McArthur made the decision to override the results of testing in favor of a design that fired the .30'06 cartridge. His decision was based on the huge stockpiles of .30'06 ammunition left over from World War I and the onset of the Great Depression. He also decided that the .276 caliber was not suited for machinegun use and this would necessitate two calibers, complicating logistics. Luckily, John Garand had originally developed his rifle in a .30'06 version and had continued refinement of the design in his spare time. With minor adjustment, his design was adopted and standardized in 1936 as the U.S. Rifle, Caliber 30, M1. Unfortunately, this would not be the last time that economics and bureaucracy prevented soldiers from getting the best weapon possible.

## World War II

There were significant developments in small arms during World War II. Mechanized, maneuver warfare replaced static, positional warfare. The potential of the airplane and tank were fully realized, and the Infantry was often relegated to supporting this mechanized warfare.<sup>22</sup>

Mechanized units required that crews be armed with lighter, shorter weapons than the M1 rifle, though still retain a defensive capability to 100 yards. The M1911, .45-caliber automatic pistol was not capable of accurate fire to 100 yards and several other weapons were adopted to fulfill this role. Two examples are the .45-caliber Thompson submachine gun, which fired a 230-grain round nose bullet at 910 feet per second and the .30 caliber carbine, M1.<sup>23</sup> The .30-caliber carbine fired a 110-grain blunt nose bullet at 1,950 feet per second. The German Army filled this requirement with the 9-mm MP40 submachine gun and the Russian Army with the 7.65 x 25-mm PPsh 41 submachine gun, the British with the 9-mm Sten gun.

While originally envisioned primarily as secondary, defensive weapons, the sheer firepower of these weapons was soon sought out by front line troops conducting assaults, urban fighting, or in combat in close terrain, such as in the Pacific Theater. All of these operations are characterized by engagement distances of 100 meters or less.

The use of these weapons represents a shift in the method in which infantry units conduct operations. The composition of modern armies encompassed draftees who were not trained in the precise application of rifle fire. Militaries did not have the time to train their large conscript armies and so relied on massed suppressive fire to achieve results. Suppressive fire could be used to fix the enemy and the application of indirect fire from artillery and mortars was then used to finish him.

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<sup>22</sup> John A English, and Bruce Gudmundson, *On Infantry*. (Westport: Praeger Publishers, 1994, 59-77.

<sup>23</sup> John Weeks, *World War II Small Arms*. (New York: Galahad Books, 1979), 130.

The Soviet Union took the idea of submachine guns and suppression too far however and equipped entire units with the submachine gun. This weapon worked well in close range combat, such as at Stalingrad and in the subsequent offensive campaigns, where the goal was to keep attacking, at some point, all the time.<sup>24</sup> In 1943, after several significant failures against Germans armed with a mix of rifles and submachine guns, the Soviets realized that by equipping complete units with one type of weapon, they did not have the flexibility needed to conduct different types of operations in different terrain. What was needed was a weapon that combined the firepower of the submachine gun with the range of a rifle or a reorganization of the squad to allow a mix of weapons capabilities.

German research conducted during and after World War I revealed that most infantry engagements occurred within 400 meters and the long-range capability of the standard 7.92-mm rifle cartridge was generally wasted.<sup>25</sup> During World War II, the Germans succeeded in producing the most significant small arms development of the entire war with the StG44 “Sturmgewehr” assault rifle. The StG44 fired the new 7.92 x 33-mm kurz cartridge, with a 123-grain bullet fired at 2,340 feet per second. This gave the rifle an effective range of about 300 meters.<sup>26</sup> This class of cartridge came to be known as an intermediate cartridge, bridging the capabilities of the submachine gun firing a pistol caliber cartridge and the rifle, firing a full power cartridge. This concept of an “assault rifle,” firing an intermediate cartridge, would later be adopted by the Soviet Union in the well-known AK47 Kalashnikov.

The American infantry squad at this time had 12 men; a squad leader, assistant squad leader, seven riflemen armed with M1 Garands (two of which were scouts) and a three-man automatic rifle team. The automatic rifle team consisted of an automatic rifleman equipped with the M1918A2 Browning

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<sup>24</sup>Ibid., 112.

<sup>25</sup> Peter R Senich, *The German Assault Rifle 1935-1945*. (Boulder: Paladin Press, 1987), 1.

<sup>26</sup> Ibid., 175.



Automatic Rifle (BAR), an assistant automatic rifleman armed with an M1903A4 sniper rifle and an ammunition bearer.<sup>27</sup> During this period, the Marines experimented with a nine-man squad armed with one BAR, five Thompson submachine guns and three M1 Garand rifles. When broken down into three, three-man “fire groups,” this allowed every group to have two automatic weapons and one rifle.<sup>28</sup>

Following World War II, the lessons learned were consolidated and a group of senior leaders formed the War Department Equipment Board to discuss what equipment worked well and what the anticipated requirements of future wars would require with regard to equipment and training.<sup>29</sup> One result of this board was the formation of a new qualification course, which encompassed the lessons learned from the fighting in the Pacific and European theaters. It was known as the rifle qualification course of 1949.<sup>30</sup> It is the author’s opinion that this course is the most realistic and comprehensive marksmanship qualification course the United States Army employed during the twentieth century.

The qualification course of 1949 takes the lessons learned from the various theaters of World War II, and encompasses them in one overall qualification course. This qualification course consisted of four qualification tables with soldiers firing from different shooting positions and ranges, to a distance of 500 yards. The first part of rifle qualification was conducted on the known distance range. Table IV of the qualification had soldiers conduct slow fire from the standing position at 100 yards, followed by the kneeling and squatting positions at 200 yards, and finally the prone position from 300 and 500 yards. Table V of the qualification had shooters engage targets with rapid fire at distances of 200 and 300 yards.

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<sup>27</sup> Virgil Ney, *Organization and Equipment of the Infantry Rifle Squad: From Valley Forge to ROAD*. CORG Memorandum, (Fort Belvoir: Combat Operations Research Group, 1965).

<sup>28</sup> English and Gudmundson, *On Infantry*, 132.

<sup>29</sup> *War Department Equipment Board*. Report of findings, (Washington: Government Printing Office, 1946).

<sup>30</sup> Louis R. Moore, "The New Rifle Marksmanship Course." *Infantry School Quarterly*, Vol 35, No 2, 1949: 5-21

At 200 yards, shooters were required to start in the standing position and move to either a squatting or kneeling position and fire nine rounds in 50 seconds, to include a reload. At 300 yards, shooters were required to start in the standing position and move to a prone position and fire nine rounds in 50 seconds, to include a reload.

The most interesting aspect of this qualification course is found in table VIII. Table VIII consisted of a ten-lane range with two targets per lane. Engagement distances ranged from 125 yards to 500 yards. Each lane presents a different type of terrain for the shooter to occupy and attempt to engage the target. This terrain included the foxhole, a rubble pile, a window, a stump, prone, a barricade, a ditch, a rooftop and finally a log. These positions were chosen as representative of common terrain soldiers encountered on the battlefield. Soldiers were given four rounds for each lane to engage the two targets. As long as both targets were hit, any saved rounds were worth the same value as a hit and added to the soldier's score. The one exception was the fifth lane, which consisted of a bullseye target at 500 yards, meant to simulate a vehicle front, with all four rounds scored based on their location on the target. Soldiers moved from lane to lane until all ten lanes had been fired.

The final portion of this qualification course consisted of a quick fire lane. This lane was 25 yards wide by 130 yards long. Engagement distances could range from zero to 55 yards, depending on when the soldier detected the target. Soldiers began the lane with 24 rounds available with one eight-round clip<sup>31</sup> in the rifle, and two additional clips available for reloading. The lane consisted of 20 targets grouped in single, double or triple target engagements. Once again, if all targets were hit, any saved rounds equaled the value of a hit and were added to the soldier's score.

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<sup>31</sup> The M1 Garand rifle utilized an en bloc clip, which held eight cartridges. When all eight cartridges were expended, the clip ejected from the rifle with a distinctive "ping" This system was an advancement over the previous five round stripper clips used to charge the internal magazines of bolt action rifles, but was not as refined as future magazines, which fully enclosed the ammunition.

A maximum possible score of 620 points were available for this qualification course. The difficulty of this course is demonstrated with the associate levels of qualification. A soldier earning 450 points (72%) was considered an expert. A soldier earning 360 points (58%) was considered a sharpshooter and finally, soldiers required a minimum of 300 points (48%) to qualify as a marksman. Due to the difficulty and realism of the qualification course, the average soldier was expected to shoot 50%.<sup>32</sup>

## **The Korean War**

The Korean War was almost an extension of World War II in terms of equipment and organization. Soldiers were still armed with the M1 Garand rifle as its primary rifle. The sniper rifle of the squad was upgraded from the M1903A4 to the M1C Garand, a version of the Garand fitted with a telescopic sight.<sup>33</sup> One additional change was the adoption of the M2 carbine, an evolution of the M1 carbine to automatic capability.<sup>34</sup> The automatic rifleman was still equipped with the M1918A2 BAR.

The organization of the infantry squad had changed shortly after the conclusion of World War II, reducing its size to nine men with the elimination of the ammunition bearer and two scouts.<sup>35</sup> This reduction in squad size was augmented with the creation of a weapons squad in the rifle platoon. The weapons squad had a squad leader, gunner armed with a .30'06 light machine gun, assistant gunner and two ammunition bearers, one armed with a 2.36-inch rocket launcher.

The Korean War was a return to conventional infantry warfare. Mechanized forces were of little use in the mountainous terrain of Korea. After the initial fighting, lines stabilized and a period of trench

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<sup>32</sup> See appendix A for all tables associated with 1949 qualification course, with graphic depiction of the course of fire for tables VIII and IX.

<sup>33</sup> Ney, *Organization and Equipment of the Infantry Rifle Squad*, 53.

<sup>34</sup> The M2 was a select fire variant of the M1 Carbine. It was fitted with a 30 round magazine in place of the M1's 15 round magazine. It was designed at the end of World War II and saw extensive use in Korea and later in Vietnam with South Vietnamese Soldiers and their advisors.

<sup>35</sup> Ney, *Organization and Equipment of the Infantry Rifle Squad*, 53.

warfare existed in the mountains of Korea, one that resembled the positional warfare categorized by the trench warfare of 1914-1918.<sup>36</sup>

With the exception of the qualification course, training during this time remained much the same as it was during World War II. Unfortunately, the Army had failed to implement some of the lessons it had learned in World War II when conducting operations in mountainous terrain, such as experienced in Italy by the 10th Mountain Division.<sup>37</sup> These lessons were captured in field manual field manual 70-10, *Mountain Operations*, dated 1944. Considerations for the infantry in mountain combat include the importance of long-range fires provided by snipers, the importance of range estimation and its challenges in mountainous terrain and the limitations of supporting fire.<sup>38</sup> While the necessity of these considerations had been previously captured, the Army failed to adjust either its organization, equipment or marksmanship programs. These lessons would be forgotten and learned again, with the invasion of Afghanistan by the Soviets in 1979, and the United States in 2001.

While the Korean War was underway, the United States Ordnance Branch was once again trying to identify the requirements for a future infantry rifle and produce a new family of weapons based on a new caliber. Following World War II, the Soviet Union adopted a new cartridge and weapon based on the intermediate cartridge of the Germans. Mikhail Kalashnikov designed his AK47 from the German StG44, to fire the M1943 7.62x39-mm cartridge.<sup>39</sup> The cartridge fired a 123-grain bullet at 2,300 feet per second and was ballistically very similar to the German 7.92x33-mm kurz round. The Soviet Union was the only country to adopt a service rifle with an intermediate range cartridge following World War II. The United

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<sup>36</sup> General Matthew B. Ridgway, – *Soldier*. (New York: Harper & Brothers, 1956), 215.

<sup>37</sup> “10th Mountain Division History.” [http://www.mscd.edu/history/camphale/tmd\\_001.html](http://www.mscd.edu/history/camphale/tmd_001.html) (accessed September 10, 2009)

<sup>38</sup> *FM 70-10, Mountain Operations*. (Washington: Government Printing Office, 1944), 26.

<sup>39</sup> Val Shilin, and Charlie Cutshaw. *Legends and Reality of the AK: A Behind the scenes Look at the History, Design, and Impact of the Kalashnikov Family of Weapons*.(Boulder: Paladin Press, 2000), 21.

States considered the 30-‘06 cartridge to have been a great success and therefore there was no need to diminish its capabilities with a replacement of intermediate cartridge capability.

The Infantry and the Ordnance Department pursued the adoption of a new rifle with a different set of performance requirements. The Ordnance Department and the Infantry sought to maintain the strengths of the M1 Garand and its 30-‘06 ammunition but to remedy its perceived faults. Ideally, a new rifle would encompass the lightweight of the M1 carbine with the firepower provided by the automatic BAR. In comparison to the M1 carbine at 5.5 pounds, the M1 Garand was heavy at 9.5 pounds, but the BAR weighed 20 pounds. The key features desired in the new rifle were that it weighs no more than 9 pounds, have a folding stock, bipod, 20 round magazine and select fire capability.<sup>40</sup> Ordnance designers quickly realized that it was impossible to design a rifle with those characteristics without a new cartridge.

