A DEAD CALIBERS HISTORY

The 5.56mm NATO and The .223 Remington

Dead CALIBERS

Documenting the Pursuit of Ballistic Perfection

FEBRUARY 27, 2017

Dead CALIBERS

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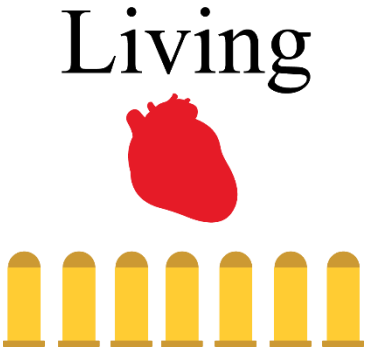
This book is dedicated to Dave for getting me started and for forgetting more about firearms than most people know and to Jason for keeping my nose to the grindstone and finishing it.

Dead CALIBERS

5.56x45mm NATO The Reigning King of Small Arms



The 5.56x45mm NATO is perhaps the single most popular rifle cartridge in the US. Owing this position as a favored cartridge in no small part to the ubiquity of its main parent platform the AR-15 in not only military and police, but civilian gun safes as well. While many attempts have been made to dethrone this cartridge from its position as the most popular choice for the AR-15, and American rifle owners, the 5.56 remains the top contender for many reasons. With cheap and plentiful ammo, a massive list of chambered firearms, as well as being the currently favored ammunition of US and NATO forces, the 5.56x45mm will almost certainly be a popular choice for decades to come.

While most people think of Eugene Stoner when they think of the AR-15 and the 5.56x45mm NATO round. The design of the caliber, and its parent platform, have a long and storied history, with many designers and inventors as well as a dash of political posturing all affecting its development history. The 5.56x45mm NATO was the result of years of research and a number of projects devoted to creating a Small Caliber, High Velocity round for military use. Many different designers worked on various projects, even in competition with each other before what we know today as the 5.56 would come to pass. However, the creation of the 5.56x45mm NATO and the .223 Remington are inexorably linked to the development of the AR-15 platform. The AR-15 was developed as a complete weapons *system* therefore changes to the cartridge prompted changes to the AR-15 itself. If nothing else, the AR-15 is an example of both mechanical and ballistic engineering coming together to create something that worked as a complete system, rifle and cartridge, together.

So any worthwhile discussion about one must talk about the other. With that I will not only be discussing much of the development history of the 5.56mm round but the early development of the AR-15 as well, though the end of the Vietnam war. It was at this point where more variants of the military's AR-15, the M16, were beginning to come to market and attempting to chart the course of the other rifle, carbine, and pistol developments over the years for both military and civilians would turn this already lengthy article into a massive tome.

Before I begin properly I must acknowledge the giants who's shoulders I stand on.

A large chunk of this article owes its existence to the writings of Daniel E. Watters over at the Gunzone.com and Looserounds.com, without his writing and research it would not be nearly as complete as it is. His timeline of the development of the 5.56x45mm NATO helped my research for this article immensely. His work gave me the starting point I needed to track down much of the historic information presented here, it also includes a ton of information beyond the scope of this article such as the development of other early small caliber rounds and military programs aimed at creating new types of cartridges, projectiles, and firearms. His work has been years in the making and it helped to give my own work here life.

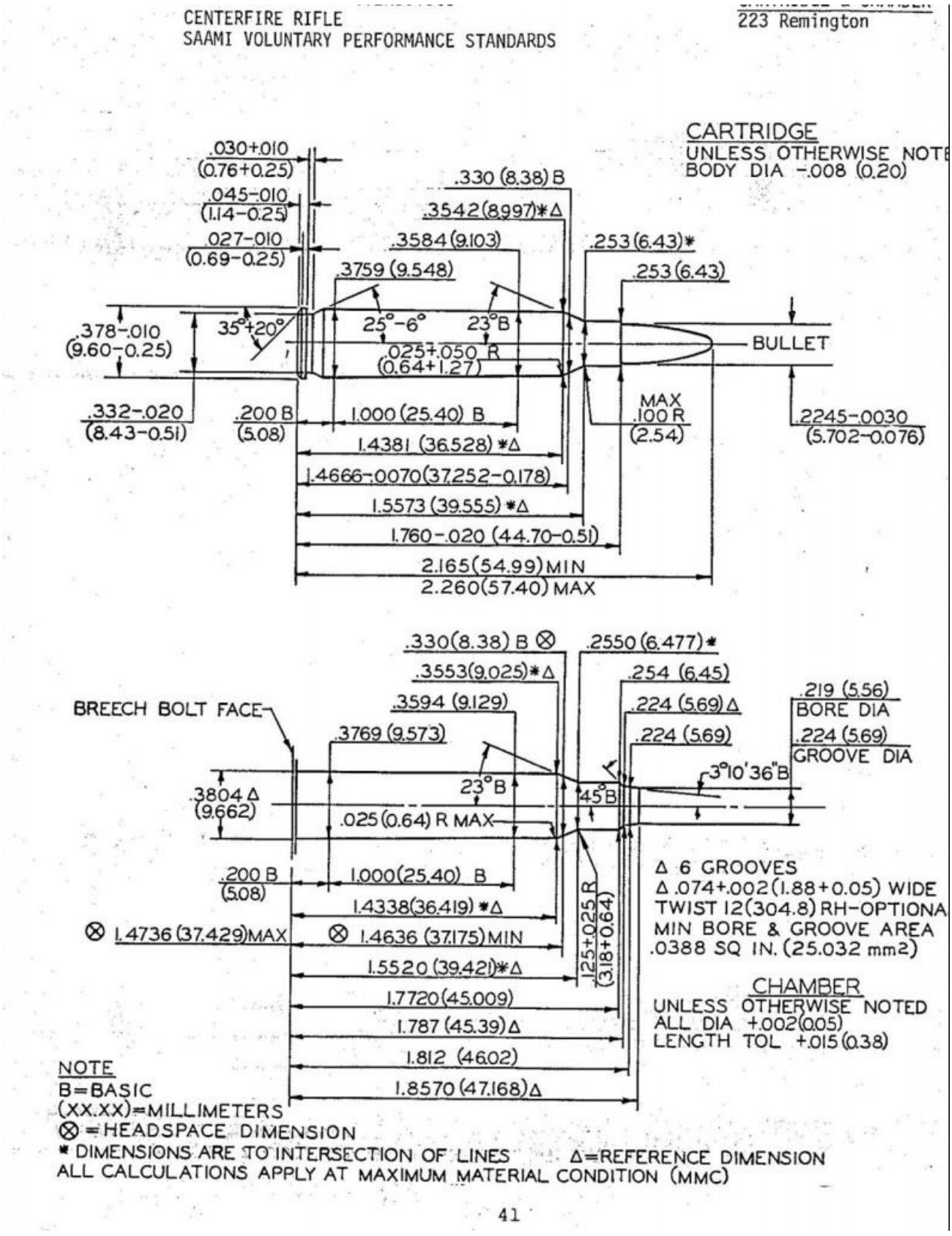


Figure 1 - SAAMI Specifications for the .223 Remington

The Beginnings of the 5.56x45mm NATO

The idea that a light and fast bullet could do just as much if not more damage than a slower, heavier bullet was nothing new. The 9mm Luger was one such example of this design philosophy, and it was first created in 1902. Yet there are even earlier examples. A fast, small caliber, bullet dates back all the way to 1882 with the development of the .22-10-45 Maynard. This idea would come and go in various incarnations until the 1930's when ballistic science started to more rigorously examine the idea.

In January of 1930, Robert H. Kent, working at the Aberdeen Proving Ground, published a paper called *The Theory Of The Motion Of A Bullet About Its Center Of Gravity In Dense Media, With Applications To Bullet Design.*

This paper showed that there was potential for a small caliber round, moving at high velocity, but with a light nose, to tumble and yaw when hitting a target. Kent also argued in his paper that there were additional benefits to such a design, such as low recoil and a flatter trajectory.

However, in the minds of military leaders this idea would sit on the shelf and gather dust, that was until 1950, when the ideas behind the 5.56 really began to incubate.

The ORO and The Pre-History of the 5.56x45mm NATO

In 1948 the US Army's General Staff created a civilian branch known as the General Research Office. Its mission was to be the scientific arm of the Army, conducting research and helping usher in new advancements in weapons technology into general use by the Army. They would set to work and after a name change in 1950 to the Operations Research Office (ORO) and they would begin not just researching complex, cutting edge weapons, but conventional ones as well. This lead to a number of projects, that would eventually lead to the creation of the 5.56 NATO cartridge. The initial impetus for the research that would lead to the creation of the SCHV program and the 5.56 would be a desire by the ORO to improve body armor. From there they realized that they need to look at how bullets actually wound and work from there. Their research would eventually lead to the development of the 5.56mm.

However, there was pushback. Colonel René R. Studler, US Army Ordnance's Chief of Small Arms Research and Development distrusted the ORO and its work. He was pushing for a full power cartridge, like the .308, and wanted the Aberdeen Proving Grounds Ballistics Research Laboratory to create its own report bolstering his ideas.

In November of 1950, Donald L. Hall began working on the study for Aberdeen, and while most of his work was theoretical, he revisited the previous work of Robert H. Kent. Again, the research showed that a smaller caliber bullet could do just as much damage when it yaws and tumbles as a larger caliber round. This theory was bolstered even more by Hall's experiments with the .220 Swift and his work with William C. Davis, Jr. and Gerald A. Gustafson.

Using a 60 grain bullet with roughly the same construction as the .30 caliber M2 ball bullets used at that time, Hall was able to show the effectiveness of these rounds as well as additional benefits. It was posited that a smaller caliber bullet would have a higher hit probability at closer ranges. Furthermore, a single soldier could carry more ammo and inflict more casualties with the additional ammo. This would be further reinforced by a study written by ORO division head, Norman A. Hitchman.

In Hitchman's study, *Operational Requirements for an Infantry Hand Weapon* published in March of 1952, Hitchman found that most combat does not exceed 300 yards and terrain and weather conditions frequently limit effective combat ranges to only 100 yards. Building upon Hall's previous work, he found that marksmanship was less important than the amount of time, and amount of the enemy that was exposed, when shooting at these extended ranges.

Hitchman proposed that with most engagements operating at no more than 300 yards, having a weapon that could provide a predictable "pattern-dispersion" within a 300-yard range, and could be easily controlled, would be better than a weapon that could be pushed out to even farther ranges. He argued that a four round burst of fire could double the probability of hitting the target when compared to a single round of fire from an M1 Rifle. Finally, by decreasing the size of the cartridge a single soldier could have enough ammo in a single magazine to fire the same number of these bursts of fire as was available from the then current rifle.

Ironically a good chunk of these findings, specifically the desire to create a more controllable round that was still effective at 300 meters, had already been considered and integrated into the design of the 7.62x39mm cartridge that the Russians had been developing since 1943.

Experiments with the .222 Remington

It was during this time, in 1950, that Remington created a now somewhat obscure caliber, known as the .222 Remington. While this caliber would eventually fade from popularity, it did become a big hit with benchrest shooters because it was fast and accurate. However, for the ORO and Gerald A. Gustafson, the .222 Remington would be the perfect parent cartridge for their plans to create a new "Small Caliber, High Velocity" (SCHV) round.

So in November of 1952, Gustafson would begin work in his spare time on modifying an M2 Carbine to work with a modified version of the .222 Remington, after receiving authorization from T. F. Colleran, the Director of Development and Proof Services (D&PS) and COL J. D. Armitage, the Chief of the Arms and Ammunition Division at Aberdeen in April.

His work was delayed because much of the military brass at that time saw the experiments with SCHV rounds to be pointless. Gustafson had considerable difficulty in obtaining the necessary barrels and chamber reamers that his work needed so his progress was delayed for months. Gustafson had much to prove since the work would only continue if the early tests showed promising results. With pressure on Gustafson to produce results he set to work on the new round.

This new round would be shortened to 1.32" inches and would be designated the .22 Gustafson Carbine (.22 APG/.22 SCHV). Using a 41 grain bullet, Gustafson was able to produce velocities of 3,000 fps, which would have produced 819 foot pounds of force at the muzzle.

Gustafson's carbine and its new SCHV round were entered into a new program inspired by Hitchman's concept of controlled "volley/burst" fire. The multi-agency project, SALVO, not only included testing of Gustafson's carbine, but also of a number of other designs such as a .22-06 Duplex M1 Garand which Ian at Forgotten Weapons recently showed on his YouTube channel, Forgotten Weapons.

Figure 2 - The .22-06 Duplex M1 Garand as well as the cartridge designs.

The Office of Naval Research, in cooperation with Aircraft Armaments Inc. proposed a different solution and submitted 12 gauge flechette rounds for testing along with other designs such as Winchester and Springfield Armory's multibarrel submissions. The SALVO project would continue for quite some time and while it ultimately failed, it did produce some incredibly interesting designs and concepts. Yet the full history of the SALVO project will have to wait for another time.

In June of 1953 the Office of the Chief of Ordnance (OCO) finally began to see merit in Gustafson's work with SCHV rounds and moved the project from a “back burner” status to an actually assigned project that would see real support. By the end of September, Gustafson was able to publish a report of his findings, *Design and Fabricate a High-Velocity Caliber .22 Cartridge, Modify a Standard M2 Carbine to Fire the Cartridge, and Evaluate the Weapon-Ammunition Combination*. In his report Gustafson finds that not only could his new .22 AGP round effectively replace the .30 caliber rounds that were used in the M2 Carbine but also be a potential replacement for the .45 ACP submachine gun as well.

A91617 CONFIDENTIAL ABERDEEN PROVING GROUND 13 August 1953

Project No. TS1-2. Test of .224 Carbine Ammunition and Weapon.
LEFT: Cartridge, Ball, Caliber .30, Carbine, M1. CENTER: Cartridge, Ball, Caliber .22 Carbine. RIGHT: Cartridge, Ball, Caliber .45, M1911.

Figure 3 - The three rounds compared in Gustafson's report.

Yet Gustafson decided to ignore military brass politics and openly stated, in front of the Infantry Board (Board No. 3) that his modified carbine and its ammunition, "compares favorably with the M1 rifle" out to ranges of 300 yards. This did not go over particularly well with the board, especially when he requested that five carbines and 20,000 more rounds of ammunition for testing at Aberdeen be provided to him. However, history would prove Gustafson correct, and many naysayers of SCHV rounds wrong.

It was not until March of 1954 that more progress would be made. Gustafson and Davis submitted a new report, once again defending the idea of a SCHV cartridge. In this new report they put forth ideas for new SCHV cartridges that use existing commercial and military brass, as well as modifications for existing weapons. They also had a design in mind, a .224", 68 grain bullet, that would use the same internal design as the .30 caliber M1 ball. The idea was to create a cartridge that was based off of the 7.62mm NATO case, necking it down to .224". Finally, this proposal was approved, and Gustafson was able to continue researching with Davis.

Turning to Sierra bullet company, the pair procured the necessary bullets and began testing. What they were able to create was tentatively named .22 NATO. The 68 grain projectiles flew down rage at 3,400 fps and hit with 1,746 foot pounds of force. The .22 NATO rounds continue to be tested as part of the SALVO program until December of 1955, when Davis filed a new report, *An Investigation of an Experimental Caliber .22 High Velocity Bullet for Rifle*s. Despite promising results, the pair ran into a road block. Those in control of the purse strings were unwilling to continue funding the pair's research and they were denied additional funding.

Meanwhile, Dr. Frederick H. Carten, Chief of Small Arms R&D, insisted that Aberdeen is in the business of "testing" weapons, not "inventing" them in his statement denying continued funding of the project. Dr. Carten would continue to do everything in his power to see that the SCHV testing would not turn into an actual working firearm. Hindering not only Gustafson and Davis, but others as well in their attempts to bring a SCHV rifle to the US Military. For Dr. Carten if the firearm was not made of metal and wood, and did not shoot a .30 caliber or larger round it was simply not worth consideration. He would continue to be skeptical of not only the SCHV program but the AR-15 and the 5.56x45mm NATO until the end.

Undaunted, the pair began drawing up plans for yet another .224 caliber cartridge. This new design called for a 55 grain boat tail round launched at 3,300 feet per second and potentially hitting with 1,330 foot pounds of force. Meanwhile new changes in leadership would prove to be a boon for the SCHV project and help spur progress for the struggling concept.

Enter A New Player

In 1956 the US Continental Army Command (CONARC) Infantry Board who had previously torpedoed the SCHV project found itself with new leadership. Colonel Henry Neilson was put in charge of the Board and he was a strong proponent of the SCHV project. It could be argued that he is ultimately responsible for spurring on the series of events that would lead to the final creation of the 5.56x45mm NATO and the AR-15 platform. However, to give any single person credit for what happened would be to deny the complexity of history.

Late in 1956 a copy of Davis and Gustafson's denied request for continued funding in 1955 found its way onto the desk of General Willard Gordon Wyman. No doubt the work of Colonel Neilson, as at his urging General Wyman requested that the Infantry Board make a formal request for a SCHV rifle based around Davis and Gustafson's previous designs. Wyman also slipped information to ArmaLite and Eugene Stoner that a scaled down version of the AR-10 prototype might be exactly what the Infantry Board was looking for when they made their request.

Moving The Goal Post

Since 1952 and Norman A. Hitchman's work, research and development of SCHV rounds had targeted 300 yards as the maximum expected effective range. But in the spring of 1957 certain members of CONARC felt that this was too short a range and it needed to be extended. So the targeted range was first pushed out to 400 yards, then to 500 at the behest of these voices and to assure that the concept would be accepted at the Pentagon.

However, there were other requirements that were brought down on the SCHV project. The full, finalized request called for a rifle, in .22 caliber, weighing no more than six pounds. It had to have a conventional stock and utilize a 20 round magazine. Furthermore, the round had to penetrate a standard issue steel helmet, body armor, and a .135" inch thick steel plate at 500 yards. All of this also had to be done while maintaining the trajectory and accuracy of an M1 rifle using M2 ball ammo. Finally, it also needed to meet or exceed the wounding capability of the .30 Carbine.

A tall order to be sure.

With these new goals in mind for the SCHV project ArmaLite began working on a rifle to enter into formal trials. However, there is some disagreement as to who exactly designed the first SCHV prototype for ArmaLite. ArmaLite's prototype was called the AR-11, or the "Stopette" and there are two people whom various sources credit with working on it. They are 'Doc' Wilson and Robert Enewold. Enewold is also credited with designing the ArmaLite/USAF AR-5 .22 Hornet survival rifle for aircrews.
So with conflicting information from this time it is hard to say for certain which designer was ultimately responsible. While speculation on my part, it may be that both contributed to the work, hence the confusion.

Regardless of whoever designed the AR-11 prototype it ended up being a failure. Being too light and having a high cyclic rate it was difficult to control when used with fully automatic fire. The end of the prototype was actually when the barrel extension failed during testing.

With General Wyman having already hinted that he favored the AR-10 design, ArmaLite decided to work on a scaled down version of the design to work with the new, SCHV calibers. However, this design, created by John Peck used the same barrel extension and was set aside due to the issue. Later sources claimed that the barrel extension was scaled down too much, making it weak and prone to failure. Whether or not this was true, ArmaLite decided to start from scratch and give the task of scaling down the AR-10 design to work with .222 Remington to Robert Fremont and L. James Sullivan. Decades later in 2015, Sullivan would sit down with Ian for an interview on InRange and talk about his work on the AR-15, as well as his continuing work to improve the platform.

Figure 4 - L. James Sullivan talks with Ian about his past and continuing work

We're STILL Not in the Business of Making Weapons

While all of this was going on, Springfield Armory and Earle Harvey had been trying to cook up a new SCHV round of their own. Harvey had already worked on scaling down full power cartridges in the past and had been instrumental in the development of the 7.62x51mm NATO. Since the distance required by CONARC had been changed to 500 yards, the .222 Remington alone would not be sufficient. Knowing this Harvey contracted Remington to make 10,000 loads of unheadstamped, but lengthened .222 Remington. This new round was tentatively dubbed the .224 Springfield and of the initial 10,000 round batch, 9,500 used 55 grain bullets while the remaining 500 were 68 grain bullets in the same design as the M1 ball.

Working with Harvey was Albert J. Lizza who designed a new rifle to fire these modified cartridges. Drawing on the past design prototypes that eventually became the M14 rifle, Lizza worked to create something that built upon the best aspects of the "T25" and "T47" M14 prototypes. Despite making some promising headway, even probably converting a T25 prototype for testing, the pair's work was short lived.

Dr. Carten found out about Harvey and Lizza's work and promptly shut it down much like he had done previously at Aberdeen. Dr. Carten was bent on getting the T44 prototypes approved and would eventually succeed, with them becoming the M14. Dr. Carten saw the work on the .224 Springfield cartridge as, once again, a waste of resources. To him small bullets make small holes and I'm sure that it was this attitude that informed much of the resistance to the SCHV projects. Remington, however, is still able to manufacture the .224 Springfield round and decides, instead of letting the design sit on the self, to introduce the modified round as the .222 Remington Magnum to the commercial market in February of 1958.

The Birth of the .222 Special

In May of 1957 Stoner gave a live-fire demonstration of the work in progress AR-15 for General Wyman. With burgeoning backing and fewer skeptics of the SCHV program, CONARC decides to formally request 10 rifles for the Infantry Board to test. This, ironically, came but five days after the official adoption of the 7.62mm NATO M14's. A move that would eventually see the M14 and the 7.62 NATO replaced and moved to a more specialized role than the standard infantry round.

Stoner realized, much like Harvey already had, that the .222 Remington was not going to meet CONARC's requirements without excessive case pressures. So he began looking to improve the round himself. Unfortunately for Stoner he was essentially replicating Harvey's work and would not know about the .224 Springfield until it's commercial release as the .222 Remington Magnum. Stoner went to both Remington and Winchester looking for someone to be able to make the larger case that he needed. Winchester flat out refused, because, unbeknownst to Stoner, they were already trying to make their own SCHV cartridge and had little interest in helping the competition. Remington on the other hand, had already helped Harvey and were more than happy to accommodate Stoner.

However simply lengthening the case was not going to be enough. More design changes were needed. Working with Frank Snow at Sierra they took the .224" caliber 68 grain round that they were working with and lightened it to 55 grains. Shortening the bearing length and the boat tail. However, they kept the 7 caliber ogive and the 9-degree boat tail. Using Speer's Ballistic Calculator to help the pair, Robert Hutton calculated that they needed to ensure that the 55 grain bullet would be traveling at 3,300 feet per second when it left the barrel.

To achieve this velocity Hutton started experimenting with various loads using a number of different powders. IMR 4198, IMR 3031, and an unknown Olin ball powder were all used. Loads were tested using a Remington Model 722 with a 22" Apex bull barrel and a Lyman 25x scope to round out the testing platform. Once Hutton was able to successfully penetrate a US helmet at 500 yards at a public demonstration the idea of a SCHV round finally began to prove itself. Once Remington was on board to make the necessary cases the final cartridge developed by Stoner, Snow, and most importantly, Hutton became known as the .222 Special.

Winchester Throws Its Hat in the Ring

Despite the successes coming out of Stoner's work with the AR-15 CONARC wants more options and invites Winchester to submit their SCHV cartridge and rifle design to compete with the, then prototype .222 Special. Winchester assigned one of their in-house design team members, Ralph Clarkson who had previously worked on the M1 Carbine, to the task. With ArmaLite and Stoner already having provided impressive results Clarkson no doubt felt mounting pressure to get a new Winchester prototype up and running.

To do this he borrowed heavily from the previous work of David "Carbine" Williams and took Williams .30 carbine design and modified it to work with the new SCHV round that Winchester was working on. In less than two months Clarkson was able to deliver a working prototype rifle for testing. In October of 1957 Clarkson's prototype Light Weight Military Rifle (LWMR) using .224 Winchester was delivered to and demonstrated at CONARC headquarters.

Sometime between November and December of 1957 Winchester's LWMR is tested for the Infantry Board at Fort Benning. While initial tests were promising, prompting Ordnance Weapons Command and CONARC to order fifteen more LWMR's for testing the .224 Winchester case begins to show some problems.

Despite being based off of the same .222 Remington case that much of the previous experiments had been, Winchester's cartridge was unable to meet the necessary penetration requirements because of its short overall length (OAL). Using a short 53 grain projectile, the round is unable to keep the necessary velocities required to penetrate the steel targets. Much like Stoner and Hutton had already seen and dealt with, the .224 Winchester (.224E1) cartridge was simply unable to meet the requirements without making the chamber pressures dangerously high.

To put even more pressure on things, the Infantry Board declares that Winchester and ArmaLite have to cooperate in making their ammunition interchangeable between the competing rifle designs for all future tests. This, and the previously encountered issues spur Winchester to increase the case neck length. To further intermingle ArmaLite and Winchester's work the .224 Winchester round begins using the DuPont IMR 4475 powder that Stoner was using in the .222 Special. This no doubt caused some tension as DuPont owned a majority interest in Remington at that time while Olin, a competing powder manufacturer, owned Winchester.

The end of these changes to address the issues with the .224 Winchester round resulted in the .224E2 cartridge. It kept the same OAL from the .224E1 but was still able to be chambered in the AR-15 prototypes. Conversely, the ArmaLite designed .222 Special was unable to work with the Winchester LWMR. Because of this issue trials after this were ran using the Winchester cartridge, instead of the .222 Special.

More Money, More Problems

With the M14 Rifle being pushed by other officials General Wyman worries that the US Army will have already committed itself to spending money on what he views to be an inferior weapon design. In an attempt to save the SCHV program from dying on the vine General Wyman writes to General Maxwell D. Taylor, Chief of Staff of the US Army.

> *"As you know, in April 1958 we will receive two types of small caliber rifles, an Armalite and a Winchester, for evaluation at the USA Infantry Board. Should these rifles be found superior to the M14, as I am almost certain they will be, it would be most unfortunate if the Army had committed itself before Congress to irrevocable support of the M14 rifle. Disregard of the potential presented by the small caliber rifle at this time might well preclude Army exploitation of a superior rifle system which could conceivably appear on the developmental scene at an early date."*

While General Wyman worked to ensure the future of the project, in March of 1958 Fort Benning took delivery of ten AR-15 rifles chambered in .222 Special for Infantry Board field trials. With the changes that were being made to the Winchester LWMR to accommodate the new .224E2 Winchester cartridge Winchester's rifle was not ready yet. Forcing the AR-15 to compete against a number of new T44E4, pre-production M14 rifles. While the M14 rifles were used as a control group, they exhibited an embarrassing malfunction rate of sixteen malfunctions every 1,000 rounds. Meanwhile the AR-15's only malfunctioned 6.1 times every 1,000 rounds.

At this time the .224E2 Winchester cartridge was being tested as well, despites being the "defacto" cartridge for testing in both the AR-15 and the Winchester LWMR designs, the .224E2 fails to penetrate a metal helmet at 500 yards. The .222 Special, however manages to do this with flying colors.

By the end of April of that year Aberdeen's Ballistics Research Laboratory publishes a new report, *A Comparison of Proposed Small Arms Weapon Systems*. Once again they find that the .22 caliber rifle systems that are being experimented with, when using a 50 grain projectile, will have considerably better effectiveness when compared to other weapon systems at that time.

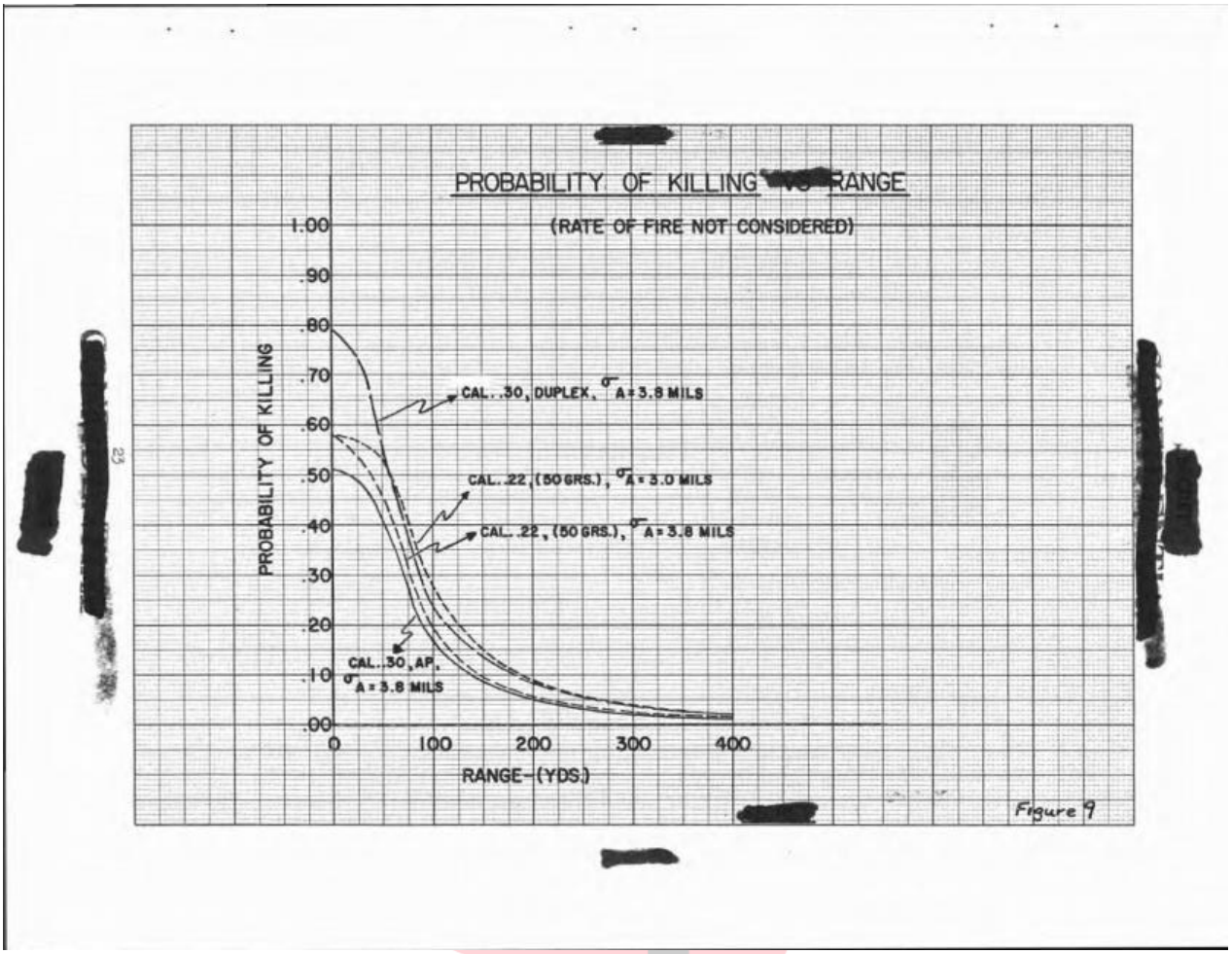


Figure 5 - While beaten by the .30 Duplex rounds out to just over 50 yards the .22 caliber would have a higher probability of killing compared to the other calibers tested.

The Results Are In

In May of 1958 the Infantry Board published their findings on the AR-15 in a report named *Evaluation of Small Caliber High Velocity Rifles - ArmaLite (AR-15)*. In this report they came to three basic conclusions. First, the AR-15 was a potential replacement for the M14 rifle. Second, the AR-15 equipped with a bipod and hinged butt plate should be a potential replacement for the M15 rifle. Third, the penetrating capability of the .222 Special and .224E2 Win are significantly less than that of the 7.62mm NATO and should be improved.

During this time another interesting change happened to the safety selector. While early prototypes had the safety selector, clockwise, "Auto", "Safe", "Semi" this was changed after the 1958 Infantry Board trials to the current configuration that we see today. Now the selector positions are "Safe", "Semi", "Auto".

This was done because there was because the troops would find that the selector would change from safe to full while crawling across the ground. While there are no confirmed instances of this actually becoming a problem and causing a negligent discharge.

Having your rifle go into an "unsafe" condition while crawling was worrying enough to those working on the design that it was quickly changed and later prototypes would reflect this change. Recently, Ian from Forgotten Weapons took a look at the first AR-15 prototype, serial number "000001" from ArmaLite and you can see the changes to the safety selector on it.

Based on the results of this testing the Infantry Board requested that eight AR-15 rifles be modified to address these concerns and be supplied for further testing. While the Infantry Board was now seeing promise in the new rounds, they are still concerned about the bullet's ability to penetrate and resist disintegration.

While these were promising results, both the AR-15 and the Winchester LWMR run into an issue.

In June of 1958, the Chief of Ordnance, MG John H. Hinrichs was overseeing rain testing on the AR-15 platform and informed General Wyman that his pet project had hit a snag. Aberdeen had been conducting rain tests on the AR-15's and found something concerning. Because of the water in the bore building up during the rain testing and the fluted barrels two of the test AR-15, the rifles had destroyed their barrels because of over pressure issues stemming from the trapped water. However, ArmaLite's rifle was not alone, Winchester's LWMR also used fluted barrels and experienced the same issue, however, with not nearly so much attention from military leaders.

CONARC officials wanted to see if this issue could be duplicated and ordered the Infantry Board to conduct their own rain tests. Unfortunately, the problem occurred again and while ArmaLite and Winchester both respond by using unfluted barrels from that point on, it gave naysayers an opening. Dr. Carten, who had continued to oppose the work on these SCHV cartridges saw an opportunity and decided that if he was not going to be able to beat the SCHV program, it would be ***his*** SCHV program that would be adopted. Dr. Carten began to campaign for a new SCHV cartridge in .258 caliber based off of the .25 Remington case.

Meanwhile in the midst of these issues, Winchester began to experiment with alternative projectiles for their .224E2 cartridge. What they developed was a 38 grain steel bullet running at 3,618 feet per second with a force at the muzzle of 1,105 foot pounds of force. With these tweaks they were finally able to deliver their modified rifle and cartridge for testing.

Winchester Is Finally Ready

In July of 1958 Winchester was finally able to deliver the modified LWMR to Fort Benning to be tested. In the report, *Evaluation of Small Caliber High Velocity Rifles - Winchester* written by Captain Herbert P. Underwood and Colonel Felix E. Tharpe the report documents an extensive series of tests that they put the LWMR through.

The LWMR was able to meet most of the requirements, however a few issues were noted in the report. Under the durability and reliability requirements the LWMR is noted to not have *"a bore and working parts which are resistant to wear, rust and corrosion to the maximum practicable extent"*. Furthermore, they found that the LWMR was not *"...sufficiently rugged to withstand normal usage encountered in training and combat."*

Despite these knocks against it and a number of tests that the pair were simply unable to do because Winchester did not provide them with cleaning kits and other accessories they ultimately found that, much like the AR-15 design it could be a potential replacement for the M14. However again, the .224E2 was criticized for its penetrating capability and the report stated that it, quote *"should be improved"*.

After these tests the Infantry Board requested that eight LWMR's be modified to address the issues noted and that three of them be outfitted with a bipod and hinged butt plate. However, the Infantry Board, in particular wanted to expedite the development of a bullet for the Winchester rifle that better resisted disintegration and had a better ability to penetrate targets.

Back to the AR-15

In August of 1958 the Infantry Board published the results of their additional testing of the AR-15. While the water retained in the barrels during rain testing was causing over pressure issues, the Infantry Board still saw the AR-15 as a viable replacement for the M14 rifle. They found that they could mitigate much of the overpressure issues simply by partially extracting the round from the chamber before firing. Yet, they found that the issue was not just a design flaw in the AR-15 but a problem with the caliber in general. Stating that *"Weapons of approximately .25 caliber or larger do not retain water in their barrels due to surface tension or capillary attraction when the rifles are fully loaded."* The small bore size was causing enough surface tension to keep water in the bore and chamber.

At this point the Infantry Board decided to continue their SCHV research and to purchased more AR-15's for service tests. They wanted ArmaLite to continue refining the design to address this issue, and determine the minimum caliber at which water being retained in the barrel stopped being an issue. However, if this was not successful they were willing to modify soldier's training to deal with the possible water retention.

Meanwhile the SCHV project suffered another loss as General Wyman retired and the program lost one of its strongest advocates. Despite this, the SCHV program would continue and gain momentum as the military had already put too much time and effort into the project to see absolutely nothing come of it.

A Final Judgement

In September of 1958 CONARC issues what would be their final judgement on the Infantry Board's tests of the AR-15 and the Winchester LWMR. Both rifles finally are judged to be better than the existing M14 when compared in terms of weight and ease of handling. They note that, as theorized, a single soldier with a SCHV rifle and caliber could carry around 650 rounds, almost three times the 250 rounds that could be carried with the M14.

Of the two rifle designs, the AR-15 comes out on top, giving superior reliability and ease of service when compared to the M14 and the LWMR. Yet the issue of the burst barrels was again noted. However, breaking with the Infantry Board's findings CONARC notes that even .25 caliber or larger rifles may have burst barrels due to water retention.

But it's not all sunshine for the AR-15. Because of the continuing concerns over penetration when compared to the 7.62mm NATO, CONARCH decided that the SCHV calibers, .222 Special and .224E2 are both not suitable for use by the Army. Despite this the report recommended that both Winchester and ArmaLite submit sixteen improved rifles and 96,000 more rounds for further testing by not only the Infantry Board but the Arctic Test Board as well.

Because of this decision Winchester decides to drop out of the competition and shelves the LWMR and its .224E2 Win. round. Leaving just the AR-15 and the .222 Special alone for continued trials.

Another Shakeup

Headed up by General Herbert B. Powell, the Deputy Commanding General of CONARC, a board was assembled by General Powell and began to look at the various disparate rifle research and production programs that were operating at that time. However, there was some disagreement as to who exactly ordered General Powell to assemble the board. Some sources claim that it was General Wyman's last act before retiring, while other pint to General Bruce C. Clarke. Personally, given General Wyman's previous evangelism of the SCHV project, I'd not be surprised if it was his final act before retiring.

Outside of the military sphere other events were happening that would affect the path of the burgeoning SCHV program. ArmaLite's parent company Fairchild Engine & Airplane Corporation was in trouble. In July of 1958 Fairchild's stock had been briefly taken off of the stock exchange in New York and the company was looking at a first half loss of $5 million that year. Due to these difficulties Fairchild was not in a position to give ArmaLite its own production line to work on the AR-10 and AR-15 rifles.

Seeing this issue Colt stepped in and through Cooper-Macdonald, Inc. a sales representative for Colt in Southeast Asia, they agreed to take over ArmaLite's work on the AR-15. Happy to have the burden of R&D for a new rifle off of their back Fairchild gives Colt the rights to manufacture AR-15's.

Winter Games

In December of 1958 Stoner delivers replacement parts to the Arctic Test Board trials being conducted at Fort Greely. Much to his surprise many of the AR-15's had parts switched out. Front sight assemblies were removed from the barrels and the few rifles that did have them had their tapered pins inserted backwards or replaced with welding rod.

After delivering the parts and inspecting the rifles, Stoner gave a presentation on the AR-15 to the Powell Bard. At that time Stoner believed that the Arctic Test Board had just begun their testing of the rifles and reported that there were only some minor problems that had been corrected. In reality the Powell Board had already received a rather negative review of the AR-15. Citing poor accuracy and reliability in cold weather. Yet the testing at the Arctic Test Board was conducted in a way to ***make*** the

AR-15 fail. So with the inherent bias of this testing of the rifle, it was guaranteed to fail and receive negative reviews.

Despite this the US Army's Combat Development Experimentation Center (CDEC) started to conduct mock combat trials with the AR-15, Winchester LWMR, and the M14. The trials were done at Fort Ord in California and they were conducted to test the effects of the new firearms designs on squad tactics and organization. In total more than 500 firing runs were made on two "attack" ranges and one "defense" range. They experimented with different fire techniques and combinations of techniques. They also experimented with four different squad sizes and accumulated data on what squad sizes worked best with each weapon.

1959 The .223 Remington Gets Its Name

At this point there were a number of "triple deuce" rounds being talked about in the SCHV competition. The .222 Remington, the .222 Special, and the .222 Remington Magnum. With so many similarly named rounds Remington took it upon themselves to clear the air and officially rename what had previously been known as the .222 Special, to the .223 Remington. Not exactly a markedly different name but it was at least "different". Yet it was still not over for the 5.56x45mm NATO, the .223 Remington had not been yet submitted to the Sporting Arms and Ammunition Manufacturers' Institute (SAAMI) and its exact specifications were still up in the air. While the name had changed, the specifications for this round were far from finalized. It would be another three more years before SAAMI would have the .223 Remington be submitted to them for certification and standardization.

In January of 1959 the Powell Board finally concluded its report, ahead of the reports from Aberdeen and CDEC, into the SCHV concept. They recommend that 750 more AR-15's be purchased for extended trials. But the .223 Remington, in their opinion, was not a suitable replacement for the 7.62mm NATO. They instead, recommend developing another AR-15 design based on a .258 caliber round. Ironically the exact caliber that Dr. Carten had, in 1958, pushed as an alternative caliber for the SCHV program. This, they recommend, should be expedited as a replacement for the M14 rifle as the general issue rifle while keeping the M14 for the role of automatic rifle.