## **The Pentomic Era**

The Pentomic Era describes the period from the end of the Korean War to the beginning of the Vietnam War. The Army found itself adjusting its role for the operational and strategic environments in which it was to be used, with the overall focus on nuclear weapons strategy.<sup>41</sup> The fiscal principals of the Eisenhower era forced the Army to do more training with fewer resources, and redefine its mission for the anticipated warfare in the atomic age. The requirement for infantrymen with precision fire capability was dismissed in favor of a cost effective system that would produce more soldiers trained to a lower standard. This system remains in use today and was originally called the trainfire course.

The trainfire course, initially conceived in 1958, was designed to reflect actual distances encountered in combat. It had realistic targets that conditioned soldiers to see what an enemy combatant

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<sup>40</sup> Edward Clinton Ezell, *The Great Rifle Controversy: - Search for the Ultimate Infantry Weapon from World War II Through Vietnam and Beyond*. (Harrisburg: Stackpole Books, 1984), 42.

<sup>41</sup> A.J.Bacevich, *The Pentomic Era: The U.S. Army between Korea and Vietnam*. (Washington: National Defense University Press, 1986), 6-9.

would look like at different distances. It was designed to be used in conjunction with the known distance range to maintain the capability to engage targets to the maximum effective range of organic weapons. General Willard G. Wyman, the Continental Army Commander (CONARC)<sup>42</sup> stated that the marksmanship program had two goals; “The first, and obviously the most important, is the rapid and economical production of effective combat marksman. The second is the development of precision marksmen for combat and competitive firing.”<sup>43</sup> Unfortunately, the requirement to train new recruits quickly during periods of conflict placed all emphasis on the first goal, to the detriment of the second.

During this time period, weapons designers sought to develop a round of smaller diameter than the .30 caliber of the 30’06 cartridge, with a range similar to the 7.92x33-mm kurz round. The British developed two cartridges, one a .270 (6.8-mm) cartridge firing a 130-grain bullet at 2,400 feet per second and a .280 (7-mm) cartridge firing a 140-grain bullet at 2,300 feet per second. The British Beeching report used a similar test protocol as the 1920’s pig tests and came to the same conclusions.<sup>44</sup> It affirmed that most engagements occurred within 600 yards and a full power cartridge, such as their own .303 or the .30’06 cartridge was overly powerful for typical engagement distances. This report was corroborated with the Hall report from Aberdeen Proving Ground and the Hitchman report from the Operations Research Office at Johns Hopkins. Both reports used current data from the Korean War, in conjunction with ballistic studies, to determine that the ideal infantry weapon should be capable of controlled automatic fire and effective to a distance of 600 yards.<sup>45</sup>

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<sup>42</sup> The Continental Army Command (CONARC) was the predecessor to today’s Forces Command (FORSCOM) and Training and Doctrine Command (TRADOC). In 1973, CONARC split into these two organizations as part of the post-Vietnam reorganization.

<sup>43</sup> General Willard G. Wyman, "Army Rifle Marksmanship Today." *Infantry*, Jul/Sept, 1958: 6-7.

<sup>44</sup> Hallahan, *Misfire*, 419.

<sup>45</sup> *Ibid.*, 428.

Despite these reports, the Ordnance Department insisted on a .30 caliber cartridge. They cited the requirement for specialized ammunition such as armor piercing, incendiary and tracer and claimed that these types of rounds would be ineffective in a smaller caliber. New developments in rifle propellants allowed designers to duplicate the characteristics of the .30'06 cartridge in a cartridge that was .65 inches shorter. A shorter cartridge would allow for a reduction in receiver length and therefore a reduction in weight. The new cartridge was developed and adopted as the T65 and standardized as the 7.62x51-mm cartridge. Due to cooperative security agreements and political pressure, the 7.62x51-mm cartridge was standardized as the NATO rifle cartridge in 1953.<sup>46</sup>

Numerous tests and adaption of previous designs were conducted to determine the next rifle of the United States military. In the end, it came down to a product-improved version of the M1 Garand and a Belgian rifle, the Fusil Automatique Leger (FAL). After extensive testing and refinement of both rifles, the final decision was made in 1957 to adopt the American design and standardize it as the U.S Rifle, Caliber .30, M14.<sup>47</sup>

At almost the same time that the M14 rifle was standardized, the Armalite Company demonstrated a new rifle to the small arms community. It was designed by Eugene Stoner and was known as the AR10. It was designed for the 7.62x51-mm NATO cartridge and was reliable and lightweight. It had a simple design and used modern manufacturing techniques and materials. Word quickly spread about this new futuristic weapon and even the Army Ordnance Corps commented that with development it could be the next rifle of the U.S Armed Forces.<sup>48</sup>

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<sup>46</sup> Ibid., 452.

<sup>47</sup> Ibid., 441.

<sup>48</sup> Ibid., 448.

While receiving praise for his design, Eugene Stoner was asked by General Willard G. Wyman, the Continental Army Commander, if he would build a rifle chambered for the .22 caliber (5.56-mm) cartridge tested in the SALVO project,<sup>49</sup> as that would be more effective and controllable under automatic conditions. As a private company venture, Armalite decided to invest in the concept and Stoner eventually modified his AR10 into a scaled down version, the AR15, which fired the 5.56-mm cartridge. The 5.56-mm cartridge, as originally designed, consisted of a 55-grain full metal jacket projectile traveling at 3,250 feet per second out of a 20-inch barrel.

Armalite and its representatives did an excellent job of marketing the new rifle but given delays by Army bureaucracy and financial hardship, they approached Colts manufacturing with the plans to produce the rifle. Initial inroads into the armed forces was achieved by demonstrating the effectiveness of the new rifle and cartridge at a fourth of July picnic at which the Vice Chief of Staff of the Air Force, General Curtis Lemay was present. He desired a lightweight rifle to replace the M2 carbine for his airbase security personnel. He was sufficiently impressed and placed an order for 8,500 rifles.<sup>50</sup>

The Army Ordnance Corps quickly downplayed the effectiveness of the new cartridge and the AR15, because it was in direct competition with the M14 rifle, a project in which they had invested over twelve years and 100 million dollars. Despite infighting, the AR15 was eventually adopted as the M16 and production of the M14 was suspended.

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<sup>49</sup> The SALVO project was conducted by the Operations Research Office from 1953-57. Its charter was to explore the viability of a weapon that launched multiple projectiles in a circular area of dispersion. The theory behind the concept was that when multiple projectiles were fired in a dispersed, circular pattern, the pattern ensured that one or two of the projectile would strike the target, while one conventional shot might miss.

<sup>50</sup> Ezell, *The Great Rifle Controversy*, 185.



## Vietnam

Organization of the infantry squad had changed once again during this period and resulted in a change, which remains to this day, with a nine-man squad, consisting of a squad leader and two fire teams of four men each. Each fire team was augmented with one M79, 40-mm grenade launcher. The M79 is a single shot, breech loaded weapon, which augments the maximum range of a hand thrown grenade, to a distance of 350 meters, against an area target. One negative of the reorganization of the squad in 1960, was the loss of the M1D sniper rifle and its long-range capability for the rifle squad. With the adoption of the M16, the last remnants of a long-range capability were lost.

Vietnam saw the first widespread use of a lightweight, automatic rifle. However, the M16 as originally fielded, was plagued with problems. These initial problems with the rifle were mostly due to changes adopted by the Ordnance Corps without consultation with Eugene Stoner, the weapons designer. The two most significant changes were the elimination of chrome lining in the chamber, barrel bore and bolt carrier, which prevent corrosion,<sup>51</sup> and the substitution of a ball type propellant in place of an extruded stick type propellant. In the humid and wet jungle conditions of Vietnam, the failure to chrome line the chamber resulted in cartridge cases becoming stuck in the chamber when left in the chamber overnight. The result was the first cartridge fired became stuck in the chamber, requiring a steel cleaning rod to extract.

There are numerous cases of men being killed while attempting to clear this common malfunction.<sup>52</sup> Stoner was advised of the requirement to use ball powder for ammunition production, but he failed to use it while developing the cartridge. Ball type propellant is better for mass production of cartridges because it meters more accurately into the case. The problem with this type of propellant is that

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<sup>51</sup> Chrome lining is a process that coats ordinary steel with a thin plating of chrome. This renders the steel less susceptible to rust and makes it easier to clean.

<sup>52</sup> Keith William Nolan, *Operation Buffalo- USMC Fight for the DMZ*. (Novato: Presidio Press, 1991), 70.

its combustion produces more residue and higher temperatures. In the case of the AR15, that residue and higher temperature combustion moves from the gas port in the barrel to the bolt carrier, to cycle the action. This high heat burns off any lubrication, and combined with powder residue, increases the rate of malfunctions.

Compounding the fouling issue is the fact that cleaning kits were not issued with the weapon and no space existed in the butt stock for a cleaning kit, as had traditionally been the case. Soldiers originally issued the rifles were told that it was self-cleaning. Complaints from the field quickly reached the highest levels of Congress. When members of the Armalite design team went to Vietnam to get first hand explanations for the complaints, they learned that most soldiers did not know how to maintain their rifle. Magazines, a critical component of the rifle, were found to contain debris and dirt, and the ammunition contained within was dirty. These magazines were originally designed to be disposable and were therefore constructed of a lightweight aluminum, which was easily damaged with extensive use.<sup>53</sup> The maintenance of the magazines proved to be just as important as the maintenance of the rifle. A lengthy campaign ensued with an attempt to instruct soldiers on the proper maintenance of the weapon system. Unfortunately, 45 years after the fact, the Army is still having the same problems.<sup>54</sup>

Changes were made to address the mechanical problems of the rifle. These changes resulted in a new model designation, known as the M16A1. The M16A1 incorporated chrome lining for the bolt carrier, chamber and bore and included a forward assist for the bolt carrier. It also changed the original flash hider, which was a three-pronged device and prone to catching on vines, with an enclosed flash hider. In this configuration, the M16A1 proved to be a reliable system, which was lightweight and offered a high volume of fire. The effectiveness of its cartridge was reasonably good, considering the short

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<sup>53</sup> Ibid., 70.

<sup>54</sup> Feickert, *The Army's M4 Carbine*, 5-6.

engagement distances of a jungle environment, and the configuration of the rifle with a 20-inch barrel, which kept velocity of the 55-grain bullet above 3,200 feet per second.

Doctrine and training during this period focused on the ability of the squad to gain fire superiority with one team and assault with the other. The automatic capability of the M16 lent itself to this tactic and was effective at the short engagement distances typical of modern combat operations.<sup>55</sup> While the M16A1 was effective in its automatic role, it was not ideal as it possessed only a 30-round magazine and would quickly overheat in the sustained fire role. As the design fired from a closed bolt position, sustained fire could lead to cook offs of a cartridge in the chamber.<sup>56</sup> The Army needed a lightweight, belt-fed weapon, capable of accurate, sustained fire.

## **Post Vietnam**

As with the proceeding wars, designers sought to incorporate the lessons of the Vietnam War and anticipate future requirements. They anticipated that the next war would be fought in Europe against the Soviet Union. The 5.56-mm cartridge needed a longer range and better armor penetration capabilities if it was to be used in a squad automatic weapon. In NATO tests, the Belgian SS109 round had better armor penetration due to a steel penetrator encased in its bullet. It was capable of penetrating 3.5 millimeters of steel at 640 yards and a U. S. steel helmet at 1300 yards. This round was heavier than the 55-grain M193 cartridge and fired a 62-grain bullet. The increased length of the bullet allowed for greater effective range, but required a barrel with a faster rifling twist to stabilize the longer bullet.

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<sup>55</sup> Ezell, *The Great Rifle Controversy*, 168.

<sup>56</sup> Machineguns fire from an open bolt position, meaning the cartridge is only loaded into the chamber at the moment of firing. In most individual weapons, a cartridge is chambered and remains in the chamber until it is fired. Once approximately 100 rounds are fired in rapid succession, such as in an ambush, the heat generated by firing reaches a temperature that can ignite the propellant in the cartridge without the trigger being pulled.

The Belgian-designed M249 Minimi ended the search for a new squad automatic weapon. Due to logistics and the NATO “standardization” of two calibers (7.62x51 and 5.56x45), the new squad automatic weapon was chambered for the 5.56-mm Belgian designed SS109 cartridge. This cartridge was standardized as the M855 “green tip” cartridge in the United States and is still in use today. The M249 squad automatic weapon subsequently replaced the automatic rifleman’s M16 in each fire team.<sup>57</sup> The adoption of the M249 corresponded with the improved M16A2 rifle, capable of firing the new, heavier ammunition. This new rifle required a change in rifle twist from the previous one turn in twelve inches of the M16A1 to one turn in seven inches for the M16A2. This new rifle also replaced the automatic feature of the rifle with a 3-round burst mechanism,<sup>58</sup> added range adjustable sights and a heavy barrel.

Initial reports as to the ineffectiveness of the M855 cartridge in the M16A2 came during Operation Desert Storm. Engagement distances were longer than those experienced in Vietnam and the cartridge was used outside of its effective range. The mission in Somalia further confirmed the ineffectiveness of the cartridge on targets that were malnourished and not protected by body armor. Unfortunately, these conflicts were of a short duration and the lessons learned had little impact on improving small arms lethality.

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<sup>57</sup> The role of the automatic rifleman is to provide suppressive fire for the rest of his team. The M16 is a select-fire weapon, which can be fired in either a single shot mode, or in a fully automatic mode; as long as the trigger was held to the rear and ammunition was still in the magazine, the gun would continue to fire. The automatic rifleman’s M16 was primarily fired in the automatic mode and was sometimes fitted with a bipod to increase the accuracy.