More Setbacks

After reading the report and with the urging of the OCO, General Taylor decided to have the production of the M14 continue as scheduled. He also decided to halt any more Army purchases of the AR-15. The 7.62mm NATO was retained as the standard cartridge, and unless a new caliber offered significant improvement no changes would be made.

Shocked by the decision, ArmaLite lobbies Senator W. Stuart Symington (D-MO) to protest the decision. While Symington did enter a protest into the Congressional Record, he failed to push the issue any farther. Meanwhile Colt and Fairchild were finalizing their licensing agreement. Colt paid $75,000 and a 4.5% royalty on all of their future AR-10 and AR-15 production to Fairchild.

In February of 1959, looking to see some profits on their investment, Fred A. Roff, Colt's president pays Cooper-Macdonald $5,000 to start promoting the AR-10 and AR-15. They began a "world tour" that, in reality primarily consisted of countries in Asia. While Robert Macdonald finds that most potential buyers were not interested in the AR-10, the AR-15 however, becomes immediately popular. Orders start coming from Malaya, India, Australia, Burma, and Singapore for AR-15's. More would have come if not for one caveat. Countries like the Philippines were interested in using the AR-15, however it was not a US military ***issue*** rifle, making funding for the purchase of AR-15's unavailable through US military assistance pacts.

Despite the setbacks new hope seemed to emerge from the CDEC testing reports. While the Arctic Test Board published *Evaluation of Small Caliber High Velocity Rifles* in April claiming that there were 48 malfunctions during a 40 round test, the CDEC reports radically different findings in May. In the report *Rifle Squad Armed with a Lightweight High-Velocity Rifle* they find that a five to seven-man squad, armed with AR-15 rifles would be able to have more hits and kills than an eleven-man squad with M14's. In particular contrast to the findings of the Arctic Test Board the CDEC praises the reliability of the tested AR-15 rifles and pushes to advance the SCHV design of the AR-15 and the .223 Remington as replacements for the M14.

By the end of 1959 AR-15's began to sell in various places around the world and by March of 1960, 1,250 AR-15's are sold to Indonesia alone.

Colt Strikes Back

In June of 1960 Colt pushed for new Ordnance testing of the AR-15 rifle. They had worked to improve upon it and keep the project going, however Dr. Carten put up a roadblock. Arguing that the military did not need a new rifle he denied Colt's request. In response Colt President Roff sends off a copy of Dr. Carten's refusal along with a Congressional report that contained potentially helpful statements from Army CRD LTG Trudeau. Colt also includes a letter from Charles Dorchester outlining arguments against Dr. Carten's decision and a test report from Aberdeen.

Yet it would take more than just arguments before Congress to stop Dr. Carten from killing the AR-15 and the .223 Remington. They needed to start playing “dirty” and use some more “unusual” channels. So in July of 1960 a very “fortuitous” meeting took place between Macdonald and General Curtis E. LeMay. Macdonald, knowing that he needed friends in higher places if he had any hopes of earning more royalty money from the AR-15's set up a meeting with not only General LeMay who was the US Air Force Vice Chief of Staff but former Fairchild president Richard Boutelle as well.

Inviting the two men to his combination 4th of July party and birthday party for Boutelle. He just so happened to have a new production Colt AR-15 on hand. LeMay was given a chance to shoot the new rifle and after disintegrating two watermelons at 50 and 150 yards LeMay becomes convinced of the prowess of the .223 Remington and the AR-15. LeMay had already been somewhat friendly to ArmaLite's designs in the past and had lobbied for the AR-5 survival rifle to be adopted by the USAF. However, upon seeing what the AR-15 could do, he made an offer.

At that time the USAF had an aging stock of M2 Carbines that they were looking to replace. Since LeMay was so impressed by the new rifle and round, he offered to recommend them for consideration as a replacement for the USAF's carbines. Colt, ArmaLite, the AR-15, and the .223 had their foot back in the door that had been previously slammed by Dr. Carten.

Shortly after the party three Colt AR-15's were sent to the Air Force Marksmanship School at Lackland Airforce Base for testing. LeMay also meet with Army CRD LTG Trudeau and with representatives from Cooper-Macdonald. Out of this meeting came a request for the OCO to do additional tests on the AR-15 for the USAF.

This is a massive boon for Colt, with President Roff writing Cooper-Macdonald confirming Colt's approval of Cooper-Macdonald representing Colt in further attempts to get the AR-15 approved by the US Military.

Back to Testing

In August of 1960 the USAF Marksmanship School was given five more AR-15's to test. General Robert M. Stillman, the Lackland Military Training Center commander, oversaw the testing along with his Staff Officers and Air Police personnel. Using both Remington and Norma ammo they use scoped rifles, however loose scope mounts adversely affected at least one rifle. In addition to testing the accuracy of the AR-15 and the .223 Remington, they a look the rifle's ability to launch rifle grenades as well. With Gene Stoner and Charles Dorchester participating in the testing as well, they brought out an AR-10 to compare to the AR-15.

About a week after the initial testing of the AR-15's Major Burton T. Miller at the USAF Marksmanship School sent a preliminary report called *Evaluation of AR-15*. He noted that they have ten AR-15's and 5,000 rounds scheduled to be delivered but this will be only a fraction of the 50,000 rounds that they expected to use in completing the testing. In the memo Major Miller requested permission to work out a test evaluation program with the Air Police School and the 3720th Basic Military Training School. He suggests that a representative number of trainees use AR-15's on the course's that they would normally use M2 carbines on. Yet with so few rifles, they would have to have multiple trainees using a single rifle along with range staff who were to conduct penetration, accuracy, and function testing. It was shaping up to be a complicated process to see that not only the trainees would be able to use the AR-15's but the testing staff as well.

Seeing this problem General LeMay took the opportunity during a staff meeting late that month to not only note that the Air Force security forces needed a better small arm to replace the M2 carbine but also to order an all-command survey be taken to determine the number of rifles that they will need to replace in the USAF's arsenals.

In August of 1960 the USAF Marksmanship School published their report, *Evaluation of the Colt-Armalite AR-15 Automatic Rifle, Caliber .223*. In the report the .223 ammo was shown to be able to penetrate a steel helmet, though both sides at a distance of 600 yards.

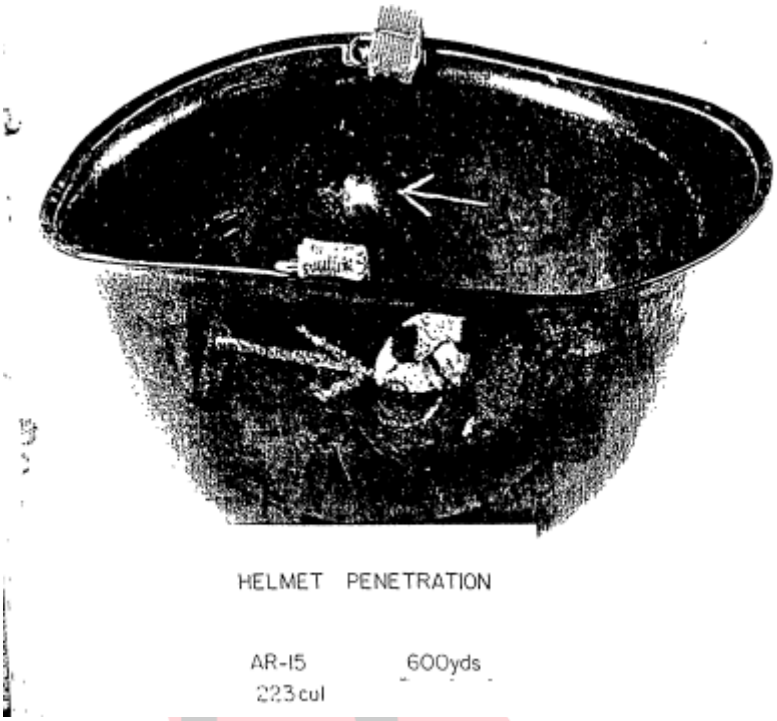
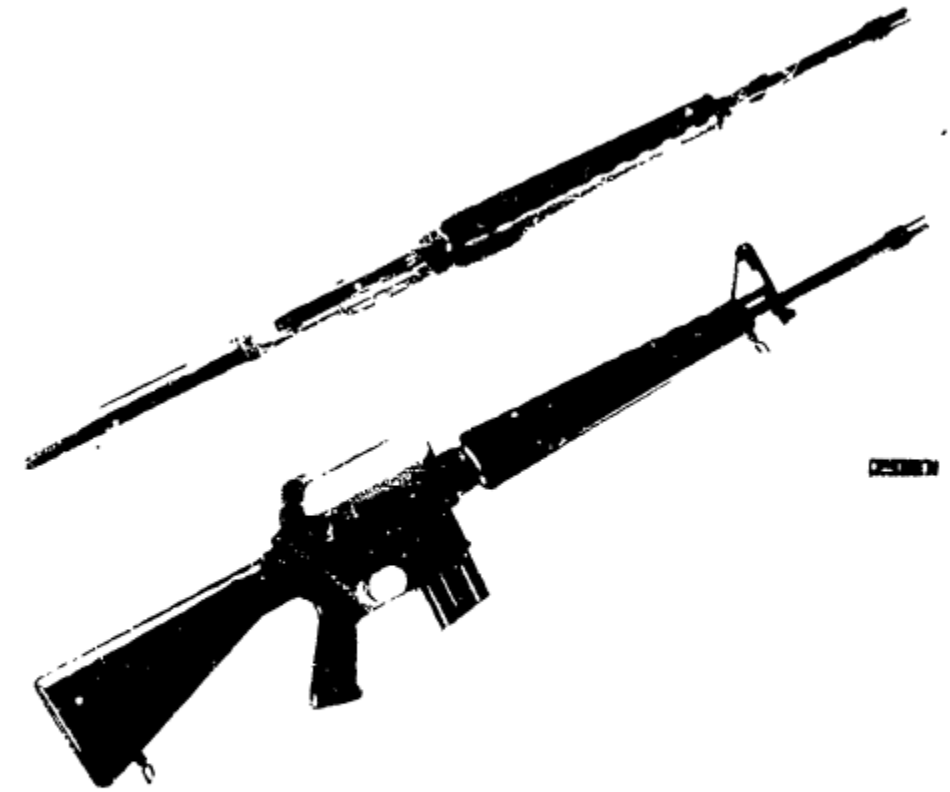


Figure 6 - A helmet sacrificed to the testing for the report, Evaluation of the Colt-Armalite AR-15 Automatic Rifle, Caliber .223.

Meanwhile General Lemay was briefed on what is going on in the latest small arms development programs from the Department of the Army. Much to his chagrin Dr. Carten received orders to provide testing of the Colt AR-15 for the USAF, the very rifle that he had worked to shut down the past. The testing coincided with Ordnance testing of Dutch manufactured AR-10 rifles, with General LeMay, Army CRD LTG Trudeau, and other representatives from the USAF and the Army all attending the testing. Also observing were Mr. Sloan from the FBI, as well as Gene Stoner, Robert Macdonald, and Gerald Gustafson who was at that time employed by the USAF Armament Laboratory.

While Laurence Moore's recommendations and conclusions were missing, again, from the November report on the testing. The new data showed that the AR-15 was working even better than in previous tests. With a malfunction rate of only 2.5 rounds in every 1000 fired. Cutting the malfunction rate of the 1958 Fort Benning tests down by more than half. When reporting to the OCRD, Dr. Carten is finally forced to admit that the AR-15 is producing *"reasonably satisfactory"* results and the Colt AR-15 is finally approved for USAF trials.



ABERDEEN PROVING GROUND

S18-001-2873-1005-54-1P/ORD-60 21 September 1960

Project TS1-2/265. Rifle, Calibe: .223, AR-15, Figure 1.
Top and right side views.

Figure 7 - Early image of an AR-15 used in testing and taken from the report, A Test of Rifle, Caliber .223, AR-15*. Published in November of 1960.*

Making Better Marksmen

While the Lackland AFB testing continued in 1961 a curious thing happened to the trainees who were using the AR-15's. 43% of those using the AR-15 rifles are able to score an "Expert" marksmanship rating in their qualifications, while only 22% of the M14 users were able to achieve the same rating. Not only was the .223 Remington proving to be a powerful round, more so than many expected, the benefits of less recoil were beginning to show real world results, allowing trainees to be more accurate and score higher marks.

In January of 1961 Aberdeen's D&PS published a new report titled, *A Test of Rifle Caliber .223, AR-15*. The battery of tests subjected three rifles to mud, dust, rain, and more. While two of the rifles showed only a few issues, one in particular gave the testers far more problems. However, as they noted in the report the rifle, Number 835, showed signs that it had been subjected to much more abuse before it had been sent to Aberdeen and was in need of service.

A Shakeup at ArmaLite

However, things were changing for ArmaLite, not only did the company split from Fairchild, but it also lost Stoner who left the company in February of 1961. However, ArmaLite's management team was still able to purchase the right and titles to all of ArmaLite's designs, but the critical AR-10 and AR-15 designs were not given back to the now independent ArmaLite.

While things were not exactly changing for the better at ArmaLite, the Colt AR-15 was seeing new, promising developments. General LeMay was briefed in March on the Air Staff recommendations on selection and procurement of a new rifle for the USAF. After the briefing, LeMay suggested that the Air Staff not only select a new weapon, but also that the Air Force Materiel Command purchase the new rifle at a rate of 19,000 each year. Of course, the rifle that LeMay had in mind was the AR-15.

Project AGILE

In the Spring of 1961 ARPA received a new mission, research how to conduct counter-insurgency warfare. This lead to the creation of Project AGILE and the Colt AR-15 would become a part of this new mission. While Combat Development Test Centers were being opened in Bangkok and Saigon, Robert Macdonald approached Colonel Richard Hallock of the US Army about using the AR-15 rifles. The AR-15 rifle had already proven to be popular with a number of Asian countries and to Macdonald the .223 Remington and the AR-15 seemed a natural fit for the "smaller stature" fighters in Thailand and South Vietnam. However, it would be some time before the .223 Remington and the AR-15 would be fully adopted by Project AGILE.

Meanwhile in April of 1961 General LeMay's efforts to replace the USAF's aging rifles and carbines hit a roadblock. In response to LeMay, the memo, *Replacement of .30 Caliber Carbine for USAF*, stated that there would be many logistical issues created by adopting such a radically different rifle and cartridge like the AR-15 and the .223 Remington. Instead the Office of the Chief of Research and Development (OCRD) recommended that the USAF consider moving to the folding-stock M14E1.

General LeMay Gets a Promotion

In June of 1961 General LeMay was appointed to the Chief of Staff of the Air Force and quickly used his new position to continue pushing for the AR-15 and the .223 Remington. That summer he requested 19,000 AR-15 rifles to be added into the USAF's budget proposal for the next year. His ultimate goal was to purchase a total of 80,000 rifles yet it hit a roadblock. The funds were withheld by the Department of Defense arguing that, again, logistics issues would become a problem if they adopted the .223 Remington. Furthermore, the .223 is not a NATO round, and adopting it would go against the objective of trying to standardize with the rest of NATO. Finally, the DOD, argued, the UASF already had a large number of M1 and M2 carbines that were still in working order, despite their age.

Yet General LeMay did not give up and in July he took the matter to the offices of the Director of Defense Research and Engineering (DDR&E) and the Assistant Secretary of Defense (Installations & Logistics) - ASD(I&L). While they had not agreed to USAF procurement of the AR-15, they did, finally, agree to, in typical bureaucratic fashion, conduct yet another study and allow the entire matter to be decided by the Secretary of Defense.

By the end of July, the study was completed and the AR-15 finally got the stamp of approval to be the USAF's next rifle.

Meanwhile ARPA made another promising decision for the fate of the AR-15 and the .223 Remington. They finally admitted that the platform is the most likely to be "compatible" with the "smaller statured" South Vietnamese soldiers. Because of this decision, ARPA bought ten AR-15 rifles for the AGILE project.

LeMay Continues to Fight for the AR-15

In August of 1961 LeMay found that he had to continue his fight for the AR-15 and the .223 Remington. At this time, he met with Deputy Secretary of Defense Roswell L. Gilpatric as well as DDR&E Harold Brown, ASD(I&L) Thomas D. Morris, and Assistant Secretary of Defense (Comptroller) Charles J. Hitch. The meeting was headed up by Gilpatric and while most were in favor of LeMay's plans to procure the rifle and the ammo, Hitch was decidedly against the idea. Among other issues brought up, the main issue with LeMay's plans was finding a way to justify the expense to the Bureau of the Budget, let alone Congress given that the Army was already knee deep in another new rifle program at that time.

However, LeMay was not deterred and continued to meet with Gilpatric to figure out the best way to get the rifle past the powers that be and into the hands of his men in the Air Force. With the ultimate fate of the rifle and round resting in the hands of the House Appropriations Committee, LeMay first started by determining how Representative George H. Mahon (D-TX), chairman of the House Appropriations Subcommittee on Defense felt about the issue. However, Mahon is less than supportive and LeMay receives the recommendation that the whole idea be dropped. Undaunted LeMay presses forward and a week later, once again brings up the idea of purchasing AR-15's in an OSD staff meeting.

In this meeting a new idea was brought forth, instead of trying to push the AR-15 and .223 Remington as a general issue weapon LeMay should instead procure it as a new weapon for special warfare. When presented with this idea Mahon reverses course and gives the idea of the Air Force buying the AR-15 for special warfare his blessing. The Air Staff submitted a new request for AR-15's and ammo, at a lower number than LeMay originally intended, however it was able to move forward. The request was to arm the Composite Air Strike Forces and other USAF forces in Southeast Asia. While the OSD helped to formulate this new plan for procuring the AR-15 for the Air Force, some in the OSD are now objecting to the approach.

It seemed that no matter how LeMay went about trying to get the AR-15 for the Air Force, someone, somewhere was going to voice some kind of objection.

However, in September of 1961 the reduced request for 8,500 AR-15 rifles and 8.5 million rounds of .223 Remington ammo reaches Deputy Secretary Gilpatric's desk and he quickly approves it the very same day.

Writing to Congress about the USAF's desire to purchase AR-15's, Deputy Secretary Gilpatric writes,

> *"Subsequent to Congressional action on the Defense Department budget, the Air Force introduced an urgent requirement for equipping a portion of its forces with the AR-15 Rifle.*
>
> *The Department of Defense has investigated thoroughly and concurs with the need for the rifle. The necessity for it has been personally justified to me by the Chief of Staff of the Air Force."*

ARPA Continues to Push for the AR-15

While General LeMay pushed for the Air Force to use the AR-15, ARPA continued to press for the AR-15 to be used by the South Vietnamese forces. In August of 1961 after demonstrating the rifle, they requested 4,300 AR-15 for testing by the ARVN, however this was denied because there were still many M2 Carbines in surplus inventory.

However, in September of 1961 things began to change. Chief of the Military Assistance Advisory Group in Vietnam LTG Lionel C. McGarr reissued the request and suggested that either 1,000, 2,500, or 4,300 rifles be purchased for the ARVN. This request came on the heels of the approval for the Air Force to use AR-15's for special warfare purposes. Again, LTG McGarr reiterated the small stature of the Vietnamese forces and proposed that the move to the more modern weapon would have political and psychological advantages. After DDR&E Brown and the OSD staff briefed Representative Mahon on the plan, Mahon promised his support for ARPA to acquire the rifles.

Figure 8 - VN Soldier with AR-15 and M1 Rifle published in the report, Field Test Report, AR-15 Armalite Rifle ARPA-AR-15. *The AR-15 was seen as "better" for the "smaller" VN Soldiers.*

Two Steps Forward One Step Back

Despite his promises to support the plans to acquire AR-15's for the USAF, Rep. Mahon only allowed seven minutes of discussion on the matter during the meeting of the House Appropriations Subcommittee on Defense and the funding is withheld. The Subcommittee wanted to see additional data on the AR-15's and was not willing to consider the matter again until January of 1962 when Congress would reconvene. Mahon writes Secretary of Defense Robert S. McNamara about these developments a few days after the request was denied by the Subcommittee.

By October of 1961 LeMay had been making so much noise about his desire to get the AR-15 in military hands that President John F. Kennedy himself allegedly told LeMay to *"Quit badgering the Army about the AR-15"*

Despite these setbacks, ARPA resubmitted their request for AR-15's along with the additional data that had been requested. Seeing which way the wind was blowing they cleverly noted that the requested rifles would had been evaluated in terms of their usefulness to ARVN units and their US advisors, not for the US military in general. The new data was gathered after limited testing in Saigon with 10, AR-15's that ARPA had previously purchased.