<sup>58</sup> The 3-round burst mechanism was an attempt to conserve ammunition. The theory was that soldiers were expending large quantities of ammunition with little result. After three rounds, the muzzle would climb off the target and any additional rounds would be wasted. Unlike the automatic setting, which it replaced, a soldier would only get three rounds if he pulled the trigger and held it to the rear. The 3-round burst mechanism of the M16A2 is particularly bad. If the cycle of fire is interrupted, as would happen when you released the trigger before three rounds were fired, on the next pull it will complete the cycle, meaning if you fired two rounds and released the trigger, the next pull would only give you one round. The M16 is the only weapon in the world that uses this type of mechanism. Instead of replacing the automatic setting, other countries added a fourth setting so that the user could select between safe, single shot, 3-round burst or fully automatic.

The fact is that in its search for the suppressive fire capability of automatic fire, the U.S. infantry weapon has devolved from the World War I rifle capable of conducting lethal fire out to 1,200 yards, to the current weapon that can hit a target out to 300 meters, but probably will not kill it. Not only is the current U.S. infantrymen less equipped to kill his enemy than his World War I predecessor, he is carrying far more weight than him.

The U.S entered World War I with a small professional Army trained in marksmanship. It filled its ranks with volunteers and conscripts and traditional marksmanship training took too much time. Between World War I and the end of the Vietnam War, the U.S. Army was a conscript Army that relied on suppressive fire, not marksmanship, and trained accordingly. The problem is suppressive fire does not do well with a light, barely lethal bullet at the distances of engagements in Afghanistan.

### **Taking back the infantry half-kilometer**

Operations in Afghanistan have exposed weaknesses in our small arms capability, marksmanship training, and doctrine. After-action reviews and comments from returning non-commissioned officers and officers reveal that about fifty percent of engagements occur past 300 meters. The enemy tactics are to engage U.S forces from high ground with medium and heavy weapons, often including mortars, knowing that we are restricted by our equipment limitations and the inability of our overburdened soldiers to maneuver at elevations exceeding 6,000 feet.<sup>59</sup> Current equipment, training and doctrine are optimized for engagements under 300 meters and on level terrain.

Since 2006, all deploying Brigade combat teams have been issued with the M4 carbine, though most light infantry units have been equipped with the M4 since 1999. This decision was made based on the requirement of soldiers to operate predominately from vehicles and conduct operations in urban terrain, which favor weapons having a short overall length. The detriment of this decision is that the

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<sup>59</sup> "Platoon Fights for its life in Taliban Ambush." *International Herald Tribune*. (International Herald Tribune, April 20, 2009).

weapons effective range is reduced to less than 200 meters. Like our World War II counterparts, short weapons of small caliber are great for close engagements, of a predominately defensive nature, but are a liability during offensive operations at distances out to 500 meters. The requirement for a reduced length weapon will not change in the near future, so other options for increasing its effectiveness must be implemented.

The first area of small arms effectiveness to be addressed is equipment issues. These issues include improved terminal performance of small arms ammunition, optimized for shorter barrels, increased reliability of the M4 and the availability of multiple weapons configurations and sighting systems for different missions. One method of achieving greater flexibility for varying environments is to implement an arms room concept. Under this concept, leaders would have multiple equipment options available to optimize their capability dependent on the mission and environment. Next, the Army qualification course and unit marksmanship programs can be standardized to reflect current combat engagements, with emphasis on shot placement and extended engagement ranges from zero to 500 meters. Finally, doctrine must be rewritten to reflect the requirements of engagements in mountainous terrain, with emphasis on engagements out to 500 meters.

## **Equipment issues**

### **M855 5.56mm “Green Tip”**

Small arms doctrine defines maximum effective range as “the greatest distance at which a weapon may be expected to fire accurately to inflict casualties or damage.”<sup>60</sup> The maximum effective range of the M4 carbine is incorrectly listed as 500 meters for a point target and 600 meters for an area target. These ranges only take into account the ability of the weapon and ammunition to hit a target and

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<sup>60</sup> FM 23-8, *M14 and M14A1 Rifles and Rifle Marksmanship*. (Washington: Department of the Army, 1974), 7.

not the terminal capability of the cartridge. For example, the M1 Garand and M14 rifles, firing a 150-grain bullet, and the M16A1 firing a 55-grain bullet, all had the same maximum effective range of 460 meters.<sup>61</sup> Clearly, these ranges do not consider the terminal ability of the round to inflict casualties. As discussed earlier, the M855 cartridge is most effective to a distance of 200 meters after which its effectiveness is limited unless hitting a vital area of the target.

Controversy had surrounded the 5.56-mm cartridge since its introduction in the M16 rifle. The M855 cartridge firing the 62-grain steel penetrator bullet is less lethal than the caliber was originally designed. Its lethality is based on its ability to fragment once it hit the target. The ability of a bullet to fragment is dependent on several factors, to include overall design and construction, but most important is the velocity at which it strikes the target. Spitzer shaped bullets will travel a certain distances within a target before exhibiting yaw.

For a bullet to exhibit yaw, it must be somewhat unstable when it hits the target. Small caliber, high velocity rounds are especially dependant on this instability for their lethality.<sup>62</sup> For the M855 cartridge, maximum stability is from 150 meters out to 350 meters and it is therefore potentially less lethal between these two ranges.<sup>63</sup>

If a bullet begins to yaw and its velocity remains high, the stresses on the bullet become too great and it breaks up into multiple fragments, typically at the cannelure.<sup>64</sup> As the bullet enters the body, the

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<sup>61</sup> FM 23-5, *U.S. Rifle, Caliber .30, M1*. (Washington: Department of the Army, 1965), 3, FM 23-8, *M14 and M14A1 Rifles and Rifle Marksmanship*. (Washington: Department of the Army, 1974), 7, FM 3-22.9, *Rifle Marksmanship M16-/M4- Series Weapons*. (Washington: Department of the Army, 2008), 2-1.

<sup>62</sup> When fired, a bullet will wobble slightly on its axis, becoming more stable for a certain distance until velocity drops below a specific level and it becomes unstable again. It is this reason that the greatest penetration of a round is often a significant distance from the muzzle. If a bullet is stable, it is less likely to yaw and all its energy is used in continuing its path forward, through the target.

<sup>63</sup> Glenn Dean and David Lafontaine, "Small Caliber Lethality: 5.56mm Performance in Close Quarters Battle." *Infantry*, September-October 2006, 31 figure 5.

<sup>64</sup> The Cannelure is the grooved area of a bullet used to keep the bullet in the cartridge body.

tissue expands away from the path of the bullet. This expansion creates a temporary wound cavity. In some cases, the tissue expands beyond its elastic limit and tears, creating a large, permanent cavity.

Additionally, if a bullet fragments, the fragments will move radially away from the path of the bullet and act synergistically with the stretch of the temporary cavity. This synergist effect of stretch and fragmentation results in an overall increase in the size of the permanent wound cavity. The closer these effects occur to a vital organ, the better. A bullet which does not yaw will only create a small permanent cavity and most of its energy will be not be deposited in the body, but will continue through the body resulting in a minor wound, generally of .22 caliber (5.56-mm) diameter.<sup>65</sup>

Tests conducted by Dr Martin L Fackler at the U.S. Army's Letterman Institute show a predictable pattern of fragmentation based on impact velocity.<sup>66</sup> (See figure 1) From these tests, it is clear that the velocity for a 5.56-mm bullet must be above 2,500 feet per second when it impacts the target to have reliable fragmentation effect. Translating this velocity threshold to a range indicates that the target must be within 200 meters for the round to break into at least two fragments.<sup>67</sup> Additionally, the performance of the bullet is also dependent on the angle of attack of the bullet as it strikes the target.<sup>68</sup>

Dr. Fackler's tests concluded that 70 percent of the time a 5.56-mm bullet travels 4.7 inches in tissue before yawing. Fifteen percent of the time, it would yaw after this distance and 15 percent of the time, it would yaw before 4.7 inches. With these statistics, 85 percent of the time, even within the velocity

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<sup>65</sup> Martin L. Fackler, "Wounding Patterns of Military Rifle Bullets." *International Defense Review*, 1989: 59-64.

<sup>66</sup> Martin L. Fackler, M.D., M.A. John S. Surinchak, B.S., John A. Malinowski, and Robert E. Bowen. "Bullet Fragmentation: A Major Cause of Tissue Disruption." *JTrauma*, 1984: 35-39.

<sup>67</sup> Initial muzzle velocity of the M855 cartridge is 2,970 feet per second when fired from the M4 carbine. At 150 meters, the velocity has dropped to 2,522 feet per second. When fired from the M16A2 or M249 SAW, both with 20-inch barrels, the velocity is above 2,500 feet per second until 200 meters.

<sup>68</sup> Bullets will wobble slightly on their axis after they leave the muzzle of the barrel. The angle of attack of the bullet when it strikes the target affects its performance. This angle affects how quickly the bullet will begin to yaw.



threshold of the 5.56-mm cartridge, the bullet will not begin to yaw and fragment until it has passed through almost five inches of tissue. With small statured or malnourished enemy combatants, the majority of bullets will just pass through them unless the bullet strikes bone or enters at an oblique angle.



Figure 1. 5.56-mm fragmentation at various velocities. Below 2,500 feet per second, fragmentation does not occur. Source: <http://www.dtic.mil/ndia/2008intl/Roberts.pdf> (accessed March 25, 2009).

For examples of M855 ineffectiveness, you can look at some of the live fire accidents that have occurred. One notable incident occurred in 1991, when then Lieutenant Colonel David H. Petraeus was shot in the chest by an M855 round from an M249 squad automatic weapon. He walked out of the hospital several days after the accident. Had the round performed optimally, he likely would have been killed.

The author witnessed a soldier shot in the shoulder from a distance of 75 meters during a night live fire exercise and the soldier was walking around smoking a cigarette twenty minutes after the accident. A soldier in the author's battalion had a negligent discharge with an M249 squad automatic weapon, during the initial invasion of Iraq in 2003, in a closed space of a building. Poorly instructed, he disassembled the weapon before unloading it and the weapon fired at the cyclic rate, firing approximately 100 rounds. From a distance of three meters, four soldiers were hit in the extremities and none sustained life threatening wounds.

In general, the requirements for the infantry squad are that they have weapons capable of reliable incapacitation from close range to a distance of 500 meters. This capability does not exist in the current family of 5.56-mm ammunition, either with military or with commercial off the shelf ammunition, though efforts are underway to remedy the situation. Currently, the infantry squad does not have this capability

unless its designated marksman is armed with a rifle of 7.62x51 caliber. Those armed with 5.56-mm versions of the SDM-R are marginally effective and then dependent on shot placement in the small vital areas of the enemy for their effectiveness.

There are several ways to extend the incapacitation capability of the infantry. First, a more effective 5.56-mm bullet can be designed which provides enhanced terminal performance out to 500 meters. Attempts to achieve this effectiveness over the last thirty years have been unsuccessful. With the recent halt in production of the M855A1 cartridge,<sup>69</sup> which designers promised would deliver this effectiveness, it appears all options within caliber have been exhausted.<sup>70</sup> The next option to increase incapacitation is to adopt a larger caliber cartridge, which will function within the operating parameters of the M16/M4. The 2006 study by the Joint Service Wound Ballistics – Integrated Product Team discovered that the ideal caliber seems to be between 6.5 and 7-mm. This was also the general conclusions of all ballistics studies since the end of World War I. The final option is to develop a cartridge between 6.5 and 7mm that is not constrained by current equipment parameters and design a new weapon capable of firing the cartridge, which takes advantage of modern manufacturing techniques and material.

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<sup>69</sup> Mathew Cox, "Ammo under fire - Temperature issues arise for lead-free slug." *Army Times*. Springfield: Army Times publishing company, August 10, 2009.

<sup>70</sup> M855A1 is the Army's second attempt to produce a lead-free bullet based on concerns of lead pollution on military ranges. Recent tests concluded that the multi piece bullet was susceptible to heat damage, when stored in vehicles, and then subsequently fired in the rifle. Tests conducted with Doppler radar revealed a failure rate above 5%, where the round did not impact anywhere near the target. This effort has wasted over 20 million dollars in research and is the second failure of this design concept. There is no evidence that lead from bullets contributes to ground contamination. There is however, proof that the lead in the primers used for the cartridges is highly toxic, though the so-called "green ammunition" still contains lead primers. Engineers have not been able to develop a lead free primer that is as stable as lead based primers.

## Alternate Calibers

### *6.8 -mm Special Purpose Cartridge (6.8 SPC)*

The special operations community also identified the requirement for a more lethal cartridge. They began a search for a new cartridge that would give them an increased capability over current M855. Two master sergeants took the historical information about effective calibers and tested cartridges in 6-mm, 6.5-mm, 6.8-mm, 7-mm, 7.62-mm cartridges that would work within the system limitations of the M16/M4. They discovered that 7-mm was the most devastating caliber and that 6.5-mm was the most accurate caliber for the above range. The 6.8-mm caliber offered the best compromise in accuracy and lethality. See Figure 2.