1961 Comes to a Close

In December of 1961 the Director of ARPA, Jack P. Runia sent a memo to McNamara titled *AR-15 Armalite Rifles for Test in Southeast Asia*, in this memo he recommended the approval of a request for 1,000 AR-15's, the necessary parts, and .223 Ammo needed for the rifles. McNamara approved the request and ARPA began purchasing the rifles and ammo. In January of 1962 ARPA would receive its first shipment of the 1,000 rifles that they had ordered and would start issuing them, with Project AGILE beginning operational testing of the AR-15's in February of 1962.

Meanwhile other developments took place that signaled the mixed feelings about the .223 Remington and the AR-15 at various levels in the military and US government.

General LeMay met with President Kennedy and made a personal appeal for the USAF to use the AR-15, but Kennedy shot down his proposal. Despite this the USAF moved to classify the .223 Remington as a developmental cartridge and a number of reports and fact sheets were issued. The US Army Chief of Staff's Office (OCSA) was given a fact sheet called *ArmaLite Rifle (AR-15)*, the BRL publishes a report called Effectiveness of Proposed Small Arms for Special and Guerilla Warfare, and finally Joint Chiefs of Staff (JCS) Chairman General Lemnitzer delivered a memo called *ArmaLite (AR-15)* as well.

Meanwhile McNamara began to reorganize the Army and while some like MG Frank S. Besson, Jr., the Chief of Transportation welcomed McNamara's plans, others such as Chief of Ordnance LTG Hinrichs, and the Chief Chemical Officer MG Marshall Stubbs opposed their organization plans.

Showing Off the AR-15

Since it was a live demonstration of the AR-15 that convinced LeMay of the usefulness of the AR-15 and the .223 Remington a live fire demonstration at Eglin Air Force Base is set up for Representative Mahon as well as Deputy Secretary Gilpatric. The demonstration, conducted in early 1962 was a success for both the rifle and LeMay who wanted to prove what he already knew about the weapon. That it was a viable alternative to the full power rifles that the US Military favored. Both, Mahon and Gilpatric walked away from the demonstration impressed by the new rifle and round. Snowballing off of the success of this demonstration another live fire test would be later arranged for President Kennedy to get him on board with LeMay's plans as well.

Meanwhile in January of 1962 Secretary of Defense McNamara was moving ahead with his planned restructuring of the military. It was at this time that Congress reconvened and Air Force Secretary Zuckert visited with Rep. Mahon and discussed the AR-15 rifle. In their discussion Mahon told Zuckert that unless the USAF was able to squeeze the AR-15 into the budget that the issue should not be brought up before Congress. Despite this the USAF classified the AR-15 as a standard weapon in its inventory marking the beginning of things to come for the AR-15 design and the, up to that point "experimental" .223 Remington.

In February of 1962 Hill AFB began yet another series of tests on the .223 Remington to determine if the round was able to meet the standards necessary to justify it being moved into more rigorous testing and development as a round for the USAF. After this testing, in March of 1962, the House Appropriations Committee was finally ready to approve LeMay's mounting requests for the USAF to purchase the AR-15 and the .223 Remington rounds needed for the rifles.

The .223 Remington Goes On Trial

Up to this point the .223 Remington was essentially a "wildcat". The Sporting Arms and Ammunition Manufacturers' Institute (SAAMI) had yet to receive the exact specifications for the round. So, finally, in the spring of 1962, Remington would submit the specifications of the .223 Remington to SAAMI for standardization. This move "legitimized" the round and would allow for other manufactures to have an exact specification sheet to work off of when producing ammo and firearms for the round.

On the heels of the standardization of the .223 Remington by SAAMI, *The American Rifleman* published an article in May of 1962about the AR-15. During this test, a limited test done during winter, *American Rifleman* claims that the .223 and the AR-15 are unreliable and inaccurate during cold weather. One of the issues cited in this article was the rifling twist of the barrel, which the author suggested should have been changed from 1:14" to 1:12". While ostensibly written for civilians this article would come into play during the USAF's attempts to move to the AR-15.

The same month the article in *American Rifleman* was published, the USAF resubmitted the request to purchase 8,500 AR-15's and 8.5 million rounds of .223 Remington. However, during the hearings, the subject of the *American Rifleman* article came up and became a point of contention during the deliberations as to whether or not to approve the procurement request. LeMay and the USAF went back to the much more rigorous testing that had been done previously on the AR-15 and pushed back against the conclusions reached by the *American Rifleman* article. Eventually they won out and in a few days the USAF received approval from the Appropriations Committee to purchase the desired rifles and ammo.

Seeing that the USAF was pushing hard for the AR-15 the US Navy began to look at the rifle itself and ordered 172 AR-15's for use by Navy SEAL Teams. In particular sources indicate that SEAL Team Two's Lt. Ray Boehm, though the open purchase system bought 136 rifles from Colt, using 66 for SEAL Team Two and the rest going to SEAL Team One.

The .223 Finally Gets Its Due

After languishing for so long as a maligned caliber, too small for "real" military use, the midpoint of 1962 saw the .223 Remington begin to receive real respect from military leaders. Perhaps it was finally the culmination of LeMay's pushing after what he had seen the .223 do back in July of 1960, maybe it was the use of the AR-15 by Navy SEAL's, maybe it was just that the .223 and the AR-15 was a design that was destined to succeed.

Whatever the final reason 1962 marked a substantial shift in the way that the AR-15 was seen in the eyes of testers and military leaders. While some previous tests had attempted to paint the .223 in a bad light, the truth was beginning to shine through. The SCHV concept that the .223 Remington was born of was an important shift in bullet design theory and the AR-15 was a design that could hold up to the rigors of combat despite what its naysayers thought.

In June of 1962 the AR-15 was demonstrated before the OSD staff with Systems Analyst Alain C. Enthoven and Comptroller Charles J. Hitch in attendance. The OSD staff was able to do side by side comparisons of not only the AR-15 but the M14 and the AK-47 as well. However, the real progress was made in July of 1962 with the report, *Test of ArmaLite Rifle, AR-15* from ARPA was released. The report concluded that the AR-15 was superior to the M2 Carbine and "better suited" to the Vietnamese soldiers. However, the report did not stop with the M2 Carbine. When comparing it to the M1918 BAR, the Thompson SMG, and the M1 Rifle the report came to the same conclusion. That the AR-15 was the superior weapon, calling it the "best all-around shoulder weapon". Of particular note was that the report listed no parts breakages in almost 80,000 rounds and only two parts had to be replaced. The few blemishes that the report did note were that the texture of the handguard should be changed to provide a better grip when wet and add a T-shaped handle to the cleaning rod.

To further solidify the effectiveness of the .223 round the report included graphic details of the .223 Remington's terminal effects, describing them as "explosive". In an almost about face from much of the previous testing the ARPA report recommended that the AR-15 be accepted as the basic weapon for all South Vietnamese forces. This was instead of the special warfare designation that the USAF had been forced to relegate it to.

The report from the ARPA prompts Comptroller Hitch, the Systems Analysis Directorate of the OSD to begin a study on procuring the rifle. ARPA's reports even make their way to the White House in a brief called AR-15 Armalite Rifle, Test Completion and Adoption for Vietnamese Armed Forces in August.

By August of 1962 the USAF had officially awarded Colt a contract to make 8,500 AR-15's for them and earmarked the funds for an additional 19,000 AR-15's in its 1963 budget. Following suit General Harkins, commander of MACV, requests that $4.6 million be added to the 1963 budget for the Military Assistance Program (MAP) so that Project AGILE can purchase 20,530 more AR-15's for the forces in Vietnam working under ARPA.

But It's Not NATO Standardized

While things were looking up for the AR-15 and the .223 Remington there were still a number of obstacles to overcome.

In September of 1962 General Harkins' request was denied by the Commander in Chief, Pacific Command (CINCPAC), Admiral Harry D. Felt. Felt did not view the AR-15 as an inferior rifle, however, it was monetary concerns that drove his decision. Felt argued that introducing a new rifle would not only be costly but detract from other projects that had a “higher priority”. The budgetary issue was brought to the forefront after Secretary McNamara reduced the 1963 MAP budget and Felt decided that it was more important to focus on the projects that had been designated as higher priority.

However, proponents of the AR-15 had new ammo to push the AR-15 with, in the form of a new report tilted, *A Comparison of AR-15 and M14 Rifles*. The report, requested by Comptroller Hitch, frequently called *The Hitch Report*, detailed the history of various rifle calibers from the .276 Pederson all the way up to the .223 Remington. However, the meat of *The Hitch Report* was its comparison of the AR-15, the M14, and the AK47. When compared the study found that, of the three rifles, the AR-15 and the .223 Remington was the best rifle and caliber combination. A squad armed with AR-15's could, potentially, inflict up to five times more casualties than a squad using M14's. Finally, the report praised the AR-15 for its durability, stating that it was more durable than the M14. However, AK fan boys like myself should take heart in that the AK-47 was judged to be superior to the M14 as well. With the introduction of the 5.45x39 the gap between the AR and the AK has closed quite a bit, yet that is a topic for another day.

The Hitch Report would make it all the way to President Kennedy. In October of 1962 Jerome Weisner would brief Kennedy on *The Hitch Report* making the President begin to take interest in the development of the AR-15 and the .223 Remington.

With *The Hitch Report* released the OCSA responded to a question raised by Secretary Vance. The memo, *Rifle Procurement Program*, attempted to take the AR-15 to task, citing a number of issues, including the testing done by *American Rifleman*. The memo stated that changing the rifling twist would likely decrease the terminal effectiveness of the rifle and that the M14 was already better at penetration and lethality. However, the bulk of the criticisms in the report revolved around the supply of the firearm. The OCSA did not want Colt to be the only source of rifles for the AR-15 and furthermore they claimed that it would have taken 27 months for the production of AR-15's to catch up with the rate of M14 production at 300,000 each year. They continued their complaints against the new design by saying that moving to the .223 Remington would go against NATO standardization directives and would introduce logistics and supply issues where none were currently. The memo was summed up in the following line,

"The AR-15 is not now acceptable for the Army for universal use."

Why Are We Not Using This?

In October of 1962 Secretary of Defense McNamara wrote to Secretary Vance asking him why the *"definitely inferior"* M14 was still being procured when the *"markedly superior"* AR-15 was on the market. Secretary Vance passes this question on to Army Chief of Staff General Earle G. Wheeler. Wheeler, lacking any immediate response, proceeded to have a series of tests ran to examine the tactical and technical merits of the three main competing platforms, the AR-15, the M14, and the AK-47 (which at that time was still probably being called something along the lines of "that damn commie gun").

The testing would be done in a number of locations at bases in the US, Europe, the Caribbean, as well as the Arctic. While the AR-15 and the .223 Remington had previously undergone many different tests, this would see the rifle and ammo tested in the widest variety of conditions yet.

It was about the same time that the Department of the Army reversed course on General Harkins previous request to purchase AR-15's for the MACV. Not only did they green light Harkins' request but they also recommended the suspension of the supply of M1 rifles and carbines to Vietnam under the MAP in 1963 so long as the AR-15's were approved. This prompts General Harkins to resubmit his request, however Admiral Felt decided that he would continue to put up roadblocks and denied the request. He justified this action by stating that the AR-15 had already been put up for consideration and turned down, ignoring, or ignorant of, the biased testing that had been done on the AR-15.

Yet more biased testing was to come.

A memorandum stemming from a meeting of members of the AMC, Aberdeen's BRL and D&PS, TECOM, and the USAIB done at AMC's headquarters stated that,

"The US Army Infantry Board will conduct only those tests that will reflect adversely on the AR-15..."

While others had reviewed the AR-15 and the .223 Remington with an unbiased eye and found it to be a worthy replacement to the current rifles that the US Military was using, it seemed that the Infantry Board was very much still in the mindset that had been seen from Dr. Carten, the AR-15 was not to be given a fair shake.

Biased or no the testing would go on, so 300 AR-15's and 600,000 rounds of .223 ammo was purchased. However, by November this would be increased to 338 under the approval of LTG Besson.

Procurement and Experimentation

With the USAF at that time moving forward with its purchase of AR-15's large amounts of ammo were going to be needed. This prompted the Ogden Air Material Area, in October of 1962, to send a litter titled, *Production of Cartridge, 5.64 mm, H.V. Ball* to Picatinny Arsenal along with a partial technical data package. The letter documents the USAF's full ammunition requirements at that time. While there was ammunition that had already been ordered for the USAF's incoming AR-15's there was still more ammunition that was needed to be purchased to keep up with the projected demands. The technical data package was sent to Picatinny Arsenal to see if they had any interested in helping meet these demands.

At first glance the title of the letter is somewhat confusing. If we are talking about 5.56mm ammo why is it being referred to here as 5.64mm? The answer lies in the conversion of 5.64mm to .222". This was done to reference the old .222 Remington Special name.

In November of 1962 representatives from the USAF met at Frankford Arsenal to discuss the creation of an initial technical data package for the Air Force purchase of .223 Remington cartridges from the commercial market. Meanwhile the OSD at this time submitted a budget reprogramming action to purchase 19 million rounds of .223 Remington ammo for the military.

While at this time the .223 Remington was solidified in its specifications, that was not to say that experimentation with the cartridge was not continuing. As we've talked about in previous sections the SPIW program was developed around the same time as the initial inception of the SCHV program that would help to create the .223 Remington.

One of the ideas that came out of the SPIW program was the idea of Duplex loads. These loads, as I've previously touched on use two bullets in the same case instead of just one. It was in November of 1962 that Frankford Arsenal created a small number of duplex loads for the .223 Remington to test. While they were created in limited numbers, with some sources indicating that less than twenty of these duplex .223 Remington loads were made, they were a met with limited success. As were many of the SPIW derived projects. However, one does not have to look very far when trying to figure out why these duplex loads didn't make it very far beyond the testing phase.

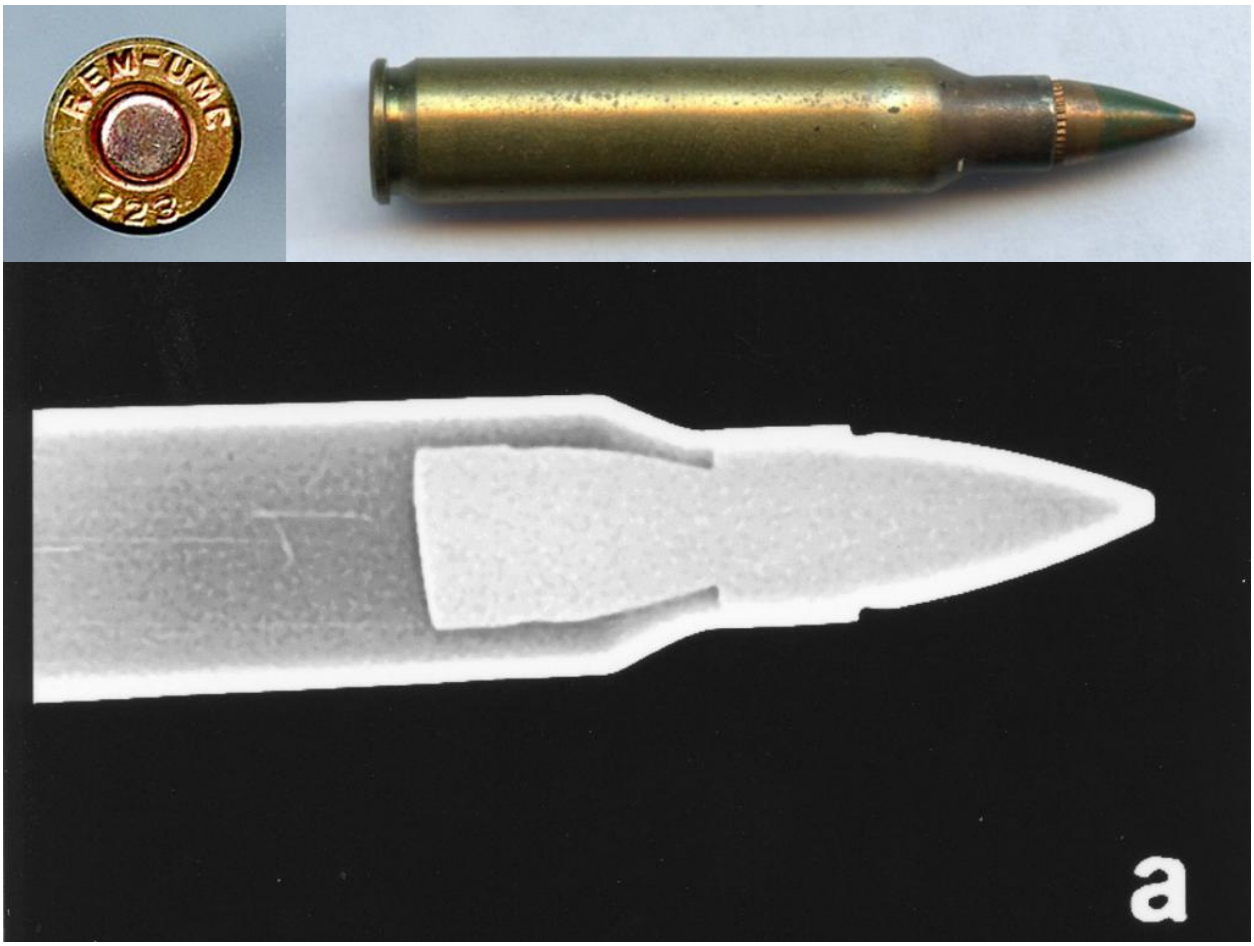


Figure 9/10 - While externally the duplex .233 rounds looked similar to a standard round, X-Rays show the dual slug design.

They were loaded with two bullets, a 33 grain bullet at the case mouth, and a 34 grain slug behind that. Moving at an alleged muzzle velocity of 2,760 feet per second they would have each hit with a force of 558 and 575 foot pounds of force respectively. With such light bullets and reduced muzzle velocity from having to reduce the charge to make room for the extra bullet. The impact velocity also suffered because of this, so it's not hard to see why these rounds quickly failed.

While the execution of these rounds was doomed to failure, the core idea remained viable, getting more rounds to the target. What would eventually replace the idea of duplex rounds would be the burst mechanism that, in various incarnations has been included in a number of military rifles. Below you can see an image from a video demonstrating how Eugene Stoner's 3-Round Burst Mechanism works, created by StealthTheUnknown. Note the three notches that were used to control the burst fire while still using the standard, full auto sear.

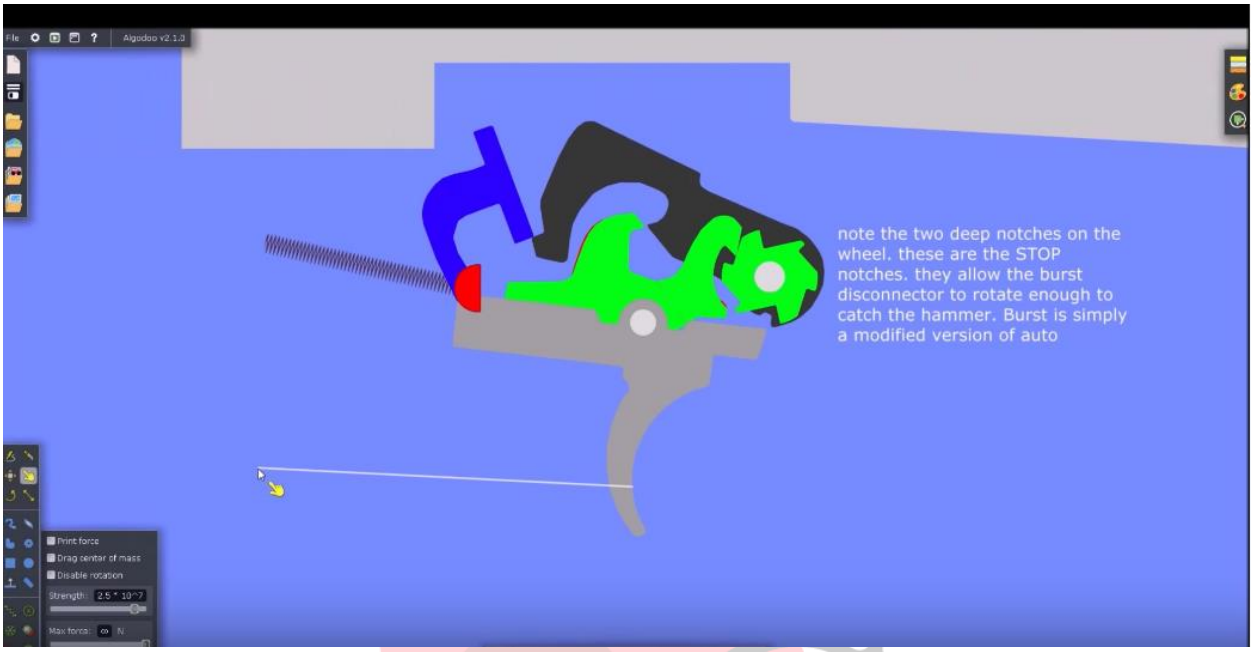


Figure 10 - The 3-Round burst mode was a simple yet ingenious solution to the problem that the duplex round concept sought to solve.

With burst fire like this weapons designers were able to achieve all of the benefits that they were looking for from the duplex concept with none of the drawbacks. Civilian shooters today are able to have similar capabilities from their rifles with new trigger systems such as the Franklin Armory Binary Trigger or the Fostech Echo Trigger.

However back to the history.

The Month of Reports

December of 1962 saw a number of reports be released on the AR-15 and the various testing that was being done on the rifle.

Aberdeen's D&PS issued the report, *Comparative Evaluation of AR-15 and M14 Rifles*, in the report the AR-15 was shown to fire groups that were less than half of what the M14 produced when used in full auto. Yet the report once again raised the specter of water in the bore as a potential issue for the rifle. Meanwhile the US Army Arctic Test Board put out their own report, *Comparative Evaluation of AR-15, M14, and AK-47 rifles and M79 Grenade Launcher*.

Meanwhile the CDC's Infantry Combat Developments Agency filed its own report, *Rifle Evaluation Study*. The study aimed to figure out what the desirable characteristics of a rifle were in a military role. Comparing the M14, M14 (USAIB), AR-15, AK-47, as well as the SPIW rifle that was still in development the study looked at each rifle and assessed how well it met these military requirements. While the study concluded that the number of malfunctions exhibited by the AR-15 made it a suitable rifle for use by combat units the report ended up suggesting that the SPIW program should be given more resources to speed up its development. The report went on to suggest that full or partial adoption of either the AK-47 or the AR-15 would not be wise as it *"did not meet the requirements for an infantry squad weapon"*.

Yet the CDC produced its own report, also called *Rifle Evaluation Study* which came to a somewhat different conclusion about the AR-15,

> *"The AR-15 represents a marked improvement over the M14 rifle primarily because of lower weapon and ammunition weight. …*
>
> *However it has two characteristics which would have to be corrected before the AR-15 were [to be] considered an acceptable military rifle in any role: its poor rifle-ammunition reliability and its poor night firing characteristics.*
>
> *…*
>
> *If the basic decision were to be made now, without reference to the impact resulting from the decisions already made, in my opinion the preferable rifle for world-wide usage would be the AR-15. Even in these circumstances, however, I would, not standardize the AR-15 without an expedited improvement program to correct the unreliability of the rifle-ammunition combination and the poor night firing qualities. Both appear correctable."*

While the report did not recommend that the AR-15 be used for mass deployment it did recommend that AR-15's be given to Air Assault Units, then Airborne Units, and finally Special Forces Units. Much like the Infantry Combat Developments Agency's report it also recommended that the SPIW program be looked at as a potential replacement in the long term for the M14 and the AR-15. However, history would prove that the SPIW program would eventually fail despite so many attempts a making it work.

Along with these reports a slew of other reports were filed in December of 1962. *Comparative Evaluation of Rifles by the CDCEC*, *Rifle Evaluation and Comparative Evaluation of AR-15 (Armalite) and M14 Rifles* by the USAIB, *Evaluation Exercise 3 Dec -20 Dec 62'* by The US Army Infantry School (USAIS), *Comparative Evaluation AR-15 and M14 Rifles* by the CDC, *Comparative Evaluation of U.S. Army Rifle 7.62mm, M14; Armalite Rifle Caliber .223, AR-15; Soviet Assault Rifle AK-47by TECOM*, and *Studies of Rifle Effectiveness* by Laurence F. Moore of the Army Research Office.

With all of these report coming in Secretary Vance ordered the US Army Inspector General MG Edward H. McDaniel to conduct a review of how the Army was conducting its comparative rifle testing. Apparently the reviews needed reviewing, and in doing so it became apparent that if such a move had been done sooner than the AR-15 might have been adopted sooner.

The Fix Is in: The Bias Against The AR-15 Is Revealed

January of 1963 saw a new report being filed by the Army's Deputy Chief of Staff for Military Operations (DCSOPS) LTG Theodore W. Parker titled *Rifle Evaluation: A Comparative Evaluation of the U.S. Army Rifle M14, the Armalite AR-15, and the Soviet Rifle AK-47.* The blatantly biased report concluded that not only the AR-15 was a less reliable rifle, but it also had poor handling and night firing characteristics when compared to the M14. The report concluded by saying that,

"[O]nly the M14 is acceptable for general use in the U.S. Army."

Parker went on to suggest that the struggling SPIW project be favored as the replacement for the M14 instead of the AR-15. As history would show this would prove to be the exact opposite of what would happen.

General Wheeler took this and ran with it, telling Secretary Vance, in a memo called *Comparative Evaluation of the M14, AR-15, and Soviet AK-47 Rifles*,

"The AR-15 is not now acceptable for the Army for universal use"

He bolstered this position by reporting a number of issues with the rifle and ammo. First the M14 was superior to the .223 Remington at ranges beyond 400 meters, ignoring the fact that studies had already proven that engagements rarely take place beyond 300 meters. Second, he attempted to assert that the AR-15 was not as rugged or reliable as the M14, pointing to reports claiming that the AR-15 had a rate of failure eight times higher than the M14's it was compared to. Third, he pointed to issues at Aberdeen and Edgewood Arsenal in repeating the effectiveness of the rounds that the ARPA reports from Vietnam were claiming. Finally, he reiterated the issue of NATO Standardization and how adopting a non NATO standard cartridge like the .223 Remington would fly in the face of these efforts.

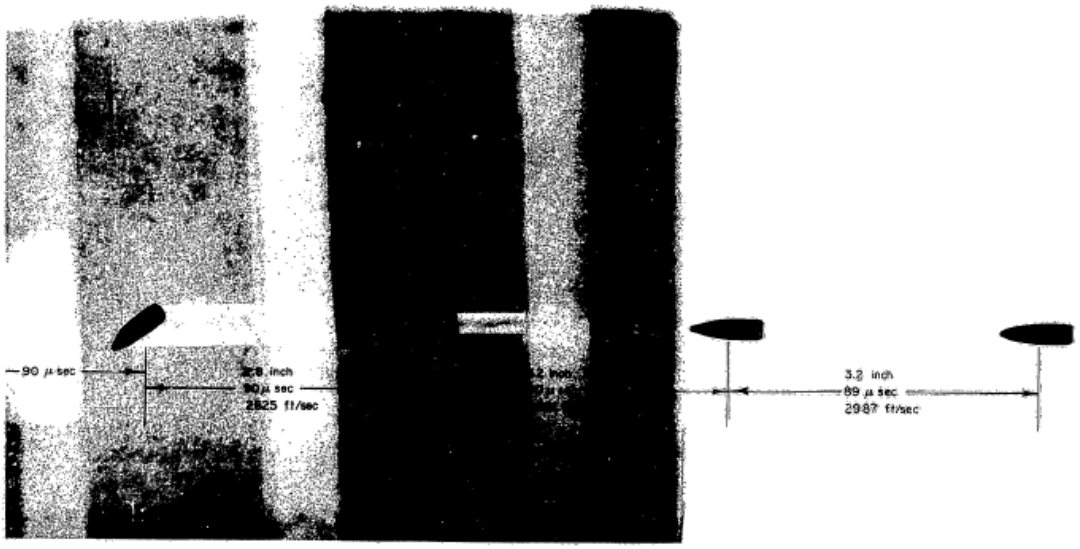


Fig. 9: Typical Flash X-Ray Showing Bullet During Impact in Gelatin Block.

Figure 11 - X-Ray from testing published in the report, Exterior Ballistics of the AR-15 Rifle*. Published in February of 1963*

However, issues were coming to light with the testing done on the AR-15 rifles. While there were legitimate issues with the prototypes and early production firearms and ammo Inspector General McDaniel found glairing issues with the test protocols being used to compare the AR-15 and the M14. All of this came out in a March 1963 report from the Inspector General, comprising six volumes, called *IG Rifle Evaluation.*

In short, the fix was in.

Allegations emerged of handpicked lots of ammo being used to compare the rushed .223 Remington ammo to in order to create a discrepancy of accuracy and reliability between the two rifles. However, there was more. For comparison testing the Infantry Board brought out not only squad automatic versions of the M14 such as the M14(USAIB) but also match grade prototype rifles that would never have been fielded to normal solders. At Aberdeen's BRL a M14 was even switched out when it showed signs that it was beginning to wear out and become inaccurate. Yet there were even more issues and cheating when it came to testing the AR-15.

The AR-15 found itself judged against requirements used on the M1 rifle, which included aimed fire at distances of 800 meters. When using this standard, the AR-15's were shot in full auto, however the M14's were left in semi-auto. There was even attempts to deliberately make the AR-15 fail certain tests. The Office of the Chief of Research and Development went so far as to phone TECOM, suggesting to Aberdeen's D&PS that they utilize a specific form of rain testing in order to keep the issue of water in the barrels alive, even as Armalite made attempts to correct this problem.

In general, the M14's issues were downplayed in reports, while the AR-15's issues were brought out front and center, to the point where even when testing results showed that the AR-15 was the better rifle, the final report would state otherwise.

All of this came to a head when the attendees of the October 1962 planning conference were questioned. All denied, under oath, that there were any attempts made to sabotage the test results against the AR-15. Even the Army Colonel who had given the order that *"The US Army Infantry Board will conduct only those tests that will reflect adversely on the AR-15"* denied that what he had said meant that the testing was to be rigged, instead blaming the whole thing on "administrative error".

Despite the bias that was now on display for all to see there were still issues with the rifles and the ammo being made for them. One of the largest, actual, problems encountered was the .223 rounds blowing out primers from the cases when firing. However, these were correctable issues and not the massive, inherent to the design, problems that the authors of many of the negative reports were attempting to have people believe.

Making The .223 Remington A Military Caliber

With many of the issues with the AR-15 now being proven as either a fabrication or correctable issues, the Army approved a "one time" order of 85,000 rifles with the intent on eventually replacing them with whatever came out of the SPIW program. However, there was still much work to do on making the .223 Remington into a true military caliber. While early testing had shown its potential, work was still needed to bring it up to snuff for regular use.

Below is a table outlining the expected use of the 85,000 rifle order created by the ODCSLOG.

Use	Air Assault Units	Special forces Units	Airborne Units	Total
Initial Issue	13,000	6,665	34,352	54,017
Maintenance Reserve	630	333	1,718	2,701
Combat Support (Six Months)	5,070	2,598	13,386	21,054
Pipeline (Two Months)	1,690	366	4,462	7,018
Total	20,410	10,462	53,913	84,790

To this end a meeting was held at the Lake City Army Ammunition Plant with representatives from both the Army as well as the USAF in attendance. The goal was to develop drawings and specifications for use when mass producing the needed .223 ammunition. Since the USAF had had far more experience with the round they brought fourth four main issues with the ammo that they had been using.

First was the issue of key holing and tumbling when the round was in flight. This was adversely affecting accuracy and while the idea was to make a bullet could tumble, it was not supposed to until after it hit the target. Next was the issue of the rifling of the barrel stripping the jacket before it even left the barrel and hit the target. This was also adversely affecting the performance of the round when hitting the target, leading to early disintegration of the round. Next was the packaging as well as light powder charges, again affecting the performance of the round.

All of these issues needed to be addressed before the .223 Remington could be as reliable at the other rounds that the Army was using at the time and MUCOM stressed the importance of standardizing both the ammunition and the rifle as any changes to one might requires changes to the other.

In January of 1963 Aberdeen's Human Engineering Laboratory (HEL) was hard at work with two different projects testing the AR-15 and the .223 ammo. First was the paper, *Measurement of Peak Sound-Pressure Levels Developed by AR-15 and M14 Rifle Bullets in Flight*, testing the sound levels produced by the bullets as they broke the sonic barrier. Next was the *Summary of Studies Conducted with the AR-15,* which looked at a number of different methods of trying to mitigate recoil from the AR-15 when used with full auto fire. While they tested various muzzle breaks and other changes to the stock, in the end they were not able to find any solution that could be universally applied to all troops in all shooting positions.

The Marine Corps Says No, For Now

In February of 1963 USMC Commandant General David M. Shoup was looking to conduct a comparative evaluation of the AR-15 to explore the use of the rifle by the Marine Corps. To oversee this testing Shoup appointed BG Lewis W. Walt to be the board chairman and review the findings. Eventually Walt's findings were looked at by an informal board of officers at the HQMC. They concluded that while the M14 and the AR-15 were equal in terms of reliability and combat effectiveness the AR-15 had and edge when it came to handling as well as training time required. With the lower weight in both the rifle and the .223 Remington ammo the AR-15 came out as the top choice for the USMC. However, there was a catch. Since at that time there was not .223 chambered machine gun available to replace the M60 in the Marine Corps armories the USMC elected, at that time to pass on adopting the AR-15, stating that,

> *"Until a .223 machinegun can be developed, no .223 rifle should be adopted by the USMC."*

Despite the Marine Corps passing on the AR-15 the USAF and the Army found they still had issues to work out in regards to the ammo being used.

Primer Problems

Hot on the heels of the JCS recommending procurement of the AR-15 in a memo called *Rifle Procurement Plan*, which was approved just a day later by McNamara in a memo with the same name. LTG Besson was writing to MG Lynde who was the director of WECOM and MUCOM about issues that had been identified with the ammo. Not only were the primers raised and uneven but there were also many instances of inaccurate primer staking. Additionally, the cases were not being crimped properly, leading to the bullets being loose or simply falling out of the brass. Issues with chamber pressures were cropping up as well, as they were either too high or the pressure curves were wrong, causing the rifles to fire sluggishly. Finally, the cartridge and the chamber dimensions were also not matching up, further underscoring the need for standardizing the specifications of the round.

This lead to the OSD ordering the military services to draft a set of requirements for all branches of the military that was going to be using the AR-15, in March of 1963. Since a high number of changes would cause an increase in cost to implement part of the directive was to keep all necessary changes to a minimum to keep the costs under control. A bit of a shock to us today who are used to seeing government largesse. However, the issue of modifying the AR-15 would come up again when Springfield Armory was requested to test six rifles to not only provide an unbiased look at any problems with the AR-15 but also look at changes to the magazine and feeding system. Changes to the muzzle break as well as the possibility of adding a forward assist were also looked at in addition to possibly adding a grenade launcher. Finally, Frankford Arsenal was also ordered to look at the compatibility between the chamber and the ammunition. Again these changes were also looked at with a mind to keeping the costs down oddly enough.

I Heard You Like Committees

Since there were a number of different branches to organize and bring together on creating a unified specification for the .223 Remington LTG Besson created the "Office of Project Manager for AR-15 Rifle Activities". Appointed to the positon was LTC Harold W. Yount, however his task was immediately complicated by a meeting at the office of the Assistant Secretary of the Army (Installations & Logistics) - ASA(I&L). Paul R. Ignatius, who was the ASA(I&L) as well as Army and USAF representatives were fighting over a number of changes to the AR-15, including adding a forward assist and changes to the twist rate of the rifling.

One of LTC Yount's first acts in his new position was to quickly procure 600,000 rounds of .223 ammo for use in the Army's 338 AR-15's. This leads to Frankford Arsenal being assigned to oversee the procurement of the ammo. William C. Davis headed up the efforts as "AR-15 Project Director" and he began to create a technical data package for use. Meanwhile a new report comes out on the interchangeability of various parts of the AR-15 rifles being produced called, *Engineering Test on Interchangeability of Rifles, Caliber .223, AR-15.*

As March came to a close the Technical Coordinating Committee or TCC was established by MG Lynde. Comprising its members were LTC Yount, representatives from all service branches, as well as William C. Davis, Charles F. Packard of Springfield Armory, and members of the OSD. Each with their own ludicrously long title. Deputy Assistant Secretary for Weapons Acquisition and Industrial Readiness, James N. Davis and program analyst from the Directorate of Major Items, Materiel, Installations & Logistics, Frank J. Vee. Technically LTC Yount was the chair of the committee however the OSD members retained absolute veto power over any changes made by the TCC.

They all end up clashing over a number of changes to the AR-15, again a forward assist and the rifling twist come up as points of contention. Yet these are not all of the changes that were debated, over 130 different modifications were discussed, including chrome plating the bore and chamber, but the Army's suggestion was shot down by the OSD. Despite all of this at the end of the day a memo comes out from the OASA(I&L) called *Changes in the AR-15 Rifle*.

That same month McNamara had sent out a memorandum to Secretary Vance. Called *AR-15 Ammunition and Rifle*, it made the Department of the Army the source for all purchase requests and procurements of .223 Remington ammo as well as AR-15 rifles and parts for all DOD users. An almost odd choice given that it was the USAF and General LeMay who had spearheaded the use of the AR-15 in the first place.

Powder Problems

With the start of April, 1963 came a new memo from Secretary Vance, called, *Standardization and Procurement of the AR-15 Rifle* the memo to McNamara helped to outline some of the Army's plans for the AR-15 as well as .223 Remington Ammo. The plans include allowing the USAF to complete their 19,000 rifle order, along with another 19,000 for next year and another 85,000 rifles for the Army in 1964 as well. However, the USAF was to be limited to 33,500 more rifles to bring the number up to the 80,000 that the USAF was projecting for its needs. Meanwhile the MACV's request for 20,000 AR-15's was ignored. With these numbers also comes a number of other recommendations. First that Colt should remain the only AR-15 supplier for the US Military, as it would require less red tape and lower costs.

Vance also went into the proposed changes to the AR at that time. A forward assist, changes to the magazine, and changes to the chamber throat to ease extraction were all on the table. However, if one change was to be implemented then all of them should be. Additional changes such as changes to the sight protectors (to improve sighting in low light), rifle twist rate, and changes to the chamber to solve the issue of ammunition compatibility were also discussed.

With the chamber and the ammo dimensions not always the same, issues were cropping up and the first suggestion was to look at changing the chamber. If this ended up affecting the ballistics of the .223, it was decided that only then should changes to the ammo be looked at. Finally, Vance's memo stated that .223 ammo would be bought from commercial sources at competitive prices. Again a bit of a departure from our modern way of thinking.

While the USAF was signing a contract for another 19,000 rifles issues were cropping up with the powder being used. Specifically, the IMR 4475 that was being used in the .223 Remington loads was not getting the necessary 3,300 feet per second velocity that they were expecting without going over the maximum chamber pressures. This was an opportunity for Winchester to once again try to shoehorn its way into the proceedings and push their new .224E5 cartridge. The .224E5 was a derivative of the .224E4 and was in the same loose "family" of experimental Winchester rounds, specifically the .224E1 and .224E2 that had already competed against, what would become the .223 Remington and lost. The .224E5 and the .224E4 were both based off of a shortened .25 Remington case and had a rebated rim. The idea was to offer this new caliber as a potential contender to the .223 but it was not to be. The military was already hard at work trying to work out the bugs in production of one round and it made little sense to start over from scratch on a new one.

Yet, the issues with the .223 Remington production continued to persist. Both the USAF and the USMC were experiencing slam fires. While this was at first blamed on primers not set deep enough into the primer pocket this explanation was dismissed and other explanations were examined.

Davis, at Frankford Arsenal issued a report, *First Memo Report on AR-15 Rifle Ammunition Systems: Investigation of Firing Pin Energy and Primer Sensitivity*. In this report he found that a AR-15 firing pin, without the hammer striking it, would exert between four to fourteen inch-ounces of force. This was the likely cause of the slam fire issues.

When producing the .223 ammo Frankford had used advice from Remington, stating that the sensitivity of the primers should be the same as the .30 Carbine primers already in use, between six to thirty-six inch-ounces for their "None Fire / All Fire" tolerances. With this new information on how hard the firing pin alone was striking the primer Davis recommended that the lower limit of sensitivity of the primers be changed to at least fifteen inch-ounces.

As April closed two more publications of note arise, first Aberdeen's D&PS released *Evaluation Test of the Rate of Rifling Twist in Rifle, Caliber .223, AR-15,* testing the accuracy of various twist rates. Second, BG Anderson sends out his memo *Appointment of AR-15 Technical Committee.*

Delayed Production

Compared to other months, May of 1963 was relatively quiet with only a solitary letter being issued by MUCOM on the *Production of 5.64 mm (caliber .223) Ball Ammunition for the AR-15 Rifle,* however June brought new problems to the production of both the AR-15 as well as the .223 Remington ammo.