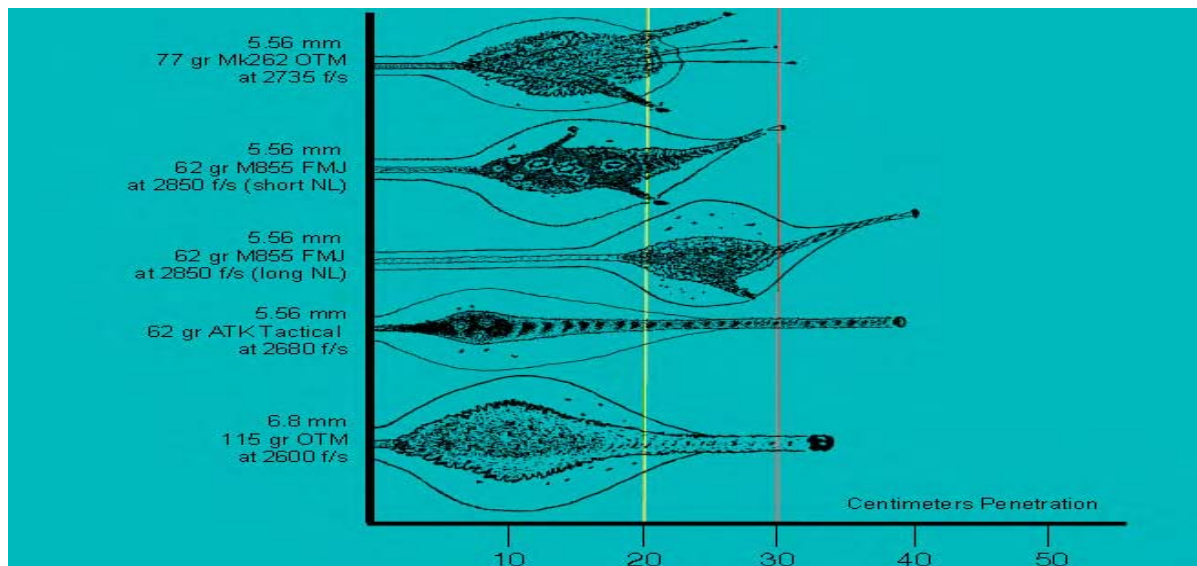


Figure 2. Comparison of wound profiles of 5.56-mm cartridges and 6.8 SPC. 20 centimeters represents the average chest depth of a human. 30 centimeters represents the minimum recommended penetration capability for a military cartridge. Source: Robert, Gary. *Defense Technical Information Center*. March 25, 2009. <http://www.dtic.mil/ndia/2008Intl/Roberts.pdf> (accessed March 25, 2009).

The Army's Project Manager, Maneuver Ammunition Systems, assembled a team of experts to determine if there were any commercial off the shelf (COTS) 5.56-mm bullets or other calibers that were better than M855. The Joint Service Wound Ballistic - Integrated Product Team (JSWB-IPT) conducted tests in 2006 and determined that an intermediate caliber was the answer to trade off balance. They also found that 6.8-mm was "far and above the best performing ammunition tested" and that the 6.8-mm

cartridge offered the optimal balance of mass, velocity and configuration. In the overall ranking of the cartridges tested, the 6.8-mm cartridge placed first, beating the 7.62x51-mm cartridge.<sup>71</sup>

The 6.8-mm Special Purpose Cartridge (SPC) fires a 110-grain bullet at a velocity of 2,650 feet per second. Unlike M855, it is optimized for short-barreled carbines and does not rely solely on fragmentation to incapacitate. This cartridge can be used in existing M4/M16 rifles with only a change in the barrel, bolt, and magazine, making it a cost effective alternative to procuring a new rifle. The magazines for this cartridge are externally identical to the 5.56mm versions, so they will fit in existing load carrying equipment and pouches. See figure 3 for relative size comparison of military cartridges.



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<sup>71</sup> Dr. Gary Roberts, interview by Major Thomas P Ehrhart. *Member, Joint Service Wound Ballistics - Integrated Product Team* (August 10, 2009).

Figure 3. Comparison of military cartridges. From left to right - .30'06, 7.62x51, 6.8 SPC, 7.62x39 and 5.56 "Green Tip."  
Source: Photograph by author.

### 6.5 Grendel

In 2002, Bill Alexander of Alexander Arms and Arne Brennan of Competition shooting sports developed the 6.5-mm Grendel cartridge. It was designed so that it would function on the M16/M4 platform and deliver increased lethality at extended ranges while producing low recoil. In contrast to the 6.8 SPC cartridge, the designers used a longer bullet and shorter case to fit the magazine length limitation of the M4/M16. In doing so, they developed a cartridge that fires a streamlined bullet that retains velocity better than the 6.8 SPC, equating to better overall performance beyond 400 meters.

There are several benefits to the design approach used for this caliber. First, there is a larger selection of bullet weights available for the cartridge. Current options provide bullet weights from 90 grains up to 144 grains allowing for a heavy machinegun round and a lighter assault rifle round. Second, sectional density of the 6.5 Grendel, when loaded with its heavier bullets allows for increased hard target penetration.<sup>72</sup> This hard target penetration is so good that it exceeded the penetration capability of 7.62x51-mm out to a distance of 1000 meters.

In comparing the 6.5 Grendel with the 6.8 SPC it becomes clear that the 6.5 Grendel is better suited to extended engagement distances. In comparing retained velocity and energy, the 6.8 SPC with a 115 grain bullet has a velocity of 1,461 feet per second and 545 foot pounds of energy at 600 meters. The 6.5 Grendel with 123 grain bullet has a velocity of 1,881 feet per second and 946 foot pounds of energy, almost twice that of the 6.8. Interestingly, the 6.5 Grendel cartridge is ballistically very similar to the British .280 caliber cartridge designed after World War II but discarded when the U.S forced NATO to adopt the 7.62x51 cartridge.

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<sup>72</sup> Sectional density compares a bullets weight to its diameter. When design, composition, and construction are the same, a smaller diameter bullet will penetrate better than a larger diameter bullet of the same weight because the energy is concentrated in a smaller area.

The 6.5 Grendel cartridge is the first viable option for a one caliber system, able to replace the 7.62x51 cartridge of sniper rifles and machine guns. This is especially true given the 6.5 Grendel's penetration capability and long range effectiveness. Its size allows it to be fired within existing M4/M16 lower receivers and for the M249 to be modified to accept the new round with relatively little to moderate modification. The only negative aspect of the 6.5 Grendel is that it has not been tested as extensively as the 6.8 SPC. Initial comparison between the two cartridges reveals that 6.8 SPC is more lethal from zero to 400 meters and 6.5 Grendel is more lethal beyond 400 meters and offers better penetration of barriers.

### *7 x 46-mm Advanced Rifle Cartridge (ARC)*

One final option available is to start with a fresh design concept not constrained by the limitations of the M16/M4 platform. One of the co-designers of the 6.8 SPC, Chris Murray, developed a cartridge based on the successful Czechoslovakian 7.62x46-mm cartridge, necked down to accept a 7-mm bullet. This concept was based on their original development of the 6.8 SPC in which it was noted that 7-mm bullets offered the best terminal performance. When not constrained to the magazine length of the M16/M4, he could use a case that allowed a 130-grain bullet to be fired at a muzzle velocity of 2,600 feet per second. Development of this cartridge is currently progressing and may result in the ideal balance for a one-caliber force.

One significant issue with the adoption of a new caliber to the arsenal is the capacity to produce the ammunition for it. Currently, Lake City ammunition plant is the sole manufacturer of 5.56-mm ammunition for the United States military. They produce 1.6 billion rounds of 5.56-mm ammunition a year for training and operational use.<sup>73</sup> Since the Afghanistan invasion in 2001, they have steadily increased their production in an effort to meet the demand of the force. As of June 2009, they are at maximum capacity, running three shifts a day, seven days a week. They produce 1,200 rounds of loaded

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<sup>73</sup> Barbara A. Wright, "Plant Tour - Lake City Army Ammunition Plant." (Independence, May 7, 2009).

ammunition every minute. They have the capability to switch to a new caliber; however, the facility does not have the capacity to produce two primary rifle cartridges in the quantities necessary for combat operations.

Any adoption of a new caliber would require the re-opening of one of the many ammunition plants that were closed under the Clinton administration or by going outside the Department of Defense to a commercial manufacturer. This can be accomplished, but it would have to be financially lucrative for the producing company, as these calibers are not widely accepted calibers in the civilian community. The government would have to come to an agreement that either guarantees procurement for a set period and/or provides the machinery necessary to produce the cartridges.

## Optics

The Arms room concept also applies to different optics requirements. Afghanistan presents several kinds of terrain from short-range urban to mid and long-range mountainous terrain. Typical reports from soldiers indicate that at least half of their engagements occurred beyond 300 meters. The limited capability of the current M855 cartridge combined with the extended distances of engagements in Afghanistan requires that shot placement on target is more critical than ever before. In conjunction with training for long distance engagement, the use of optics can greatly increase the potential of incapacitating hits, as well as provide target detection and discrimination. There are currently two primary optics approved for use on the M4 and M16 rifles. They are the Aimpoint- M68 Close Combat Optic (CCO) and the Trijicon- Advanced Combat Optical Gunsight (ACOG).

### *Trijicon TA31F ACOG*

The ACOG is a four-power optic, which magnifies the target by four times. It includes a bullet drop compensator, calibrated for the M855 cartridge, to allow for engagement out to 800 meters. It has a range estimating reticle, which corresponds to the average width of a man's chest (19") at varying



distances from 300 to 800 meters. (Figure 4)

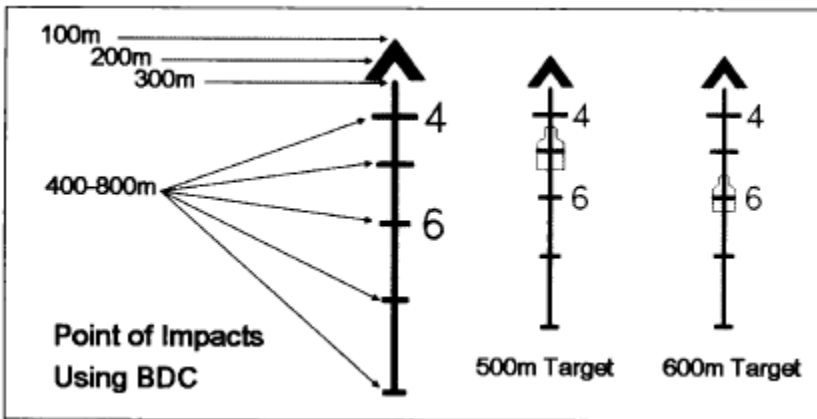


Figure 4. Trijicon ACOG model TA31F bullet drop compensating reticle. *Source: FM3-22.9, 8-18.*

In theory, a soldier places the appropriate width line on the target and the round will strike that point of aim. In practice, different atmospheric conditions such as the effects of altitude affect the strike of the round. To engage targets accurately, soldiers still need to adjust for the effects of wind and angle of the shot.

One of the limiting factors of a magnified optic such as the ACOG, is that it is not ideal for close quarters battle and multiple targets. To address this concern, one of the latest variants, the TA31F, includes a red chevron aiming point, which uses the Bindon aiming concept. Under the Bindon aiming concept the shooter keeps both eyes open and engages a target in a similar manner to the M68 red dot sight. The red chevron is illuminated by tritium for nighttime use and fiber optic for daytime use. In theory, the bright red chevron is similar to a red dot scope. At close distances, a shooter will unconsciously transfer the red aiming point and unmagnified image presented by his non-dominant eye into one picture to engage the target.

One of the flaws of the Bindon aiming concept is that it relies on the shooter having the same vision in both eyes. If not, the system does not work and the soldier is limited in using the optic in close quarters battle. Additionally, the system works well for one target but is very slow if transitioning between multiple targets, as the soldier will have to focus on the threat, un-focus, and re-focus on the additional target.



While not perfect, the Trijicon ACOG represents the best option currently available to the soldier when engagement distances exceed 300 meters. The current table of organization and equipment has three ACOG's per squad, one for the squad leader and one in each team issued to a rifleman.<sup>74</sup> Generally, this issue has been augmented by the rapid fielding initiative (RFI) to equip most of the squad with the ACOG - TA31F variant.

### *Aimpoint M68 Close Combat Optic*

The M68 is a red dot optic with no magnification. It is designed for two-eyes-open shooting to increase situational awareness. It also simplifies sight alignment in that a soldier no longer has to align a front and rear sight. Simply place the red dot on the desired point of impact and fire. Using this system, the position of the soldier's head and eyes is not critical, as it is in the use of iron sights, which allows for the more fluid engagements of close quarters battle. The latest version of the M68 has a small, two-minute-of-angle dot<sup>75</sup> and a battery life of 80,000 hours with one AA battery. Effectively, you can leave the sight on all the time and never worry about the battery dying.

Augmenting the capabilities of the M68 red dot sight is a recently developed three-power magnifier made by Aimpoint. The purpose of this magnifier is to increase engagement capability and target identification and discrimination out to a distance of 300 meters. A private company, Larue Tactical, makes a mount for this magnifier which allows the magnifier to be swung to the side when not needed, preserving the situational awareness benefit of red dot sights and swung back when more precision is necessary or to identify a target. It is also quickly detachable so it can be stored on the soldier when not needed. This feature also allows the magnifier to be used for general observation without

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<sup>74</sup> MTOE narrative, section one - *FMSWeb*.  
[https://webtaads.belvoir.army.mil/protected/WebTAADS/Fram\\_DocTypes.asp?GUID=1705394423](https://webtaads.belvoir.army.mil/protected/WebTAADS/Fram_DocTypes.asp?GUID=1705394423) (accessed July 16, 2009).