Writing in a memo called, *Action on Rifle Production Plan* McNamara complained that the TCC was failing to make any real progress and this is, in turn, causing delays in the production of both rifle and ammo. With so many proposed changes flying around it was not difficult to see why there might be an issue, and to alleviate this McNamara recommends that if any changes are going to be made, they be done with the supervision of both Colt and Eugene Stoner.

Furthermore, McNamara takes up the issue of slam firing and suggests that it's neither improperly set or too sensitive primers but an issue with loading a single round from the ejection port and not from a magazine. With this he attempts to put to bed any notion of changes to primer sensitivity or modification of the firing pin.

Meanwhile other issues are cropping up at Frankford Arsenal. Despite creating a gauge to measure the pressure at the gas port, the arsenal's engineers have no idea what the range of pressure at the gas port should be, further complicating matters.

With all of this going on a meeting at the Hill AFB was held to facilitate the transfer of the USAF's technical data to Frankford Arsenal. Oddly it goes under the name "5.64mm" instead of the metric designation of 5.56 that we are used to seeing today. However, this is not the only technical data flying around. The US Army finishes its Technical Data Package (TDP) for delivery to Frankford Arsenal, this time under the name "5.56mm".

Bullet Time

The issue of chamber dimensions kept cropping up, this time William C. Davis submitted a new report on behalf of Frankford Arsenal. Called, *Investigation of Test-Weapon Chamber Configuration*, the report finds that Remington's own specifications for the cartridge dimensions did not match what Colt was producing. Yet the issues kept coming.

This time the memo, *Third Memo Report on AR-15 Rifle-Ammunition System: Investigation of Bullet Configuration,* finds that unbeknownst to the military Remington had seen fit to modify the design of the .223 Remington bullet. Switching from a 7 caliber ogive to a less aerodynamic 5.5 caliber ogive Remington claimed that the new design was easier for them to create en masse.

When looking at this change Davis finds fault with it, citing that if Remington was to switch back to the original design not only they could reduce the chamber pressure by about 3,000 to 4,000 psi, but they could gain higher impact velocities at ranges beyond 100 meters. The only caveat to this was that the muzzle velocity would have to be slightly scaled back to 3,150 feet per second. The only thing that needed to be worked out still was the proper twist rate for the Sierra bullet and make sure that the terminal ballistics were still up to snuff.

When bringing his findings to the TCC Davis' findings are also put up with a BRL report on their own research into what barrel twist rate to use, with both 1:12" and 1:14" twist rates both being looked at in conjunction with the Remington bullet design. However, the Sierra bullet was not looked at in the BRL's report and LTC Yount asked the BRL to include the round in its future testing. However, there was a bigger problem than just the bullet design and twist rate. Colt came back to the TCC with some bad news. In order to fix the slam firing issue a major redesign of the AR-15 would have to be undertaken to address it.

Forward Non-Assist

While the bad news was coming in from Colt about the slam firing issue, Springfield made progress towards finalizing two design changes for the AR-15. First, were several designs for a flash suppressor and muzzle brake, with two combination flash hider and muzzle brake designs being competed. Second, seven different designs for a forward assist were worked on and eventually two would be created for testing. Despite this progress the TCC was encountering issues.

The TCC's progress was being stalled by disagreements over the inclusion of the forward assist, with the USAF flat out denying that it was necessary and the Army demanding that it be included. While the USAF and the Army fought over the forward assist the USMC remained neutral on the topic and was willing to accept it either being left out or added into the AR's design. To attempt to help settle the debate Eugene Stoner had been brought on to advise on the matter. Of the various competing designs from both Colt and Springfield Armory, Stoner favored the initial concept from Springfield as it offered the fewest additions to the design. However, the Army disagreed with the rifle's primary designer and wanted a design from Colt's Foster E. Sturtevant. Sturtevant's design included a plunger that would interface with teeth on the side of the bolt and could be struck by hand to send the bolt fully into battery. The matter was far from settled however.

The AR-15 Conference

July of 1963 saw the USAF contract Remington for 19 million rounds of .223 ammo for their AR-15's. Meanwhile under the direction of WECOM Deputy Commanding General BG Roland B. Anderson, LTC Yount works on purchasing the planned 85,000 AR-15's for the US Army. However, there are a few things that LTC Yount needed to work on. First was getting the production rights, second, was getting the Technical Data Package for the rifle, and third, was to negotiate out the long standing royalty that Fairchild still had on spare parts for the rifle.

With this going on in the background the so called "AR-15 Conference" began at Springfield Armory. Comprising members of WECOM, Springfield Armory, the USAF, the US Navy, and the USMC performance specifications were discussed at the conference. These specifications included headspace requirements, proof testing, firing pin indent, trigger pull weights, and more. It was decided that acceptable malfunction rates and broken parts for the AR-15 going forward would be more or less the same as those approved for the USAF's previous contract AF-33-(675)-10871. With these guidelines in place the final order, coming down from Secretary McNamara, was that acceptance testing for the AR-15 could not be harsher than what had been required for the M14 in order to prevent any more biased testing, like what had been done previously. All of this was documented in a Springfield Armory Purchas Description *(SAPD) 253: Acceptance Testing Specification for Rifle, AR-15.*

After the conference the issue of a forward assist came up once again with Secretary Vance telling McNamara that,

> *"[A] modification of the AR-15 rifle (the bolt closure device) is absolutely essential to improve its reliability to an acceptable level in accordance with Army combat requirements"*

Since the TCC was taking so long to acquire everything Deputy Secretary of Defense Gilpatric decided that not only quality control but parts interchangeability and acceptance standards should be relaxed in order to speed up the process of actually getting the rifles issued. His memo, *Action on AR-15 Rifle Modifications,* detailed this and also directed that the OASD(I&L) would work on any further request from the branches of the military on changes to the rifle.

July also saw the formalization of a change in standard twist rate for the AR-15. McNamara, after looking at the data coming in from the testing, approved the change from a 1:14" to a 1:12" twist rate. Meanwhile LTC Yount was reporting on the efforts to procure the necessary .223 ammo and sent MUCOM a letter called, *Procurement Program, 5.56mm Ammunition for AR-15 Rifles.*

While this was going on the HEL was still testing how well soldiers with AR-15's could perform. In the study, *Ability of Shooters to Gauge Two-Round Bursts From the AR-15 Rifle*, written by J.P. Torre, Jr. HEL wanted to see just how controllable the fully automatic fire from an AR-15 could be and tested troops' ability to fire just two rounds at a time with a single trigger pull. Testing three different firing conditions they found that they could expect the troops to be able to fire just two rounds with a single trigger pull about 75% of the time.

Primer Sensitivity Training

In August of 1963 WECOM put out a Request for Quotation (RFQ). This provided for a complete Technical Data Package for the AR-15 to be created, it also served to cut out the royalty that was being paid to Fairchild for spare parts. The RFQ moved forward, along with quotes for spare parts, and securing the manufacturing rights for additional sources to make rifles for the military.

However, the issue of primer sensitivity was still hanging around. With Colt having said that a redesign would be the only solution Frankford Arsenal went back and reexamined the issue. The table below shows the results when they tested various primer sensitivities.

None Fire - All Fire Limits	Risk of Slam Fire
16 to 64 inch ounces	1 in 10 million rounds
12 to 60 inch ounces	1 in 160 rounds
12 to 48 inch ounces	1 in 6,400 rounds
14 to 56 inch ounces	1 in 11,000 rounds

While the sensitivity limit for 7.62mm NATO was set at 12 to 60 inch ounces the TCC decided that the 12 to 48-inch ounce limit was an acceptable range of sensitivity to address the slam fire issue while keeping the rounds reliable. However, ACSFOR LTG Ben Harrell voiced his objection to this and felt that a different sensitivity should be used.

The TCC also accepted McNamara's approval of the new 1:12" twist rate for the rifles.

Yet Lackland AFB is still having issues with accidental discharges and of four lots of the Remington .223 ammo they were given they were having an accidental discharge rate anywhere from 1 in 740 to 1 in 6,000. But procurement of new ammo was still needed so LTC Yount gave MUCOM the go ahead to acquire 1 million rounds of 5.56mm ball ammo at a cost of $75,000. That broke down to about eight cents around. But this was far from enough and the funds for 27 million more rounds were requested and granted just a week later.

Standardizing the M193

The end of August saw the first of several reports on testing improvements to the AR-15. The one published at the end of August was called, *Product Improvement Test of Armalite AR-15 Rifle (Test of Bolt Assist Device),* and was published by the USAIB.

September 1963 was when the Army officially adopted the AR-15 in a "limited standard" capacity under the designation, XM16E1. However, there was still resistance to the AR-15 looming and the Office of the Assistant Chief of Staff for Force Development (OACSFOR) sent a memo to McNamara called, *Discussion of Alternatives Open to the Army in Regard to the AR-15 Rifle.* The essence of the memo was that OACSFOR did not think that the AR-15 was a suitable firearm for the Army calling out the issues of slam fire and the lack of a bolt closure device.

Meanwhile the Cartridge, 5.56mm Ball, M193 was being type classified by the OSD, yet the TCC objected to the specifications. The M193 used the Remington bullet design as well as the IMR 4475 powder. Both of which had been shown to have issues with aerodynamics and meeting the velocity requirements respectively. The required muzzle velocity was to be 3,250 feet per second and multiple companies were all asked to place bids on producing the round. Remington, Olin, as well as Federal all decline to offer bids. Remington suggested that the case specifications should be changed as well as increasing the chamber pressure to between 52,000 psi to 53,000 psi. However Federal Cartridge put forth the suggestion that it should be even higher at 54,000 psi.

Meeting at Frankford Arsenal, employees from both Remington and Olin-Winchester met to talk about the primer sensitivity limits and the possibility of bringing them down. Both companies lobbied for a 12 to 60-inch ounce range but Frankford Arsenal insists on a 12 to 48-inch ounce range. Remington insists that if these standards were adhered to, half of the primer lots will be unacceptable. Olin-Winchester fears that this number would be worse with between 66% to 90% of primer lots expected to be rejected. Frankford Arsenal later sends out a letter called, *Engineering Program for 5.56mm (AR-15) Ammunition.*

Meanwhile the demand for .223 Remington ammo continues to increase as 104 million more rounds were put on order.

The debate over primer sensitivity continued and LTC Yount was told by the Army Staff that the current sensitivity of the primers poses far too high a risk of slam fires. The Army staff pushes for a limit of 16 to 64 inch ounces however LTG Besson, echoes what Colt had said, either the primer sensitivity needed to be changed or the AR-15 would have to be redesigned. Colt came back to the table with two new modifications for testing. One was a linear spring device and the other was a cam pin friction device to decrease the impact force of the pin when the bolt closed.

Do We Really Need It?

The USAF and the Army Staff put out papers on their opinion of adding a forward assist. In short, the Army wanted it, the USAF didn't. USAF BG Harry E. Goldsworthy, Director of Production from the Office of the Deputy Chief of Staff - Systems and Logistics said that both the competing designs from Colt and Springfield will not work. LTG Wallace M. Greene, Jr., who was the USMC Chief of Staff, favored the Colt design but again echoed the USMC's standing positon that adding in a forward assist was not really necessary.

Yet there were legal messes brewing over the AR-15 and the various companies that had been involved in bringing it to the military. Colt's lawyer, H. H. Owen told the US Government that if they wanted to obtain the rights to a Technical Data Package for the AR-15, they could not do it through Colt. The US Government wanted the rights to it so that they could find secondary sources for the rifle, however with the standing agreement between Colt and Fairchild, Colt was not in a position to give the government what they wanted.

This leads to Colt ultimately rejecting the Army's RFQ that had been made back in August. Colt President David Scott rejected the RFQ because of the request for a Technical Data Package and manufacturing rights. He went on to say that unless the order went over 500,000 rifles they would not consider helping with obtaining either the TDP or the manufacturing rights.

The Colt Starts Bucking

With the legal issues cropping up in October of 1963 Colt issued a threat to the Government, either put out a new contract for AR-15's or they will dismantle the production line. This sends the military into a panic and a meeting was quickly held at the office of the ASA(I&L) Ignatius. In all, DASA(I&L) Tyler Port, MG James A. Richardson III - OASA(I&L), MG Elmer J. Gibson - AMC Director of Procurement and Production, COL Williams - OASA(I&L), COL Walter J. Woolwine - Executive Officer OASA(I&L), LTC Frank A. Hinrichs - OASA(I&L), LTC Arthur G. Moors - Project Manager Staff Officer - AR-15 Rifle, and AMC General Counsel Kendall Barnes all meet at the office to discuss plans for dealing with Colt moving forward. Speaking to DASD James N. Davis over the phone with along with the others at the meeting, ASA Ignatius comes up with a stop-gap measure to move things forward.

He proposes that the requirements of the RFQ be amended to, for now, remove the TDP and the manufacturing rights. However, these would be brought up again after the initial procurement of the rifles. With this plan agreed upon, MG Lynde and LTC Yount moved forward.

Colt's positon on receiving a contract for the AR-15 soon ends up being discussed by Secretary Vance and McNamara. In multiple memos called *AR-15 Rifle*, the two discussed the ramifications of Colt's demands on the implementation of a forward assist. Vance wanted to wait until a new firing pin design, using a spring, from Colt could be tested further.

However, McNamara suggested that since neither the USAF, nor the USMC really wanted a forward assist to be included that they should simply move forward with the order from Colt, especially given that Colt was threatening to dismantle the assembly line if they didn't get one. McNamara proposed a compromise. The USAF could have the AR-15, sans forward assist, and the Army could get one since they wanted it. If the forward assist was shown to be a non-essential addition, then the Army could simply switch over to the USAF's version.

With the fate of the AR-15 production line *on the line*, MG Lynde received a briefing on how price negotiations with Colt were going. Satisfied with what Colt was asking for each rifle he approved the price and forwarded it to his commanders. Lynde then proceeded to make BG Anderson the contracting officer for when the contract would be awarded to Colt, as he planned on not being able to be there for the proceedings. The plan to give Colt the contract is forwarded by WECOM to Secretary Vance in the memo*, Submission for Approval of Award of Contract for Rifles, 5.56mm, M16.*

With the imminent awarding of a contract to Colt for the AR-15, the USAF ordered 19 million rounds of MLU-26/P, which was what the USAF was designating the .223 Remington at the time. However, Remington requested that they be able to switch out what powder they were using. Specifically, they wanted to replace the troubled IMR 4475 for WC846. In December of 1963 LTC Yount responded to Remington's request and permitted the change in power. However, the sensitivity of the primers came back and MUCOM temporarily suspended all orders of 5.56mm ammo because of the issue.

As September came to a close Aberdeen's BRL published another report on their tests with modified AR-15's, called, *An Effectiveness Evaluation of the AR-15 Rifle with a Muzzle Attachment and Comparison with Other Rifle Concepts.*

It's Only a One Time Thing

In November of 1963 the contract for Colt to produce 104,000 AR-15's for the US Military is officially awarded by the US Army. The contract, DA-11-199-AMC-508 provided for 19,000 "M16's" to be sent to the USAF and 85,000 "XM16E1's" for the USMC and the Army. However, this contract would continue to be added onto multiple times over the following years to bring the total order up to 201,045 rifles. The first AR-15's would be shipped in March of 1964 and were scheduled to end in April of 1965. For Colt, the gamble of playing hard ball with the assembly line's fate paid off, netting them a total of $13,296,923.41 for the contract.

While Colt was getting its contract Aberdeen's D&PS was working on testing a number of forward assist designs. Looking at three different designs in total, the test looked at how effective each one was in different, adverse, conditions. While they all appeared promising the testing settled on one design in particular as a standout, a "plunger type device". While attempts were made to turn the charging handle into an effective forward assist it ended up paling in comparison to the plunger. In addition to this they looked at trying to make the charging handle better for helping extract a cartridge during a malfunction, however this modification proved to be less than satisfactory. In the end the report*, Product Improvement Test of Bolt Assist Devices for Rifle, Caliber .223, AR-15*, recommended the plunger design, if a forward assist was going to be added to the AR-15.

With rifles on the way Frankford Arsenal had a few things to work on in the meantime. The Arsenal settled on standardizations for the XM197 High Pressure Test Cartridge as well as the XM199 Dummy cartridge. The XM197 or M197 utilized a large charge of Hercules Unique powder instead of IMR 447 or WC846. Today finding these rounds can be difficult and period boxes of these cartridges have gone for prices, as high as $34 for a box of twenty. If you do happen to run into them they can be easily identified by their silver colored brass and may be head stamped "R A 66". However, since these are proof loads they will be higher pressure than normal and should not be fired as it would exert dangerously high pressure levels on your firearm.

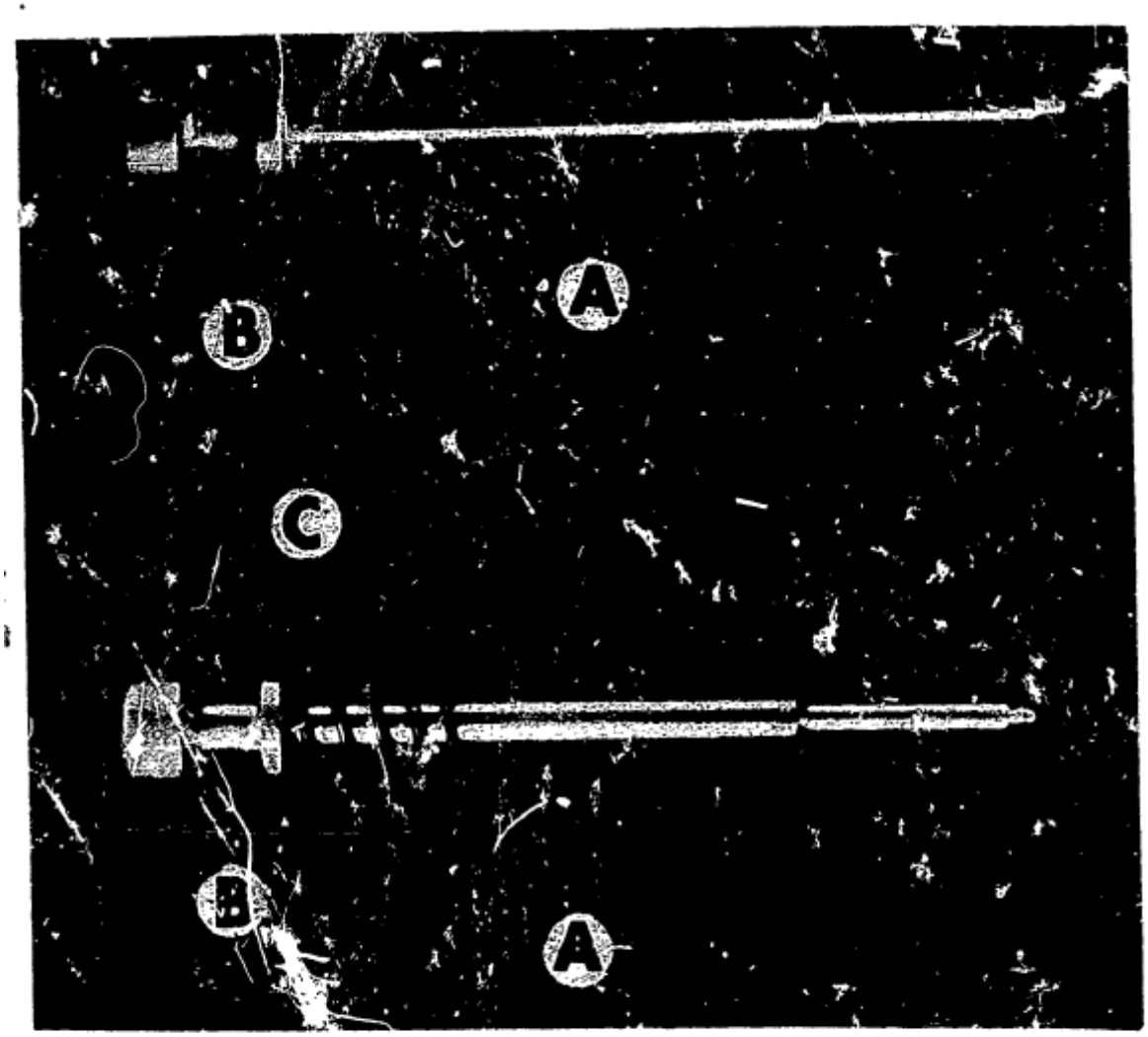
Product Improvement Test

It was in late 1963 that the first developments of a mini gun chambered in 5.56mm were created. WECOM started contract negotiations with GE to develop a mini gun for the US Military. The plan was to create not only mini guns chambered in 5.56mm but the XM144 SPIW cartridge as well. However only the 5.56mm mini gun would move forward.

In December of 1963 the USAIB was still testing designs for a forward assist on the AR-15. A report titled, *Product Improvement Test of XM16 Rifles,* was created. The testing also included a look at a new firing pin design as well as an enlarged charging handle. This particular change added a small spring around the firing pin to help dampen the amount of impact force that it was generating on the primers. After testing that included strings of rapid fire, exposing the rifles to dust and then simply wiping them down, and being submerged in water, they experienced the following malfunctions.

	Test I (Rapid Fire)	Test II (Dust)	Test III (Water)	Total
Failure to Feed	0	10	5	15
Failure to Chamber	2	2	2	6
Failure of the Bolt to Close	0	1	2	3
Double Feed	0	2	1	3
Failure to Fire	0	0	1	1
Failure of the Bolt to Remain Open After Last Round Fired	0	1	0	1
Failure to Feed First Round from The Magazine	0	1	0	1
Total Malfunctions				**30**

The malfunctions were able to be quickly cleared using the new changes to the charging handle and the plunger type forward assist. In total 7,200 rounds were fired for the test and they noted that there were no inadvertent firings when using ammo from lot number RA5024.



UNITED STATES ARMY INFANTRY BOARD
FORT BENNING, GEORGIA
USA.ECOM PROJECT NO 8-3-0030-09 F
PRODUCT IMPROVEMENT TEST OF M16 RIFLES

TOP: Standard firing pin for XM16 rifle:
A. Standard firing pin.
B. Larger shoulder.

BOTTOM: Modified firing pin for XM16 rifle:
A. Spring-cushioned firing pin.
B. Reduced shoulder.
C. Coil spring.

6

Incl 2

Figure 12 - The image above compares the old and the new firing pin designs.

The report concluded by calling the forward assist "adequate" and recommending the following,

> *"It is recommended that the modifications for bolt opening and closing and the spring-cushioned firing pin be adopted as adequate to perform their intended tasks."*

It seemed that these changes hand finally put to bed the issue of primer problems with the .223 Remington.

Retrofit

With the new report out and the findings in the hands of the TCC, the Army Staff was satisfied that the forward assist would work as they wanted and negotiations quickly begin with Colt to add the device to the rifle before production began. With little time to spare, LTC Yount wrote to DCSLOG LTG Colglazer relaying the negotiated price from Colt, and that they need a response by December 15th, if the addition is going to make it into the final production model.

Further comparison testing was done by the Arm, USAF, as well as Colt, looking at the modifications to the firing pin. With the reports all coming back favoring the small change, the TCC put its stamp of approval on one more modification to the AR-15.

AGILE was also refurbishing their AR-15's at the time, at the ARVN 80th Ordnance Rebuild Depot. The data they collected there helped to inform the rest of the military in determining how many spare parts would be needed to be kept on hand for the AR-15 as they entered into service. They also had a wealth of information on how the AR-15 was doing under field conditions, such as malfunction rates, parts failures, and wounding effects. All of this came together and was being compiled for later use.

Yet Frankford Arsenal was having problems with the commercial ammo that was being produced. In a memo called, *Eighth Memo Report on AR-15 Rifle-Ammunition System,* they found that IMR 4475 was once again causing issues. They had two lots of commercial ammo and it was causing a large amount of fouling. The primers were also, once again, place under scrutiny, as they were considered to be another possible cause for the excessive fouling. Looking at the compounds used, antimony sulfide and calcium silicide were both identified as ingredients possibly responsible for the problems. However, these commercial rounds were not made to the specifications of the Technical Data Package created by the Army.

As 1963 came to a close the Air Force Marksmanship School published a paper called *Evaluation of M16 Modification - Firing Pin Retaining Devices,* and the CDC began discussing machine guns with ACSFOR LTG Harrell in a letter called, *Machine Gun for Rifle Platoons.*

1964 And The Launch of The .223 Remington

Despite having submitted the specifications of the .223 Remington to SAAMI almost two full years previously, the .223 Remington was not available on the market from Remington. So in 1964 Remington launched the cartridge and began to make it publicly available through their distributors. In addition to this they continue to work on other variants for the military and delivered the first of a new type of loading for the .223 Remington. Called the XM195, the cartridge was produced for the military with the purpose of being a grenade launching blank.

While today the concept of "rifle grenades" has fallen to the wayside in favor of under mounted, dedicated, launchers, launching a grenade behind enemy lines was a concept that had endured for quite some time. The idea was simple, mount a grenade on a rod that would be placed down the barrel of a rifle, usually with some kind of string attached the pin to pull it as it was launched, and fire a blank round through the chamber to launch the whole grenade at the enemy. Later designs for rifle grenades would abandon the rod but move to more of a “cup and saucer” design to launch the grenade.

The USAF was also still looking at how the adoption of the AR-15 was affecting the training of their troops and published a report going into their findings in early 1964 called*, A Comparison of the Training Suitability of the AR-15 Rifle and M2 Carbine.* They found that the AR-15's that they were using were experiencing lower rates of malfunctions than the M2 Carbines that they were comparing them to. Out of the 50,698 rounds that were fired though the various AR-15's there was a malfunction rate of 1 in 783 rounds. Comparatively, of the M2's 50,707 rounds fired there was a malfunction rate of 449. While both malfunction rates were acceptable in the eyes of the USAF for training purposes the AR-15 was continuing to be the top contender. As had been shown by previous studies on accuracy with the AR-15, more airmen were able to achieve not only minimum but expert scores as well on the AR-15 when compared to the M2.

Shakeups

In January of 1964, Secretary Vance left his position and was replaced by former Under Secretary of the Army, Steven Ailes. However, this was not the only shake up happening.

Frankford Arsenal was to be the location where a number of debates would continue to go on over the specifications of the .223 Remington. Meeting with employees of Remington, Olin, Federal Cartridge, and DuPont, the USAF and the Army discussed the various aspects of the Technical Data Package for the military's .223 Remington cartridges. The first main point of contention was the continued use of IMR 4475 and still keeping the chamber pressure consistent. DuPont was concerned that it would have difficulty not only keeping the maximum mean chamber pressure at 2,000 psi under what the standard specification called for, but also increase the chamber pressure for the military by only 1,000 psi. The military was asking for a very consistent and tight standard to be adhered to for their rounds, and while supplying the materials for the cartridges would not be a problem, DuPont feared that it might not be able to keep the lots as consistent as the military wanted.

For its part the Army began redrawing the cartridge case designs, as Remington had insisted that the Army's previous drawings were incorrect, and based on a misunderstanding of Reminting's original design. Additionally, to satisfy DuPont's concerns the Army also agreed that for the upcoming order of M193 ammo they would accept them being out of the agreed upon pressure specifications. Yet any future deliveries would have to meet the agreed upon pressure specification of 53,000 psi, that had been increased from 52,000 psi. A final waver was also allowed for some rounds to test as high as 60,000 psi, but over this could begin to cause dangerous pressures in the chamber. In February of 1964, 1 million rounds from both Remington and Olin would be delivered using this waver.

Later in January the TCC would return to Frankford Arsenal for testing of production lots using alternative powders. They agreed that if they did end up making a change to the powder that it would be reflected in the contract for the ammunition and not yet another change to the specification of the cartridge. They looked at several different types of powder, including DuPont's CR 8136, Hercules' HPC-10, and Olin's WC 846. However, the TCC was not particularly interested in Olin's powder and wanted to exclude it. Forcing Olin to go the AMC Director of Research and Engineering to plead their case. With the three powders being submitted, the US Army elected to, instead of loading them themselves, send everything to Remington for the sake of uniformity.

IMR 4475 had been used since 1936 and was a tubular powder developed by DuPont. It was what the first .223 Remington loads used and the particular pressure curve that it created in the AR-15 at both the gas port and in the chamber were tuned to use this powder reliably. Changing the power, especially to a ball powder like, WC 846, which had a completely different pressure curve would have unforetold consequences.

Looking for more bids on the price of producing .223 ammo, LTC Yount directed the Ammunition Procurement and Supply Agency to get at least two bids for ammo production. Yount then proceeded to inform LTG Besson that the Army was having difficulty finding "responsive" bids for the first million rounds of the more than 150 million rounds that were projected to be required by the military in 1964.

High Pressure Tracer Rounds

In February of 1964 the military placed an order with Olin-Winchester to deliver 13,000 rounds of the XM197 test rounds. This number was expected to last the military in their acceptance test requirements all the way through June of that year. However, this depended on how fast the rifles would be delivered.

Yet the military was still looking at falling short of their ammunition needs. In a memo titled, *FY 64 Procurement 5.56mm Ball Ammunition,* PMSO AR-15 MAJ Robert C. Engle noted that of the three bids that were currently being considered for producing .223 ammunition, they were still short approximately 5 million rounds of ammo. With the AR-15 being rolled out the US Army and the USAF were both expected to need a combined 150 million rounds of ammo and if they ran out it could be disastrous for the deployment of the AR-15.

This lead to the US Army awarding more contracts for M193 ammo to Olin, Remington, as well as Federal, producing, 77,880,000; 57,000,000; and 15,000,000 rounds of ammunition respectively. With a grand total of 149,880,000 rounds contracted. Just shy of the 150 million expected to be required.

Remington in particular thanked the USAF's Director of Procurement and Production for not settling on just one type of powder to use, namely the WC846. The response was a practical one, stating that the military did not want to be dependent on just one powder manufacturer or type.

It was not just the powder to be used that was not standardized, but more importantly the bullet design. The testing of the Sierra designed bullet was not yet complete and at that time LTC Yount was getting anxious to see the results. In a letter titled, *Evaluation of Sierra Configuration Cal. .223 Bullet,* LTC Yount wrote to both the BRL and Edgewood Arsenal's Director of Medical Research asking that the studies into the lethality and stability of the Sierra bullet design be expedited so the military could finally settle on a design for the bullet being used in the .223.

Meanwhile Frankford Arsenal was working on putting together the specifications for the XM196 Tracer round. The final specification for this round would be a 54 to 55 grain projectile with a red or orange tip. The design was not all that different from today's tracer rounds. A small cup was added to the rear of the bullet for the tracer compound. However due to the weight of these tracer rounds today they are more highly sought after, compared to other, heavier 5.56mm tracer rounds as they stabilized better in a wider range of twist rates.

Sierra's Bullet and IMR 4475

March of 1964 not only saw issues with Colt's deliveries of the rifles, but continued testing of the Sierra bullet design that LTC Yount was so eager to hear the results of. Colt for its part had a monthly shipment of rifles detained after it was found that they were not keeping quality control as tight as they should have been. Issues were found with how they had calibrated their gauges for inspection and more, leaving many rifles suspect as to their quality.

Yet testing of various components continued. Modifications to the XM16E1 version of the AR-15 were tested by the AMC's Test and Evaluation Command (TECOM). They tested not only new muzzle breaks, but also a two round burst fire system that Colt had designed. However, the ammunition was receiving continued attention.

LTC Yount continued hunting for the testing data he wanted on the Sierra bullet. To his surprise the BRL recommended that no testing of the bullet be done. They argued that there was already plenty of data available on rifle bullets and testing the new design would be a waste of time. They advised that if the military did switch to the Sierra bullet they would have to change the rifle's twist rate from the current 1:12" to a 1:9.5". Furthermore, they saw little reason to even conduct the testing as they estimated that even with the increased velocity the design promised there were be little effect on the practical capabilities of the bullet. However, if Yount insisted they could start a small study to look at the bullet but it would not only require obtaining new barrels to use with the 1:9.5" twist rate but another three months before results would be finalized.

Both Remington and DuPont elected to drop the use of IMR 4475 in their cartridges however there was a problem. Colt found that six out of every ten of the XM16E1 rifles tested were exceeding the cyclic rate standards of between 650 and 850 rounds per minute. When using the IMR 4475 only one out of ten had this issue. This was the first sign that things were going wrong with the tinkering being done to the rifle and ammunition.

For the first 300 rifles that Colt delivered they had to handpick them to deal with this issue. Obviously this will be next to impossible for larger batches and Mr. Hutchins, a Colt employee, informed the TCC of this issue. He requested that the cyclic rate standard be changed, to 900 rpm. It was not an unreasonable request as the Airforce's M16 rifle used a 900 rpm standard anyway. In the interim Colt continued to adjust the buffer spring rate in order to keep the rifles reliable but within the requested cyclic rate.

With the first shipment of 300 M16's making their way to the USAF, TCC's USAF representative William Aumen presented the USAF's endurance test data from 1963. Testing was done on 40 rifles in total, 27 of them malfunctioned once every 3,000 rounds, while 13 rifles malfunctioned once every 6,500 rounds.

Still not satisfied with the specifications of the .223 round the military was using, the TCC created a subcommittee to look at a number of changes that were proposed to the specifications of the cartridge. One of the major ones was standards for fouling from the powder as well as pre-acceptance testing of the ammo. The fouling standard became an issue when it was found that some lots of ammo were causing malfunctions because of the fouling in as little as 500 rounds. However, this issue was greatly exaggerated in its importance and impact on the performance of the rifle.

Changing The Twist

While both the Frankford Arsenal and the CRDL published two reports on the wounding characteristics of various rifles, including the M14, AR-15, and the AK-47. These reports titled, *A Casualty Probability Analysis of Small Arms Weapons Systems of Various Calibers* and *Wound Ballistic Assessment of the M14, AR-15, and Soviet AK-47 Rifles,* published by Frankford and the CRDL respectively. The military specifications for the XM199 Dummy round was published under the specification MIL-D-46399(MU).

In April of 1964, LTC Yount's office completed a preliminary study by its staff into the Sierra bullet design. However, the results were not what Yount had expected. Not only would switching over to the Sierra design force a change in all rifle barrels to a 1:10" twist, it would require that all spare, stocks and M193 ammunition reserves be replaced. With millions of rounds already in production, halting at this point would be a major and costly delay. Furthermore, new propellants were still awaiting final testing results Yount elected to stop additional planned testing of the new bullet design, in favor of hoping that the new propellants would help to achieve the desired improvements in performance.

Propellant Problems

With the Sierra bullet design dropped from further evaluation the powder was the next area that was looked at. While the TCC granted a waiver, allowing Colt to pass rifles for the army with up to a 900 rpm cyclic rate, other issues were cropping up with the propellant. Some that would, at the end of the day, cause disastrous consequences for those using the AR-15.

A Colt employee, Foster Sturtevant, noted that when using the WC 846 propellant pressures at the gas port were becoming alarmingly high. However, this issue was waved away, in the internal Colt memo, *Chamber and Gas Port Pressures,* with Sturtevant claiming that it was "in no way harmful to the AR-15" and instead would lead to better performance. He was wrong.

The USAF had to reject a batch of M193 ammunition manufactured by Olin-Winchester because it was, again, failing to meet the penetration requirements. What the USAF was looking for was for the rounds to penetrate a 0.135-inch steel plate at 500 meters. This requirement had been difficult to meet and was 200 meters more than what the original SCHV cartridges were designed to target. With these performance issues cropping up the USAF was implored to dial back the requirement by 50 meters and accept rounds preforming at this reduced, but still reasonable standard. However, as the ammunition was being shipped to Frankford Arsenal for the final pre-production testing Frankford was told by the Ogden Air Materiel Area (OAMA) that the USAF would not accept any reduction in performance.

Meanwhile Remington was having issues keeping up with demands for propellant in their cartridges. They were beginning to run short on the IMR 4475 and were expecting to fall short of the 500,000 round order by roughly 19,000 rounds. Yet for Remington news would come that a solution would be offered. Frankford Arsenal wrote to Olin, Remington, and Federal that they would allow for both CR 8136 as well as WC 846 to be used as an alternative to IMR 4475 in loadings of 5.56mm M193 ball.

Following up on this Frankford Arsenal published a memo called, *Tests of Samples from First Million Production of 5.56mm M193 Ammunition*. With continuing production of the M193 ball ammo expected to be using CR 8136 or WC 846 testing of the ammo was to be much more limited, with a "simulated acceptance test" instead of the full testing normally done. While these rounds did get tested, key elements were omitted from the new testing regime, such as function and casualty testing. Between this change in powder and Colt making and being given permission to use bolts lacking drain holes (4,100) and oversized chamfers on the muzzle, the quality control of the rounds and rifles was beginning to slip.

While some changes were necessary to the rifle at the end of the day. The most disastrous change that would eventually happen would be the changing of the powder used. This affected the critical and precise dwell time of the rifles. Without realizing it, and the military penny pinching on things as small as cleaning kits, the malfunction rates of the rifles began to rise, especially under adverse conditions. So by the time the military got to its first real deployment of the rifles, after the AGILE testing, the AR-15 was already seeing changes that would adversely affect is performance, and it the words of James Sullivan,

"I don't know how many troops died because of it."

The AR-15's original design was built around very specific things, such as the pressure curve as the bullet and gas traveled down the barrel. All of these parts were interconnected and while trying to save money the military ended up throwing a wrench into what was otherwise a good design, even though attempts were made to study how these powder changes would affect the rifle, such as Aberdeen's D&PS' 1964 paper *Engineer Design Test of Alternate Propellants for Use in the 5.56mm Ball Cartridge, M193*.

The SCHV concept was solid, the AR-15's design was capable of being reliable and rugged when built correctly. However, in the interests of saving money the AR-15's performance as a fighting rifle was compromised. While the use of the IMR 4475 was never "finalized" it was, minor issues and all, what the whole AR system was depending on. With the replacement powders that were being used, namely the surplus ball powders that eventually replaced the IMR 4475 in use, the whole timing of the system was thrown off.

Why The Dwell Time Was Critical

The change in powder was an important issue as, mentioned previously, the dwell time was changed by it. Put simply the dwell time is the time from the bullet and gas reaching the gas port and then exiting the barrel. With a proper dwell time the gases have enough time to reach the gas key, unlock the bolt and send it to the rear, extracting the case, just as the pressures reach a safe level. When the pressures at the gas port were increased by the change of powder this dwell time was changed. Too much pressure was being allowed back into the system and rifles were extracting at borderline unsafe pressures. Put simply the rifle was designed as a complete and holistic system that took all elements from the bullet design, to the powder used into consideration, and messing with one element would affect the others.

However, the military would continue to make modifications to the rifle without treating it as a complete system. In their mind, it seemed, if the chamber pressures were the same then everything was ok. This could not have been further from the truth.

Yet the changes to the AR-15 were not over. Aberdeen's D&PS put out a report, *Product Improvement Test of Modified AR-15 Rifles.* The report detailed a number of new changes to the rifle, including a larger charging handle, a larger forward assist, and three firing pins with "inertia retarding devices". In all the found that the modifications were "satisfactory", but the changes to the firing pin were deemed unnecessary.

You Still Don't Know That?

While LTG Besson was given a promotion to General, the first US Army officer to earn the rank as part of a logistical organization during peacetime, LTC Yount was trying to get together training material for the Army's XM16E1 variant of the AR-15. Despite only looking to put together a five to seven-minute briefing on the use of the firearm, he meets resistance when both CONARC and the CDC refuse responsibility for putting together training materials. To resolve this conflict, the PMSO brought in AMC's Training Division to try to sort out the whole matter and get something produced. This failure to work out training materials and more importantly simple maintenance tasks would come back to haunt the military.

However, there were some shocking developments coming out of Frankford Arsenal. Both William C. Davis and Charles E. Schindler publish a memo called*, Tenth Memo Report on AR-15, Rifle/Ammunition System: Investigation of Alternate Propellants For Use in 5.56mm M193 Ball Ammunition.* The memo admits that despite approving both CR 8136 and WC 846 for use in the M193, an acceptable pressure range at the gas port had not been established.
Despite signing a contract with Colt in 1963 for the AR-15, as well as all of the testing done on the rifle, they still had no idea what the pressure range at the gas port should be, only a chamber pressure had been established. Since dwell time was so critical to the functioning of the AR-15, this was a massive oversight.

The memo went on to say that both CR 8136 and WC 846 were producing higher pressures than the IMR 4475. While IMR 4475 had been causing issues with meeting the performance requirements, it had been used since the early development of the .223 Remington and the AR-15's gas system had been designed around a particular pressure curve. One powder that was dropped from consideration as a replacement to IMR 4475 was HPC-10, oddly it was reported to be causing excessive pressures in freezing temperatures. Furthermore, HPC-10, like other cylindrical propellants was blamed for issues of premature bore erosion.

Yet, before this report was even released, two changes were already approved. First the use of CR 8136 and WC 846, were both approved, despite the continuing questions as to the increase of pressure at the gas port. Next changes to the primer tolerance were also approved, changing the None Fire / All Fire range to 12 to 48 inch ounces, despite the already modified firing pin supposedly alleviating the issue of slam fires.