<sup>75</sup> Minute of angle is a unit of measure that equates to roughly 1 inch per 100 meters, for example – Five MOA is equal to five inches at 500 meters.

pointing the weapon at civilians. Since it is just a magnifier, there is no zero to lose by continually attaching or detaching the magnifier. (See Figure 5)



**Figure 5. Aimpoint 3 x magnifier mounted behind current M68 CCO. Source: Photograph by author.**

Where engagement distances are not anticipated to exceed 300 meters, the M68 close combat optic with 3-power magnifier represents the best balance of capability. Engagements under 300 meters do not require an optic that has a bullet drop compensator or a range estimating reticle.

Attempts to marry the long-range capabilities of the ACOG with the close quarters battle capability of the Aimpoint have been tried and found wanting. One version attaches a small red dot optic to the top of the ACOG. This system places the red dot too high above the barrel resulting in an offset of about four inches between the dot and barrel with associated point of aim, point of impact errors at close distance. Additionally, the soldier cannot maintain a good cheek weld and see the dot. He is required to bring the sight up and “catch the dot” which leaves his head floating above the stock. This system is slow and error prone.

Current attempts are under way to attach Aimpoint's smaller T1 sight<sup>76</sup> to an offset mount that will place it forward and slightly right of the ACOG. (See Figure 6 and 7) This dual optic setup will only require a slight head movement to the side of the ACOG to see the red dot. This configuration keeps the range estimating reticle and bullet drop compensator of the ACOG, and adds the short-range capability of the red dot. This system, if successful will provide the optimum balance of capabilities to engage targets from zero to 500 meters.



**Figure 6. Trijicon ACOG with Aimpoint T1 red dot sight in offset mount. Source: Photograph by author.**

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<sup>76</sup> The Aimpoint T1 is an unmagnified red dot sight that is about the size of a C battery. Like the M68, it has an extended battery life of 50,000 hours.



Figure 7. Soldiers view of Trijicon ACOG with Aimpoint T1 in offset mount. *Source:* Photograph by author.

### Increasing reliability of the weapon system

The reliability of the M16/M4 weapon system has been criticized since its introduction. Some may find it hard to believe that initially it was considered more reliable than the much-vaunted M14.<sup>77</sup> Changes in the type of propellant used in the 5.56-mm cartridge increased the rate of fouling and when combined with a general lack of cleaning, led to malfunctions.

Forty years later, soldiers still do not understand how to keep their M4/M16 weapons functional in all environments. The individual operators manual does not explain what critical aspects of the system must be maintained and in what order. According to this technical manual, everything is important, which is false.<sup>78</sup> Further, weapons maintenance does not only mean weapons cleaning. There are four primary causes of malfunctions in the M4/M16. They are first, worn/unserviceable magazines, followed by a lack

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<sup>77</sup> Hallahan, *Misfire*, 451.

<sup>78</sup> TM 9-1005-319-10, *M4 Operators Manual*. (Washington: Department of the Army, 1994).

of proper lubrication, then worn parts, specifically the components of the bolt, and finally dirty ammunition.

Leaders have a tendency to repeat the things they learned while coming up through the ranks, without questioning the background of the information. One area of misinformation is the idea that it is a necessity of the M16/M4 to be parade-ground clean. Part of this is due to the backlash from the early failures of the M16 in Vietnam. The other reason is a complete lack of education on the weapon systems beyond basic training or the basic officer's course.<sup>79</sup> Contracted trainers, such as Patrick Rogers<sup>80</sup> routinely operate rifles that are not cleaned and only have lubrication added to them before the bolt and bolt carrier become dry. Using only additional lubrication, his weapons have fired over 19,000 rounds without mechanical malfunction.

A proper field cleaning should take no more than fifteen minutes and a good garrison cleaning should take no more than an hour. The key to accomplishing these tasks is to understand what areas are important and require attention. The most important areas of the M16/M4 are the bolt, bolt carrier and the chamber. This is where the majority of the allocated time should be spent.

Additionally, all points of friction, indicated by shiny areas on the component surfaces, need to be clean. Attention to the cleaning of critical areas of the M4/M16, combined with proper lubrication,

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<sup>79</sup> The only instruction on marksmanship or small arms employment for non-commissioned officers is a seven-hour block of instruction at the Warrior Leader Course, a Sergeant level school. Staff sergeants through Sergeants Major never again receive instruction in marksmanship or small arms in their primary schooling. Officers never receive additional marksmanship or small arms training after their basic course, as Lieutenants. *Advanced Leader Course (BNCOC)*. <https://www.benning.army.mil/ncoa/BNCOC/phase1.pdf> (accessed September 13, 2009)

<sup>80</sup> Patrick Rogers is a retired Chief Warrant Officer of the United States Marine Corps, with extensive experience in counter-terrorism. He is also a retired New York City police sergeant. His company, E.A.G. tactical conducts training for military, government and police agencies across the country. He has likely seen more rounds fired in combat and training than any current active duty soldier. In the capacity of primary instructor, he has witnessed what concepts, equipment, and techniques work well and what do not.

periodic parts replacement, quality magazines and clean ammunition, will result in a reliable weapon system.

### *Lubrication*

Operating in a desert environment is tough on any weapon system. Initially, it seems that any lubrication on a rifle will attract sand or dirt and lead to the malfunctioning of the weapon. Tests conducted at Picatinny Arsenal, in response to reports that the Army's cleaner, lubricant, protectant (CLP) was ineffective, revealed several interesting conclusions.<sup>81</sup> First, sand and dust are going to get into the rifle. At that point, it is better to have lubricated sand and dust than a dry weapon with sand and dust. The test found that the first magazine removed from the individual's equipment, which was also in the dust chamber, caused over 90 percent of the malfunctions. The problem was that the ammunition and the magazines were sandy and prevented the weapon from fully chambering the first cartridge. Use of the forward assist when inserting a new magazine dramatically increased reliability. This point of failure emphasizes the importance of the magazine in the proper function of the weapon. The effect of sand in magazines is greatly reduced with modern designs of the M4 magazines, such as the Magpul PMAG.

Second, heavy lubrication offered the best functioning when compared to no lubrication, light lubrication, and normal lubrication. Lubrication should only be applied where metal rubs against metal, which is indicated by worn, shiny spots. One of the most critical areas to lubricate is the bolt and cam pin. If the weapon has been fired continuously, the heat inherent in the operating mechanism will evaporate the oil. A couple drops of CLP into the gas vent holes in the carrier will allow the rifle to keep running.<sup>82</sup>

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<sup>81</sup> Lubricant integrated product team. *Evaluation of Small Arms Weapons lubricants in Desert Environments*. Team findings, Aberdeen Proving Ground: U.S. Army Research Laboratory, 2005.

<sup>82</sup> Patrick A Rogers, "Keep Your Carbine Running." *S.W.A.T.*, December 1, 2006: 72.

## *Parts replacement*

Unfortunately, preventive maintenance in the Army means that a soldier identifies when a part is broken, rather than an organizational function, which anticipates when certain items are prone to breakage and replacement of parts at a specific interval. Periodic replacement of parts on the rifle will ensure that it remains reliable. The most critical area to focus on is the bolt. The bolt assembly includes the gas rings, extractor, extractor pin, extractor spring, ejector and ejector spring. For units that fire a lot of rounds these parts can fail in a relatively short time, 3,000-5,000 rounds. There is a simple way to check for the serviceability of the gas rings. First, clean the carrier and bolt, insert the bolt into the carrier and only hold on to the bolt. If the carrier slides off, the gas rings are worn and should be replaced. The operator level technical manual explains this in the opposite way, to hold the carrier and if the bolt falls out, they are worn. Good gas rings will hold the carrier with the author's technique and since gas rings are about fifteen cents each, it is cheap insurance.

The extractor and spring are the next most important areas. The dust/lubrication test at Picatinny arsenal recommended an extractor spring upgrade for the M4.<sup>83</sup> The condition of the extractor and spring is critical. With a worn extractor or weak spring, the extractor will pull off the rim of the cartridge in the chamber and the subsequent cartridge loaded will result in a malfunction.

Additionally, the bolt itself develops cracks in the locking lugs. The Naval Surface Warfare Center in Crane Indiana, the proponent for naval special warfare small arms, states in an engineering bulletin to consider swapping the bolt out at 6,000 rounds and definitely by 10,000 rounds.<sup>84</sup>

Finally, the action spring, known incorrectly as the buffer spring to most soldiers, should be within a certain length. For the M16 that length should be between 11 ¾ inches and 13 ½ inches.<sup>85</sup> For

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<sup>83</sup> The correct spring for the M4 carbine is Gold in color and has five coils with a black rubber insert. The correct spring for the M16A2 is silver and has four coils with a blue insert.

<sup>84</sup> Patrick A. Rogers, "Malfunction Reduction, Part II." *S.W.A.T.*, January 1, 2009: 68-73.

the M4 the length of the action spring should fall between 10 1/16 inches and 11 ¼ inches. If the action spring is too short, the bolt carrier will have excessive carrier speed. This will result in either the carrier coming forward before the magazine pushes the next cartridge up, or there will not be enough resistance against the rearward movement of the carrier when the weapon is fired. If this occurs, the bolt will try to extract the cartridge case from the chamber before pressures have dropped enough to allow it to extract and will result in a malfunction.

### *Magazines*

The magazine is an important part of the rifle. When originally designed by Eugene Stoner, the magazine was meant to be a lightweight, disposable item. Due to this concept, the magazine was made from aluminum and not designed to be durable. Soldiers soon learned that the magazine was not disposable and that care was required to keep the weapon reliable.<sup>86</sup> There are several things that soldiers can do to ensure their magazines work.

The most important thing to do is to keep them clean. Just as sand can find its way into the rifle, it will find its way into the magazines. Magazines should frequently be disassembled and brushed clean. Pulling a cleaning rag through the body several times is adequate. Inspect the back of the feed lips to ensure they are not cracked and the lips have not spread apart. Load about 15 cartridges into the magazine and while holding it in one hand, smack the base of the magazine with the other. If several rounds pop out, either the feed lips are spread and/or the magazine has a weak spring. The entire magazine should be discarded. Soldiers can identify potential problems in magazines by numbering each magazine with a paint marker and noting any malfunctions caused when the magazine is used in the weapon.

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<sup>85</sup> Ibid., 72.

<sup>86</sup> Nolan, *Operation Buffalo*, 70.



Several upgrades are available to increase the reliability of the issued magazines. A company called Magpul makes the best upgrades the author has used. Their original product consisted of a slip-on rubber ring for the bottom of the magazine. It made it easier to grasp your magazines from your ammunition pouches but also protected the delicate floor plate tabs, which have a tendency to break after extended use. They also designed a new, anti-tilt follower that greatly increases feeding reliability of the standard issue magazine.

In 2007, the company came out with their own version of a magazine for the M16/M4 known as the PMAG. Constructed of resilient polymer, the magazine is nearly indestructible. (Figure 8) When the polymer cracks or breaks, it is easily recognizable, unlike with the standard issue magazines. These magazines represent the cutting edge of technology for making the rifle more reliable. Recently, the PMAG was assigned a national stock number, so units can now order these magazines through the supply system.<sup>87</sup> All combat arms units should consider replacing their standard issue magazines with the much more reliable PMAG.

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<sup>87</sup> Magpul PMAG NSN's are 1005015765159 for a black magazine and 1005015765164 for a black magazine with a narrow translucent window on both sides of the magazine with witness marks for 5, 15, and 25 rounds.



Figure 8. Comparison of standard issue magazine with Magpul PMAG with window. Source: Photograph by author.

## Arms Room Concept

The current nature of conflict around the globe requires that the infantryman be equipped and trained to fight in any environment to include the jungles of South America, the mountains of Afghanistan or the streets of Iraq. For the infantryman to accomplish these tasks, he must either be organized with different capabilities or have equipment that is adaptable to the environment. The review of historical organization depicts the problems with an organization that is formed around one capability, i.e., short-range assault or long-range precision. Attempts to bridge capabilities results in weapon systems that are mediocre at all tasks, such as occurred with the M14 trying to replace the BAR, yet remain light weight, or to have an automatic capability while firing a full power cartridge in a light weight rifle.<sup>88</sup>

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<sup>88</sup> The desire for a weapon that is lightweight, fires a full power cartridge, and is capable of fully automatic fire, is an impossible goal. Designers can accommodate any two of the criteria, but not all three. The BAR weighed 20 pounds. The M14E2 weighed 11 pounds and was completely uncontrollable despite numerous modifications.

One solution to this problem is the arms room concept. Under this concept, infantry units would have multiple systems and accessories to tailor the equipment configuration of the squad to reflect the current mission. This requires that the weapon be modular.

The modularity of Eugene Stoner's M16 design is evident in its ability to separate the upper receiver from the lower receiver. Replacement upper receivers are not required to be fitted to the lower receiver, giving the option of having uppers of different barrel length and/or caliber. With the adoption of the M4 variant of the M16, the upper receiver also adopted a standardized M1913 accessory mounting rail, also known as a Picatinny rail, (See figure 9) in lieu of a fixed carrying handle. This rail increased the modularity of the system to the point where multiple optics configurations and accessories could be mounted, dependent on the anticipated use of the rifle.



**Figure 9. M4 upper receiver with Picatinny rail. The “Picatinny Rail” is defined from a military standard, specifically MIL-STD-1913 (AR) which was adopted on February 3, 1995. This document specified exactly what the dimensions and tolerances were for any mounting systems that were to be submitted for acceptance by the military. The term “Picatinny” comes from the place of origin for this system, the Picatinny Arsenal located in New Jersey. Source: Photograph by author.**

Additional upper receivers could be purchased for each weapon system. Each soldier would have one lower receiver with multiple upper receivers optimized for different capabilities. Upper receivers could be different calibers based on requirements for operational deployment or training. Units conducting general training could continue to use 5.56-mm upper assemblies to take advantage of current stocks of 5.56-mm ammunition, both blank and M855 ball. Deploying units could use modified upper receiver groups chambered in a more effective caliber to increase the weapons lethality.

Modification of the upper receiver group could also include the incorporation of a piston system of operation. A piston system of operation reduces the fouling created by the current direct gas impingement system of the M4/M16 by containing the combustion of the cartridge propellant forward of

the receiver. Piston systems have been adapted to the M4/M16 in the form of the highly successful Heckler and Koch 416 currently in use by the elite 1<sup>st</sup> Special Forces Operational Detachment – Delta, and the LWRC international M6A3, a successful civilian version of a piston operated M4 that the author has used. Some of the negative aspects of these piston systems are that they are heavier than the traditional operating system, add complexity to the system, and initially require additional training.

The benefit of this modular capability is that the users are already familiar with the manipulation of the system and the requirements to keep it operational in all environments. Little to no additional training would be necessary. Associated costs would also be reduced by only having to replace a component of the weapon, rather than purchase multiple, complete weapons.

## **Improving Doctrine**

### **Squad Designated Marksman**

The reorganization of the infantry squad in 1960 eliminated the M1D sniper rifle with telescopic sight and the rifleman trained in its use. This resulted in the loss of the precision mid-range capability of the infantry squad. This coincided with the elimination of the mid-range qualification course that assessed soldiers' ability to engage targets to 600 meters. It was replaced with the adoption of the trainfire course in 1958, which assessed soldiers' ability to hit targets from 50 to 300 meters. This equipment and training change eliminated the institutional knowledge of what is required to engage targets to 600 meters. The infantry squad would not regain the capability of precision rifle fire until 2001 and the invasion of Afghanistan. With the invasion of Afghanistan in 2001, the United States Army relearned that some of its future conflicts would be fought in areas that were not urban in nature. It also realized that these conflicts would require the application of precision fire over a distance not typically encountered since the end of the Korean War.

The solution to this problem was varied and primarily focused on increased training for select soldiers based on previous marksmanship ability. The concept of the squad designated marksman is that a

soldier receives the training necessary to engage targets beyond the 300-meter range limitation of current marksmanship programs, but below the 600 meter and beyond capability of actual snipers. His duties as a precision marksman are secondary to his duties as a member of the squad.

As of June 2009, the equipment and training of the squad designated marksman has yet to be standardized. In field manual 3-22.9 there are only fourteen pages dedicated to training the squad designated marksman. There is no mention of the equipment or ammunition to be used. The squad designated marksman's rifle (SDM-R) is identified as either being an M16 or M4, and equipped with iron sights or optics. In theory, this could mean that the rifleman in the squad whose M4 is equipped with an ACOG is the designated marksman. In some units, the SDM-R is an accurized M14 with a 3.5 to 10 power telescopic sight, firing either standard 7.62 x 51 ammunition, or M118LR match ammunition. In other units, the SDM-R is an accurized M16 with 3.5 to 10 power telescopic sight. These differences prevent a standardization of training or capability for the infantry squad.

In addition, no mention is made of specialized ammunition for these weapons. Currently, Black Hills Ammunition, a civilian company, manufactures a heavier weight 5.56-mm cartridge designated as MK262 mod 1. This cartridge fires a 77-grain projectile and is typically capable of one minute of angle accuracy, unlike M855, which is typically three to four minute of angle accurate. The high-power shooting community and service rifle teams developed the 77-grain cartridge to extend their capability when firing competitively. With its military application, it extends the range in accurized rifles to 600 meters, though not necessarily its lethality.

One potential training solution is to adopt the instruction used during the first portion of sniper school. The difference between a sniper and a designated marksman is that a sniper receives additional training in specialized equipment, mission planning, tracking, field techniques and observation techniques, specific to the requirements of a two-man sniper team. The marksmanship portion of sniper school involves instruction on shooting fundamentals, ballistics, to include angle fire, the effects of weather, light, temperature and humidity and range estimation. The shooting skills a sniper receives are the same skills required by a squad designated marksman, and arguably, by every infantryman.

The requirement for squad designated marksman to engage targets from 300-600 meters requires a caliber larger than 5.56-mm. As discussed earlier, current 5.56-mm ammunition is not suited for ranges beyond 200 meters. One solution is a purpose built precision rifle chambered in an intermediate or full power cartridge. This rifle would be capable of precision as well as suppressive fire. This capability currently exists in the M110 sniper rifle. The M110 sniper rifle is a semi-automatic sniper rifle whose lineage goes back to Eugene Stoner's first creation of the AR10. In appearance, it is a larger scale copy of the M16, chambered in 7.62x 51-mm, fitted with a 3.5 to 10 power telescopic sight.

Under the arms room concept, each squad would be equipped with one to two M110's for designated marksmen. The designated marksman would also have standard issue carbines available for operations that did not require the long-range capability of the M110, but required a compact carbine for vehicle or urban operations. The cost of these weapons systems is just under \$8,000 each. While the price seems high at first glance, when taken in contrast to other systems, you could equip every infantry squad in the Army with two M110 rifles for half the cost of one C17 transport aircraft or one F22 Raptor.<sup>89</sup>

### Improved Battlesight zero

One area in which doctrine and training can have an immediate impact is with the battle sight zero. Doctrine instructs soldiers armed with the M4/M16, using either iron sights or the M68 CCO, to zero their weapons at 25 meters.<sup>90</sup> This is known as a battlesight zero and in theory will allow soldiers to hit targets from zero to 300 meters. Unfortunately, it is not quite that easy. One must take into account the trajectory of the bullet in relation to the line of sight. With an M4 carbine, and the above 25-meter zero, the bullet will travel up and intersect with point of aim at 25 meters. It will then continue up with a rise of

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<sup>89</sup> Current cost of the C17 is 203 million dollars and the F22 Raptor costs 159 million dollars. *Source: C17 Globemaster III*. <http://www.globemaster.de/c-17/> (accessed September 11, 2009).

<sup>90</sup> FM 3-22.9, *Rifle Marksmanship M16-/M4- Series Weapons*. (Washington: Department of the Army, 2008), 5-1.

about eight inches above the point of aim at 200 meters before starting to fall and intersecting again at 300 meters. (See Figure 10) M855 ammunition is only capable of two to three inch accuracy at 100 meters, meaning that at 200 meters the group will be four to six inches. Now add in the human error, which generally, equals about a two to three minute of angle hold error under ideal conditions and there is the potential for shooting about a foot and half high at 200 meters. Most soldiers and leaders are unaware of this problem. When combined with the natural tendency to shoot high during combat, soldiers will typically miss their target.

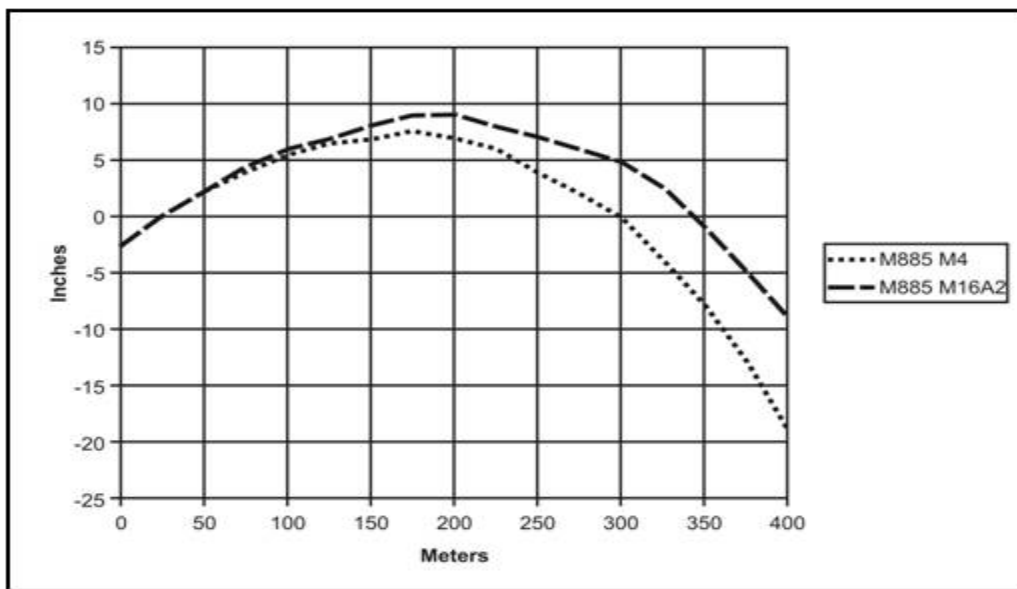


Figure 10. Depiction of bullet trajectory over line of sight. Zero represents the line of sight, with the rifle bore 2.6 inches below the line of sight. This chart tracks the trajectory of M855 with a 300-meter zero. Source: FM 3.22-9.

The general issue is that doctrine recommends only one way to accomplish a zero for a rifle and no alternative techniques are discussed or recommended. This demonstrates a lack of understanding of ballistics and the importance of different battlesight zeros. Since it is now understood that the M16/M4 is most lethal within 200 meters, the standard battlesight zero should reflect that understanding. Zeroing the rifle or carbine at a distance of 50 meters will keep the maximum ordinate of the M855 round within one inch of the point of aim from 25 meters to 200 meters, where it crosses the line of sight again. This zero combined with the accuracy potential of the ammunition and the shooter will keep the strike of rounds

within the chest area of a target out to a distance of 250 meters. This zero can provide lethal hits out to a distance of 320 meters, with rounds impacting in the vascular region of the lower abdomen and groin.

When engagement distances exceed 200 meters, soldiers have a few options. Either they can switch to their back up iron sights (BUIS) which have a provision for adjusting the range setting from 100 meters to 600 meters or they can apply the appropriate holdover for the range to the target. Soldiers attempting to utilize this method must be trained in range estimation, know the exterior ballistics of the cartridge they are firing, and know the average dimensions of potential targets. With the above 50 meter zero and M855 ammunition a soldier using an M68 CCO would need to hold two and a half feet high at 400 meters and about five feet high at 500 meters. In this situation, the soldier is better served through the BUIS, changing to the desired range and holding center of mass.

## **Improving Tactical Marksmanship Training**

### **The Rifle Qualification Course**

The current marksmanship qualification course does little to assess how effective soldiers will be during combat. It is a product of a conscript Army mentality by senior leaders. Its purpose is to qualify as many soldiers as possible in the shortest time and is a disservice to the modern, professional volunteer Army we are.

The current qualification course does not accurately depict the enemy on the battlefield. It is based on the 1960's and 70's concept of active defense strategy. Targets come up and depending on their range, remain up for a period of five to ten seconds. The modern battlefield is never this static. Soldiers fire twenty rounds from a prone or foxhole supported position, then ten rounds from a prone unsupported position and finally ten rounds from the kneeling position. Soldiers are conditioned to expect that their targets will not move, will only require one shot to incapacitate, and that a hit anywhere will result in that incapacitation.



An appropriate balance between the trainfire qualification course and the qualification course of 1949 is needed. Ideally, an updated qualification course will have the following characteristics: Engagements from 3 to 500 meters; include multiple types of terrain requiring different shooting positions; a combination of moving and stationary targets; engagements from differing elevations and a scoring system which rewards shot placement to vital areas. Any of these characteristics can be added to current qualification course in the interim. To maximize the use of time and facilities, the courses of fire could be broken up into tables, similar to the 1949 qualification course. Terrain and position shooting can be accomplished with updated known distance ranges, while the current qualification range can add moving targets and towers for elevation shooting. Finally, the short-range marksmanship course can be added to the qualification course to maintain close quarters battle capability. These three elements should be combined to give an overall score for classification as an Expert, Sharpshooter or Marksman.

The optimal incapacitation window for 5.56-mm is within 200 meters and beyond that only accurate shot placement will likely result in incapacitation. In order to drive this point home, the qualification course should reward shot placement over general hits on target. The current qualification course is 1950's technology. The Army can certainly develop a system that will accurately depict the location of hits on a target. One system that the author has used in the past is known as the Location of Miss and Hit system (LOMAH). It is used on the known distance range to maximize the number of shooters and lessen the number of range support personnel. A small TV device is plugged into each firing position and the grader calls the shots off to the shooter and records the results. A modern system, operated from a tower, is certainly feasible and would give feedback that is more accurate to the soldier and his commander.

Another concept of the qualification course that is outdated, is the requirement to fire one round per target. This requirement remains in the current version of the marksmanship manual. It programs soldiers to believe that one round that hits the target will be enough to incapacitate or kill them or that if they miss the target, that they should stop engaging it. This flawed mental training is evident in a report prepared by the Marines addressing combat marksmanship. In it, the interviewer learned that Marines

believed that they had hit the enemy numerous times and the 5.56-mm cartridge had failed to incapacitate the threat. In areas where the enemy was eventually killed or captured, the Marines learned that what they thought were hits, were actually misses. In several instances Marines called their shots as a center of mass hit and upon finding the enemy realized that their hits were in an extremity and not life threatening. The Marines are the only service that still qualifies to a distance of 500 meters, though not under realistic conditions.<sup>91</sup> They also retained the full size M16A2 rifle when others adopted the M4 carbine. Though it is more lethal, its overall length makes it less practical.<sup>92</sup>

One potential solution is to adjust the conditions of the qualification course. Soldiers would be given two magazines of 28 rounds each and should engage targets until they are down. As in the 1949 qualification course, any saved rounds count as a bonus and the final qualification score would indicate the total number of center of mass hits and periphery hits. Commanders could then determine areas for remedial training and prioritize future training opportunities based on overall weaknesses.

In addition to modifying the conditions of the current qualification course, the facilities themselves should be modified to accurately reflect the conditions of the modern battlefield. The most realistic range the author has ever shot on was during advanced rifle marksmanship at Fort Benning, Georgia during basic training. The course of fire incorporated both stationary and moving targets. Soldiers were given two magazines of 30 rounds each and engaged targets as they were presented, firing as many rounds as necessary to incapacitate the target. This course of fire stressed the dynamics present on the modern battlefield by forcing the soldier to understand the fleeting presentation of some targets while

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<sup>91</sup> The Marine Corps still uses shooting jackets and slings when conducting qualification and engages bullseye targets, not silhouettes.

<sup>92</sup> The M16A2's stock length is ideal for personnel without body armor, conducting long range prone shooting, but it is not suitable for fighting with body armor or when conducting operations from vehicles. The 20-inch barrel of the M16A2 maintains velocity, but a collapsible stock would be more appropriate for current combat conditions.

maintaining precision at distance. Soldiers were required to utilize different amounts of lead to hit targets at varying distances, a skill which is lacking in our force today.

The qualification course should also be adjusted to incorporate the varying effects of firing in mountainous terrain. As any hunter knows, shooting either uphill or downhill will cause the strike of the bullet to go high. How high the bullet goes is dependent on the angle of fire and the range to the target. This not only occurs in mountainous areas, it occurs in urban areas from multi-floor buildings as well. This subject is not addressed in the marksmanship manual or the manual on mountain operations. The only group who actually conducts any kind of marksmanship like this is the Marine Corps in its mountain warfare school. Outside of that, snipers are trained, in certain instances, to shoot from helicopters. Snipers must adjust their point of aim, based on the angle, to allow the strike of the bullet to hit its target.

While facilities for training this type of marksmanship are generally not available, this situation is easily remedied. Units can construct an 80-foot tower on the qualification range or use a rappelling tower if it is adjacent to a small arms range. Platforms can be constructed at 40 feet, 60 feet and 80 feet, and will allow soldiers to see the effects of elevation on the impact of their rounds.

## **Conclusion**

Security operations in Afghanistan, as a cornerstone of counter-insurgency doctrine, periodically require U.S. forces to engage and destroy the enemy. The unique operating environment of Afghanistan presents several problems to the modern Army, and specifically to the infantryman. The modern infantryman is burdened with excessive weight in the form of protective gear, communications equipment and weapons systems. He is fighting an enemy conditioned to the elevation and terrain. The enemy travels light and employs supporting weapons from standoff, to include mortars and medium machineguns. Faced with these conditions, the modern infantry attempts to fix the enemy with direct fire and use supporting assets to kill the enemy. Supporting assets, such as close combat attack, close air support or indirect fire, are not always available. Further, their application is often restricted when collateral damage is possible, due to the enemy's information operations and worldwide media access. Under these

circumstances, the need for the precise application of direct fire is more important than ever before. The ability of the infantryman to deliver precise fire that incapacitates targets beyond 200 meters is limited by current equipment, training and doctrine.

A review of historical capability of the infantryman's equipment, doctrine and training demonstrates that the ability of the infantryman to incapacitate the enemy at distances up to 500 meters is not a new requirement or capability. The infantryman's predecessor in World War I possessed a rifle and cartridge easily capable of incapacitation out to 1000 meters. The infantrymen trained for two months out of every twelve on the application of precise fire. The qualification course included engagements out to 600 yards and further training of sharpshooters and experts out to a distance of 1,200 yards.

The final campaigns of World War I indicated a requirement for a rapid firing rifle for assaults on enemy positions. The use of sub machineguns was useful in these assaults but had limited application during other operations. After the war, testing concluded that an intermediate power cartridge that bridged the gap between the submachine gun and the full power rifle cartridge, had merit. The .276 Pederson cartridge was tested and accepted, but ultimately fell victim of the Great Depression and large stockpiles of full power rifle cartridges in .30'06.

World War II serves as possibly the best example of what small arms and marksmanship capabilities the infantry must maintain. The lessons learned from fighting in the Pacific Theater, with its short-range engagements, prompted focus on the close quarters fight. The lessons learned from fighting in North Africa, with its long-range engagements and necessity for range estimation, validated continued focus on mid-range marksmanship. Fighting in mountainous terrain, such as in Italy by the U.S. 10<sup>th</sup> Mountain Division, demonstrated the various requirements of mountain warfare, such as the effects of range when coupled with angle fire. Finally, fighting on the European continent encompassed attributes from all the other theaters. The result was the marksmanship qualification course of 1949.

Following World War II, further testing concluded that the energy of full power rifle cartridges was typically wasted at the engagement distances most likely encountered on the battlefield. The German development of the STG 44 assault rifle promised to herald a new era of small arms cartridges of

intermediate power and assault rifles that would fire them. The British Army developed several viable cartridges that would take advantage of the intermediate cartridge concept. However, under pressure from the United States, the British adopted a full power cartridge in 7.62x51-mm.

Focus on the Pentomic Army of the 1950's and 1960's resulted in the atrophy of traditional infantry skill sets, to include marksmanship. The trainfire course of 1958 brought about the current 300-meter qualification course, based on a defensive ground posture for Eastern Europe. It also takes advantage of a conscript Army mentality by which training soldiers to hit targets at 300 meters is exponentially easier than extending that range to 500 or 600 meters. The reorganization of the infantry squad in 1960 resulted in the loss of the precision fire capability and further degradation of the infantry squad. The adoption of the M14 rifle and its full power cartridge was plagued with controversy and the political reaction resulted in the adoption of a marginally capable weapon known as the M16 and its 5.56-mm cartridge.

The environment of the Vietnam War was specifically a close range fight. Under these conditions, the M16 as originally configured was moderately effective. The combination of the M16 and 5.56-mm cartridge, the loss of the precision capability in the reorganization of the infantry squad, and the trainfire qualification course, resulted in the complete inability of the infantry squad to engage targets beyond 200 meters effectively.

Further refinement of the M16 design and the requirement for a light squad automatic weapon resulted in a heavier 5.56-mm cartridge designed to defeat soviet troops wearing body armor on European battlefields. This cartridge proved ineffective in Desert Storm and Somalia, but the short duration of those conflicts and minimal supporting data, did not warrant change. The emphasis on urban operations combined with increased movement by vehicles necessitated the requirement for a shorter length weapon. The resultant M4 carbine combined with the new 5.56-mm cartridge further reduced the incapacitation capability of the standard issue rifle.

Operations in Afghanistan quickly identified the shortfalls in equipment, training and doctrine for engagements in mountainous terrain. The M855 cartridge has limited effectiveness beyond 200 meters

and therefore requires either an improved cartridge within caliber or the adoption of an improved intermediate power cartridge, which can be adapted to a modified upper receiver group.

Criticisms of the reliability of the M4 result from a lack of effective doctrine and training. A renewed focus on the actual requirements for maintaining the M4 carbine will result in improved performance and confidence in the weapon. Reliability of the system can be drastically increased with the use of new magazines such as the Magpul PMAG or the careful maintenance and slight modification of the aluminum magazine. Lubrication and dust testing continues to favor CLP as the best overall lubricant and a generous application of lubrication on the primary wear points of the bolt and bolt carrier for operations in sandy environments. Periodic replacement of high wear parts such as the extractor, bolt, and action spring will keep the weapon operational almost indefinitely.

Any weapon system designed to perform in various environments will invariably make compromises in order to perform all requirements. The modular nature of the M4/M16 series of weapons lends itself to the arms room concept. Under the arms room concept, each soldier would have multiple weapons and optics combinations available. Commanders would have the flexibility to adjust the capabilities of the infantry squad for the anticipated environment while maintaining commonality of the manual of arms. Optics combinations would consist of both magnified optics such as the Trijicon ACOG, optimized for mid-range engagements, and non-magnified optics such as the Aimpoint M68, optimized for close range/urban engagements.

The squad designated marksman concept is currently under-developed. The squad designated marksman doctrine is currently limited to fourteen pages in field manual 3-22.9 and is completely irrelevant to combat conditions. While it discusses the effects of wind, ballistic trajectory and light conditions, it does so only with regard to iron sights. It does not address standard issue optics such as the ACOG or the differences between 5.56-mm cartridges such as M855 or Mk262 and 7.62-mm cartridges such as M80 or M118LR. Modified M14's are currently performing this role in certain units, but lack of institutional knowledge on maintaining the system as well as a separate manual of arms, results in a less than ideal candidate for selection.

Current doctrine for small arms training and maintenance does not reflect combat conditions or the input from subject matter experts. In most cases, it is a reflection of inexperience or garrison mentality. The current method of zeroing the M68 close combat optic or iron sights for the M4 does not consider the effective range of the M855 cartridge. If soldiers zero their weapon at 25 meters, as doctrine requires, the strike of the bullet will be 7-10 inches high from 150-200 meters. With a less than perfect aiming point, this will typically place the strike of the round over the shoulder of enemy combatants. Soldiers and leaders need to understand the ballistics of the cartridge they are using and adjust the zero based on the intended environment. Doctrine should be expanded to discuss the benefits of different range zeros and their effect on the soldiers point of aim.

Finally, the current qualification course consists of 40 targets, which are engaged from prone, kneeling, and standing positions. The course does not identify or reward shot placement, which is a critical consideration when employing weapons of 5.56-mm caliber. It also fails to simulate the fluid nature of the battlefield in which an enemy is moving. Targets come up and remain in one position for up to ten seconds, based on distance. Additionally, it does not require engagements from elevation, as is encountered in Afghanistan or in urban areas from high-rise buildings.

Now that the limitations of current small arms, doctrine and marksmanship training have been identified, what solutions should be implemented to increase small arms lethality? First, the 5.56-mm cartridge has proven to be ineffective beyond 200 meters. Over the last thirty years, attempts to increase lethality within caliber have resulted in failure. Ballistics testing since World War I has repeatedly affirmed that an intermediate cartridge between 6.5 and 7-mm is most appropriate for a standard issue rifle. Based on current testing, the 6.8 SPC is the best cartridge for immediate production and implementation as a replacement for 5.56-mm weapons.

Next, the squad designated marksman concept should standardize one type of semi-automatic rifle. The most developed system that is currently in production is the 7.62-mm M110 sniper system. Two of these rifles should be issued to each squad. Squad designated marksman doctrine should be re-written

to parallel the marksmanship instruction of sniper school. This system and appropriate doctrine and training will return the precision capability to the infantry squad.

Infantry units should adopt the arms room concept and maintain multiple weapons configurations and capabilities for each soldier. Commanders can then decide on the appropriate configuration of the infantry squad based on mission requirements and operating environment.

Finally, the marksmanship qualification course should be changed to be more realistic and give accurate feedback to the soldier and commander. The qualification course should combine the concepts of the 1949 qualification course with an updated short-range marksmanship component, such as the MEU (SOC) course of fire.<sup>93</sup> This combined qualification course would consist of engagements from three to 500 meters; include multiple types of terrain requiring different shooting positions; a combination of moving and stationary targets; engagements from differing elevations and a scoring system which rewards shot placement to vital areas. A digital system of scoring should be adopted which can be printed out and added to the soldier's counseling packet. In this way, commanders can track a soldier's marksmanship progression.

The war in Afghanistan has brought to light several deficiencies in training, equipment and doctrine of the infantry squad. The evolution of the infantryman and his equipment from World War I to the present has resulted in a degradation of the core competency of marksmanship. There are several reasons for this degradation. First, there were missed opportunities to adopt appropriate intermediate power cartridges following major conflicts. Next, the emphasis on nuclear strategy during the Pentomic era sacrificed the conventional capability of the infantry. The adoption of a conscript-Army mentality of marksmanship training, modeled for a defensive fight in Europe, fails to prepare soldiers for actual

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<sup>93</sup> The MEU(SOC) qualification course is a short-range qualification course fired from three yards to fifty yards. It includes movement, multiple target engagements, different firing positions and magazine changes. Targets are E-type silhouettes with a seven-inch scoring area in the chest and a two by four inch scoring area for the head. See appendix B for the full course of fire.



combat that could occur anywhere in the world. Finally, a general lack of emphasis on appropriate small arms doctrine, written by subject matter experts, has resulted in poorly trained soldiers and leaders.

The Army now has the opportunity to rectify this degradation of marksmanship capability and take back the infantry half kilometer. The ability to engage targets out to 500 meters requires significant revisions to doctrine, training and equipment. These revisions require emphasis from the highest levels of military leadership. As the elite of the warrior class, our infantrymen deserve the best equipment and training the Army can provide. Further, the political and media sensitivity to collateral damage demands a precise lethal capability for counter-insurgency operations. This capability exists only in properly equipped, properly trained infantryman.

## Appendix A 1949 Rifle Qualification

### RIFLE MARKSMANSHIP

<i>Range</i>	<i>Time</i>	<i>Rounds</i>	<i>Position</i>	<i>Target</i>	<i>Sling</i>
<b>INSTRUCTION PRACTICE</b>					
<b>TABLE I—SLOW FIRE</b>					
100	No Limit	9	Zero Prone	A	Loop
100	No Limit	8	Prone	A	Loop
200	No Limit	9	Zero Prone	A	Loop
200	No Limit	8	Prone	A	Loop
300	No Limit	9	Zero Prone	A	Loop
300	No Limit	8	Prone	A	Loop
500	No Limit	9	Zero Prone	B	Loop
500	No Limit	8	Prone	B	Loop
<b>TABLE II—SLOW FIRE</b>					
100	No Limit	8	Standing	A	Hasty
200	No Limit	8	Squatting	A	Loop
200	No Limit	8	Kneeling	A	Loop
300	No Limit	8	Prone	A	Loop
500	No Limit	8	Prone	B	Loop
<b>TABLE III—SUSTAINED FIRE</b>					
200	50 Sec.	9	Kneeling or squatting from standing	A	Loop
200	50 Sec.	9	Kneeling or squatting from standing	A	Loop
300	50 Sec.	9	Prone from standing	A	Loop
300	50 Sec.	9	Prone from standing	A	Hasty
<b>RECORD PRACTICE</b>					
<b>TABLE IV—SLOW FIRE</b>					
100	10 Min.	8	Standing	A	Loop
200	10 Min.	8	Kneeling	A	Loop
200	10 Min.	8	Squatting	A	Loop
300	10 Min.	8	Prone	A	Loop
500	12 Min.	10	Prone	B	Loop
<b>TABLE V—SUSTAINED FIRE</b>					
200	50 Sec.	9	Squatting or kneeling from standing	A	Loop
300	50 Sec.	9	Prone from standing	A	Loop

Figure 3. Tables I through V.

Source: Data from Louis R. Moore, "The New Rifle Marksmanship Course." *Infantry School Quarterly*, Vol 35, No 2, 1949: 5-21

## INSTRUCTION AND RECORD

### TABLE VIII

<i>Lane</i>	<i>Range (yds)</i>	<i>Time (sec)</i>	<i>Rounds</i>	<i>Target</i>	<i>Position</i>
1	150 & 275	60	4	E	Foxhole
2	200 & 350	60	4	E	Rubble pile
3	275 & 400	60	4	E	Stump
4	175 & 325	60	4	E	Window
5	225 & 350	60	4 (1)	E	Prone
6	500 &	60	4	B	Prone
7	125 & 400	60	4	E	Barricade
8	250 & 350	60	4	E	Ditch
9	175 & 325	60	4	E	Roof top
10	125 & 275	60	4	E	Log

(1) Eight rounds when fired for instruction practice.

Fired at least once for instruction practice and once only for record.

### TABLE IX

<i>Phase Line</i>	<i>Range (yds)</i>	<i>Time</i>	<i>Rounds (1)</i>	<i>Target</i>	<i>Position</i>
1	15-35	a-3 sec	4	1 E	Shoulder or hip
		b-4 sec		2 E	
		c-3 sec		1 E	
2	15-35	d-4 sec	8	2 E	Shoulder or hip
		e-5 sec		3 E	
		f-5 sec		3 E	
3	15-45	g-4 sec	8	2 E	Shoulder or hip
		h-3 sec		1 E	
		i-5 sec		3 E	
		j-4 sec		2 E	

(1) Four additional rounds may be fired in any phase line.

Fired at least once for instruction practice and once only for record.

*Source:* Data from Louis R. Moore, "The New Rifle Marksmanship Course." *Infantry School Quarterly*, Vol 35, No 2, 1949: 5-21

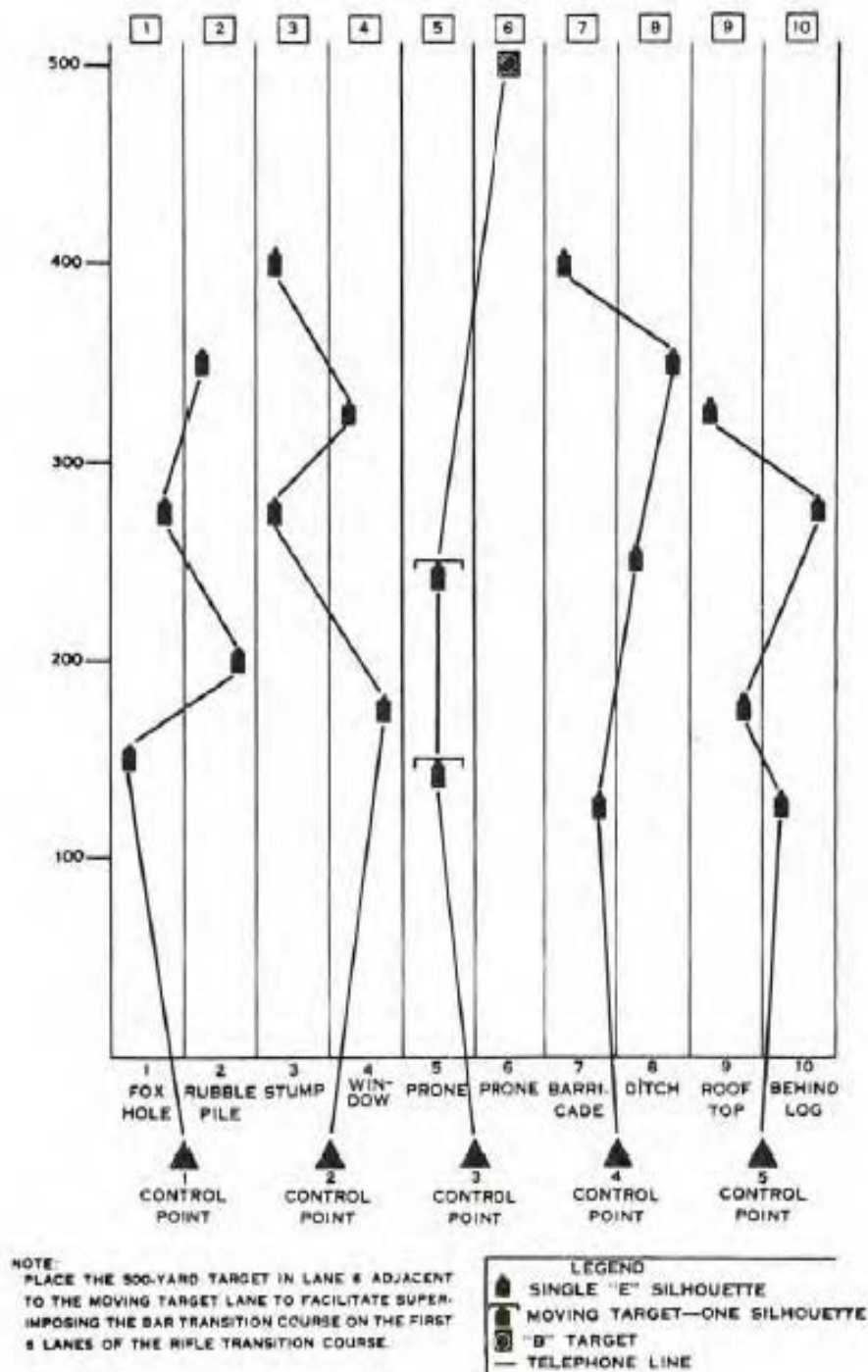


Figure 5. Diagram—Table VIII.

Source: Data from Louis R. Moore, "The New Rifle Marksmanship Course." *Infantry School Quarterly*, Vol 35, No 2, 1949: 5-21

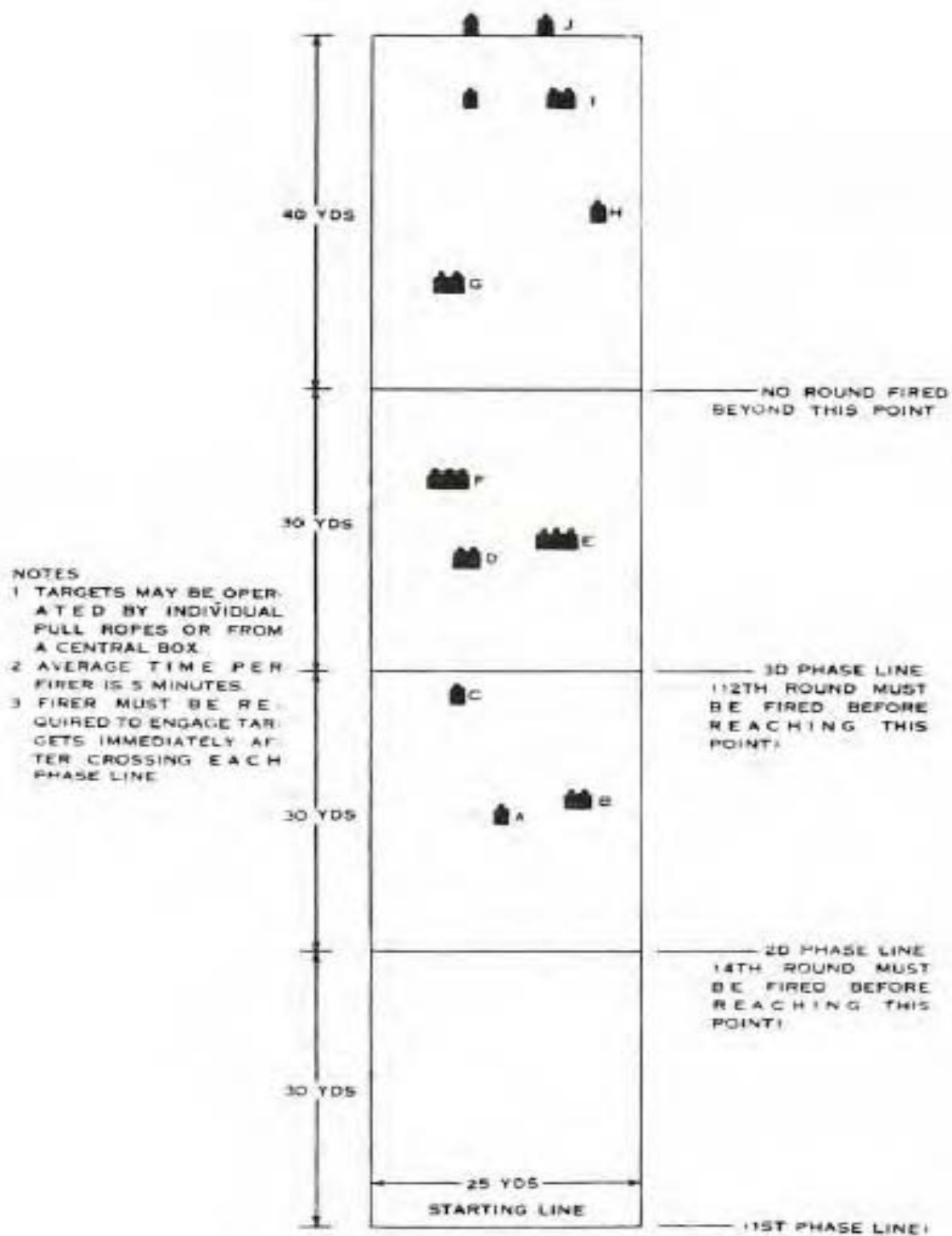


Figure 10. Diagram—Table IX.

Source: Data from Louis R. Moore, "The New Rifle Marksmanship Course." *Infantry School Quarterly*, Vol 35, No 2, 1949: 5-21

## Appendix B MEU (SOC) M4 Qualification Course

### MEU (SOC) M4A1 QUALIFICATION COURSE

#### Phase 1

For this evolution, each shooter has one target assigned.

Distance in yards	Procedure	Shots fired	Time allotment in seconds	Cumulative round count
50	Pair Standing/kneeling/Prone to body	6	10	6
25	Run from 50-25 yard line. Pair Standing/kneeling to body	4	11	10
25	Brain shot	1	2	11
25-15	Shooting on the move. Pair to body	2	5	13
15	Standing. Pair to body	2	1.5	15
15-10	Shooting on the move. Failure Drill	3	4	18
10-5	Shooting on the move. Failure Drill	3	3.5	21
7-3	Shooting on the move. Failure Drill	3	2	24

At this point, the targets are scored. There should be twenty shots to the body, and four shots to the brain. There are forty-eight points possible, with shots scored accordingly: in the desired area – 2 points. Outside the desired area, 1 point. A miss is zero points. Tally the score to this point and write it on the target. Tape the target.

#### Phase 2

For this evolution, each shooter has two targets assigned.

Distance in yards	Procedure	Shots fired	Time allotment in seconds	Cumulative Round count
50	Pair standing to body of target one reload, pair kneeling on target two	4	11	28
25-15	Shooting on the move. Pair to each body	4	6	32
15	Pair to bodies of each target	4	2.5	36
15-10	Shooting on the move. Pair to bodies of each target	4	4	40
10	Pair to bodies of each target	4	2	44
10-3	Shooting on the move. Hammer to body of each target, single shot to the brain of each target (Box Drill)	6	5	50

At this point, the targets are scored. There should be twelve shots to each of two bodies, and one shot to each brain (24 body shots, 2 brain shots). There are fifty-two points possible, with shots scored accordingly: in the desired area – 2 points. Outside the desired area, 1 point. A miss is zero points. Tally the score for this phase, add it to the score for the previous phase write it on the target. The maximum score possible for both phases is 100 points (an aggregate of Phases 1 and 2). To qualify, each shooter must score at least 80 points.

Source: Patrick A. Rogers, E.A.G tactical training



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