The final, arguably disastrous, change in the powder used in the M193 would be completed at the end of May 1964, with Remington loading the last of their IMR 4475 reserves into 1 million rounds of ammo to be delivered to the military. At this same time Colt was given the last of the "IMR 4475 M193" rounds they would receive for function and acceptance testing.

As the US Army was starting to issue the first XM16E1 rifles to troops the DCSLOG was producing a report titled, *Study of Rifle Readiness.* In the report the authors state emphatically that there will be no more purchases of the AR-15, in the XM16E1 or any configuration. While the report also recommends that the M1 stop being issued by the Military Assistance Program, the M1 rifle should be retrofitted and be tested for conversion to use the 7.62mm NATO. Again the Army was falling back on its old ways of thinking, the .223 Remington was "too small" and the AR-15 would never hold up.

While this could not be further from the truth, changes would eventually be made that would ensure that the AR-15 would experience numerous problems. While today's AR's are made to much higher standards, key changes to materials, and not just simply the powder used in the cartridge would be the problem.

The CAR Family

In an attempt to win favors for Colt and the possibility of more rifle contracts, Colt's President Paul A. Benke gave a custom XM16E1 to Army Chief of Staff General Wheeler. Benke also took this time to unveil a new project that Colt had been working on, specifically the Colt Automatic Rifle (CAR) family of firearms. This included a number of various models of firearms to include the AR-15 HBAR M1; a magazine fed machine gun, the AR-15 HBAR M2; a belt fed machine gun, a carbine with a 15" barrel, a SMG with a 10" barrel, and a survival rifle intended for use by air crews. The early prototypes of the CAR-15 SMG and carbine utilized cut down versions of the M16's triangular stock and the SMG had a retractable buttstock.

While Benke was trying to get the Army interested in the CAR rifles and only really succeeding in reminding General Wheeler that a grenade launcher might be a good idea on the XM16E1, Colt's engineers were trying to get permission to revise some technical drawings. Colt submitted two such requests and they had a total of 58 parts that they wanted to redesign and improve to attempt to eliminate malfunctions.

Maybe That Was Not Such a Good Idea

June of 1964 saw another change in the command leadership, General William C. Westmoreland took over for General Harkins as the commander of MACV, despite the change in leadership things continue running at the TCC and the report*, Study of Rifle Readiness***,** makes it into the hands of General Wheeler from DCSLOG LTG Colglazier.

Yet the really important events in June were yet to come.

After Frankford Arsenal released the memo, *Eleventh Memo Report on AR-15, Rifle/Ammunition System,* looking once again at the issue of the high pressures at the gas ports, the first signs that it is a real issue crop up. A small report surfaces that documented the first case of a case head separation and rim pull-through. While at the time this seemed like a minor issue it would be indicative of things to come and directly the result of the military's insistence on meddling with the powder used and not taking into account just how much it would affect the AR-15.

While Remington was on time with their preproduction samples, Federal was falling behind. 200,000 M193 cartridges that were expected to be delivered by Federal Cartridge were missing in action. Angry and considering attempting to levy fines against Federal for the shortage LTC Yount moved to find ways fill the gap. His first solution is to go to other manufacturers and ask for accelerated production. Olin, for their part was able to, and helped to fill in the missing rounds with an increased production rate.

However, there were other rounds that were going missing.

Blank rounds and blank firing adaptors are useful training tools, central to training then and today. However, in 1964 the funds for the development of both blanks and the firing adaptors for them dried up. Leaving the military with yet another hole in their training regimen.

Throughout July and August of 1964 a number of memos, letters, and back and forth discussions take place. The end result was that the Army did not want the AR-15. Instead they were still holding out hope that the beleaguered SPIW program will eventually be able to produce some kind of workable firearm to replace the M14. Debate raged over how much to invest, if at all in the AR-15 with some going as far as to suggest that the previous investment into AR-15 was the reason why the SPIW was delayed. DCSLOG LTG Lawrence J. Lincoln, Jr. wrote that,

"For the past several years we have fought off any solution which would commit the Army to another interim weapon which could hinder the development of a greatly improved individual weapon in the 1965-70 time frame. If a caliber .223 weapon is to be selected as the successor to the 7.62mm M14, it should be the best caliber .223 weapon available and one which fills the quantum improvement qualification. This could possibly be the AR-18, the Stoner 63 or some other design. Such a decision cannot be made until the future of the SPIW is clear."

Essentially, it did not matter what it was, even if it was to be another .223 caliber firearm, the AR-15 was a dead rifle walking to the Army and they wanted it that way.

Sir I need A Cleaning Kit

In September of 1964 the 5th Special Forces Group at Fort Bragg, gave their monthly report, what they reported was abysmal. No less than five of the rifles sent to them were inoperable upon delivery. One rifle was unable to even have a magazine inserted because the upper receiver was machined incorrectly. A second rifle lacked not only the screw but threading for one on the carrier key. Another rifle had a bent gas tube and two more rifles were shipped without the notches in the carrier for the forward assist.

To compound all of this many basic times such as magazines, slings, bipods, and cleaning kits were either missing or easily damaged. In the month that they had the rifles no less than 49 different cleaning rods had been snapped at the joints from simple use. But there were other parts breaking easily on the rifles themselves. Four firing pin retaining pins broke, along with many bolts and bolt carriers already developing rust. The only way that the troops at Fort Bragg were able to combat this was by coating the entire bolt and carrier with oil.

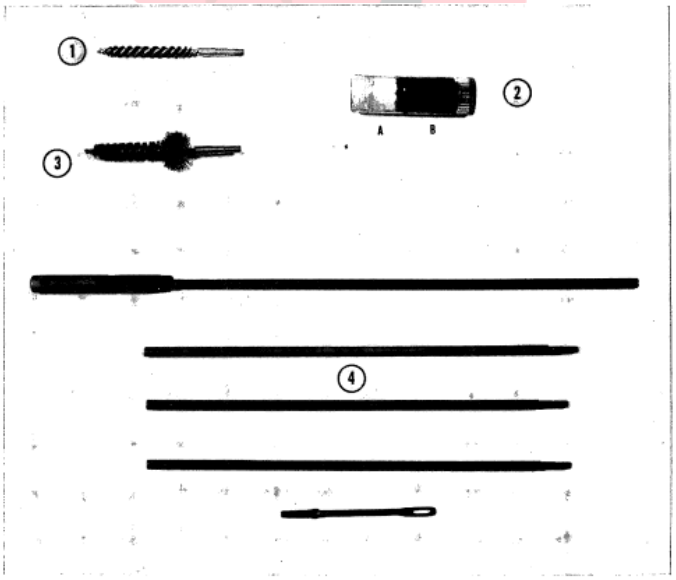


Figure 13 - The critical missing supplies, image taken from, Field Manual Rifle, 5.56mm XM16E1 FM23-9.

In regards to training they asked that the service manual for the XM16E1 be updated to reflect the need to coat the bolt and carrier with oil, however their request for training materials did not stop there. They asked for not only blanks but blank firing adaptors as well, not realizing that there were none to be issued as the funding for their development had dried up months before.

Towards the end of September to more events took place in regards to the .223 at Frankford Arsenal. Not only did they start looking at the case hardness of commercial rounds, but they also began to acquire 20 million rounds of M193 for the Army to use in 1965.

While Frankford was working on those projects the XM196 tracer round was being looked at by the USAIB. The Infantry Board published a report titled, *Service Test of Cartridge, Tracer, 5.56MM, XM196.* The report would be the first of several tests looking at the performance of the XM196 round.

We Still Want the Rights

In October of 1964, the military was still trying to obtain the manufacturing rights and TDP for the AR-15. To this end Colt offers four different possible ways to obtain them.

- *"Establishes a price of $5,400,000 plus a 5 percent royalty. A $10 credit is offered for each rifle ordered. This includes rifles that have already been delivered. Credit will also be given for spare parts purchases. The TDP will include the M16, XM16E1, and two-round burst control, but not blank ammunition, grenade launchers, or grenades. The TDP will only be delivered after full payment is made;*

- *Provides immediate delivery of the TDP upon cash payment of $3,600,000, plus a 7.5 percent royalty;*

- *Requests the order of 400,000 rifles plus a 5 percent royalty; and*

- *Requests the order of 200,000 rifles, a cash payment of $2,500,000, a guarantee of 50 percent of all future procurement plus a 4 percent royalty. "*

While these are being debated, a new modification to the contract with Colt was made. 33,500 more M16 rifles and necessary spare parts were added to the contract for the USAF, US Navy, and the Coast Guard. With the additions the contract balloons in size by another $4,305,749.62.

As more rifles were being ordered, Aberdeen's D&PS was working on making sure that the rifles coming off of the line were up to the standards that they were expecting. In the report, *Final Report of Comparison Test of Rifle, 5.56mm M16,* Aberdeen looked at the build quality of the rifle, how well they were functioning, as well as making suggestions to improve the functioning of the rifle such as giving troops a chamber brush to clean the rifles with. However, there were two problems.

One the sample size was small, at only five rifles, and while they did find that the guns were perfectly capable of running up to 1,000 rounds before running into malfunctions from lack of cleaning or lubrication, this was a sample that could not hope to be truly repressive of the thousands of rifles ordered. Furthermore, the very recommendations that were suggested by Aberdeen's D&PS were ignored and, as we would later see, many rifles would be delivered without any cleaning kits what so ever.

Frankford Arsenal completed their look at the case hardness of commercial rounds and found that it was unnecessary to oversee the production of the cases for the military. While there had been some case ruptures reported, what had happened had been attributed to issues that had already been corrected, either through training or modifications to the original design as the AR-15 went through its development in the SCHV project, such as water being trapped in the bore of the rifle.

As October ended a change was made to the specification of the M197 High Pressure test round. The specification was changed to MIL-C-46936A(MU) and required numerous standards to be adhered to. These included chamber pressure standards, force required to remove the bullet from the case (no less than 35 pounds), even being waterproof,

> *"3.4 Waterproof - The cartridge shall not release more than 1 bubble of air when subjected to a pressure differential of 5 psi for 15 seconds."*

Outside Proposals

While the DCSLOG LTG Lincoln reported to General Johnson in his study, *Study of Procurement of M14 Rifles,* that the military expected to be short more than 85,000 rifles by the end of 1970. However, Lincoln noted that "The Army staff prefers the M14 rifle over the M16." and the Army was about to make that very clear.

The Army Vice Chief of Staff received a memo titled, *Army Opposition to Outside Proposals,* in it LTG Dick attempted to defend the Army's attitude towards the AR-15 and insisted that their opinion of the rifle was not due to seeing the rifle as something not designed by the military, thus not worthy of consideration. Instead Dick attempted to claim that the Army had *"serious doubts"* about the AR-15 and its potential as a firearm for military use. He insisted that there was no valid requirement for it, that the AR-15 and .223 Remington design were of *"dubious"* capability in combat, the (previously revealed to be rigged) test results were unsatisfactory, and finally the AR-15 was simply not *"compatible"* with Army doctrine and other *"existing systems"*.

Waiting in the wings behind much of what was happening the Stoner 63 light machine gun had been in development. Much like the AR-15, the Stoner 63 was designed by Eugene Stoner and had been, at first designed to fire the 7.62 NATO. However, with the Stoner 63, the rifle was scaled down to use the 5.56mm. Previously the USMC had been looking for a machine gun to adopt before they were willing to go all in on the AR-15 and the Stoner 63 was, at that time, shaping up to be a strong candidate for what they were looking for. The day before the USMC was supposed to brief Secretary Ailes about the light machine gun General Johnson wrote to the secretary,

"I believe that it would be useful for me to bring you up to date on what has transpired and also to make my views known prior to the time that you hear the (USMC Stoner) presentation. The Vice Chief of Staff had met with appropriate members of the staff to discuss the Army rifle program generally and specifically how we intend to cope with what was beginning to shape up as an all out effort by the Marine Corps to sell the Stoner system.... You will remember that after you were briefed on the Army rifle program on 18 August, you asked the staff to study the overall rifle situation in order to determine whether a limited procurement of the M14 rifles in FY 66 could be justified. DCSLOG has completed its study, and I cannot recommend that we buy in 1966. As a matter of fact it now looks as though our assets vs. requirements picture remains good through FY 1967.

"In summary, I believe that we can and should completely re-evaluate our small arms weapons program, starting with a review of doctrine. Our posture is such that we can afford to take this action over the next year or two with a minimal risk. Only by such a deliberate and thorough approach will I be confident that our small arms weapons program reaching into the 70's will be on firm footing. I am hopeful that the Marine Corps will subscribe to this approach, will monitor our efforts as they habitually do, and will not attempt to precipitate an early decision which could prejudice the future combat effectiveness of both the Army and the Marine Corps. General Greene has given me oral assurance that he does not intend to pursue a course that diverges from that of the Army at this point."

Johnson would, the day after writing to Secretary Ailes, direct the Army Staff to review the Army Small Arms Weapon Systems (SAWS). This would be an overarching review, looking at doctrinal employment, testing of weapon systems, and more. Johnson mandated that the review should not be held back by current contracts and dogma. He stated firmly that,

"It must be based on a dispassionate analysis of those factors which can be quantified, coupled with unbiased judgment applied to those factors which cannot be quantified."

In short it seemed that General Johnson was looking to bring the military forward in a big way and he did not want to be held back by either tradition or dogma.

Running Out of Ammo

Despite having fallen behind on their ammunition shipments, LTC Yount was unwilling to terminate the contract with Federal Cartridge, even as they fell behind again in November of 1964. The Chicago Army Procurement District wrote to Federal asking for another pre-production lot, however as November came to a close Federal found themselves behind by 9,837,000 rounds. Instead of terminating the contract with them LTC Yount continued to keep them on, despite the reoccurring delays fearing that if the military became dependent on just one manufacturer then not only would the price of the M193 ammo go up but it would also be an issue if there was an emergency and additional ammo was needed.

However Federal was not the only one running behind schedule. Remington as well found themselves behind production quotas and were short another 2,929,000 rounds. Leaving the military almost 13 million rounds behind what they expected to receive by the end of November.

In December both Remington and DuPont decided to stop using CR 8136 after loading roughly 50 million rounds with it. The issue was that CR 8136 was giving both companies issues in keeping the pressures consistent from lot to lot. Because of this, Remington asked if they could use WC 846 instead to finish the current production run. Especially since they had already fallen behind in November. Despite this change in ammo, Colt continued to use ammunition loaded with CR 8136 to do acceptance testing. Again, the rifles were being qualified and tested with one type of loading and then used regularly with a different loading.

Trying to Improve

At the start of 1965 Colt was making efforts to improve the AR-15 models that the military was using. First they worked on improving the buttstock, and while the initial design was rejected as it lacked storage, the new material that Colt was using was approved to be replaced in the old design. Colt's efforts to improve did not stop there as issues were found with how well the magazines were being hard anodized by a subcontractor and Colt made steps to correct this issue.

The military continued to order more rifles from Colt; 500 for the US Navy in particular and in January of 1965 and a change was made to the dust cover to make it cheaper to produce. Additionally, new training materials were finally coming out for the M16 with the release of the Field Manual, *FM 23-9 - Rifle, 5.56mm XM16E1.*

However, by February more changes were being made to the powder used in the M193 cartridge, without any corresponding changes to the rifles themselves.

The TCC was still looking for alternative powders to use in the M193 and they started looking at two in particular. The first was from DuPont called the EX 8208-4 and was a variant of the IMR powder family. However, it came with even greater pressures at the gas port than the WC 846 that had been producing high pressures. The second was HPC-11 made by DuPont's subsidiary Hercules. Both would be tested and the results would not be in until September of 1965 when Frankford Arsenal released the report, *Fifteenth Memo Report on AR-15 Rifle-Ammunition System: Investigation of Alternate Propellants For Use in 5.56mm Ball and Tracer Ammunition.*

Written by Charles E. Schindler the report indicated that while the HPC-11 was fouling the system less than the other powders being looked at the fouling was worse in the gas tube, reducing the useable size of the gas tube. While EX 8208-4 was approved for use in the M193 cartridge, it recommended that both CR 8136 and IMR 4475 be removed from use. Finally, the companies manufacturing the powders were asked to "reduce the fouling characteristics" of their powders.

Coming Up with A New Bullet

While the Army and the USAF were both moving in opposite directions as to what to do with the AR-15 Frankford Arsenal was working on testing out bullet designs. Frankford again looked at the issue of the ogive of the bullet, and published*, Request for Deviation Approval or Technical Action (RTA) CHPD 105-65(DV)--Cartridge, 5.56mm, Ball, M193.* The found that the bullet's design was not negatively impacting the performance of the round on target. However, since a change in design might impact how troops felt about the round, that the use of these cartridges be "limited to the Continental United States". Finally, the report pointed to Federal Cartridge for needing to implement "immediate process and inspection improvements".

While General Besson noted in his April report, *Troop Reaction Reports on XM16E1*, to the Vice Chief of Staff General Abrams, the first signs that issues were cropping up with the XM16E1 with bolt carriers and bolts seizing up. However, Besson noted that,

> *"My concern is that individuals becoming familiar with this rifle are going to complain bitterly to home and press when they find themselves in SE Asia with an M14....I think you have a potential flare-up--and I honestly believe the M16 is a better rifle for jungle and rice paddy warfare."*

He was correct, however the OACSFOR was pushing against the AR-15 in its memo, *Army Requirements for the M16 Rifle.*

> *"Prior to the completion of the SAWS project, the Army has no logical or compelling reasons to expand the current basis of issues of the M16 rifle. Such an expansion might in fact be damaging to SAWS in that it could be interpreted as prejudgment of the expected results of the study."*

No Maintenance Needed?

In May of 1965 Chief of Staff General Johnson told the ASA(I&L) Daniel M. Luevano that not only would the Army's rifle program remain unaltered until after the SAWS study was finished but that he saw no reason to do maintenance of the operating line for the M16's. However General Johnson found that during his visit to South Vietnam the demand for AR-15's from ARVN generals was only increasing as the troops in Vietnam find that the AR-15 is vastly superior to the M14 for their needs in the close quarters, jungle, environment.

Despite the Army's resistance to the AR-15, the USAF Logistics command estimated that over the next four years, 1966 to 1970, they will need well over 65,000 rifles for their troops. This spurred AMC General Counsel Barnes to start looking at renewing negotiations over the manufacturing rights and technical data for the AR-15.

William C. Davis, who had been previously working on experimenting with different types of powder to use in the M193 cartridge was loaned to Colt were he started working as the M16E1 Engineering Project Manager. During May of 1965 he started working on a new design for a .223 round known as the GX-6235. The loading used a 68 grain bullet with a ten caliber ogive. Because the bullet was heavier than the 55 grain M193 ball a 1:9" twist was needed for the new loading. Davis also tested the bullet with a 1:7" twist barrel but issues arose with excessive fouling during testing.

Colt continued to attempt to refine and improve the design of the AR-15 in the meantime, moving to a parco-lubrite process over the previous electrolize process for not only the bolt, but the ejector, extractor, and extractor pin as well. This change was implemented in order to make the parts not only last longer but the attempt to increase the wear resistance as well.

DuPont's IMR Experiment

While IMR 4475 had been dropped from use in the M193 cartridge DuPont continued working with the Army to create an IMR powder variant that could have more ballistic stability over a wider temperature range. Unless you are an avid reloader or precision shooter how temperature affects case pressures is probably an esoteric topic. However, as a rule of thumb as ambient temperatures increase, chamber pressures do as well. If you look at many old African big game loads you'll see that they are very "low pressure" loads, this is to accommodate for the increase in chamber pressures caused by the African sun.

What DuPont and Picatinny wanted to create was a powder that could be more consistent and less susceptible to these temperature shifts. What they developed was the powder IMR 8138M. While the initial testing and development of the powder was focused on refining it for 7.62mm NATO, they found that they could also use the powder in the military's 5.56mm loadings as well. However, there was a catch. The grain size of the powder made it difficult for machines to be able to keep the powder loads even across the board. This stymied attempts to use the powder in the kinds of mass production that the military was looking for.

Investigating The Cyclic Rate

Sometime between May and June of 1965 Colt found themselves without any more CR 8136 loaded cartridges for testing. Because of this they continued to do testing with batches of WC 846 cartridges, and they once again found themselves with a higher cyclic rate. Going back to the TCC Colt asked that they receive more waivers on the maximum cyclic rate acceptable for the rifles they were producing. But the TCC denied Colt's request and Colt in turn suspended production of the XM16E1, but not the M16. By June Colt decided that if they were not going to get the waivers then they would, instead, attempt to find the cause of the higher cyclic rate and attempt to remedy it. Colt's liaison to the TCC, Mr. Hutchins requested that the military assist Colt by providing them with the equipment they needed to find out what the problem was.

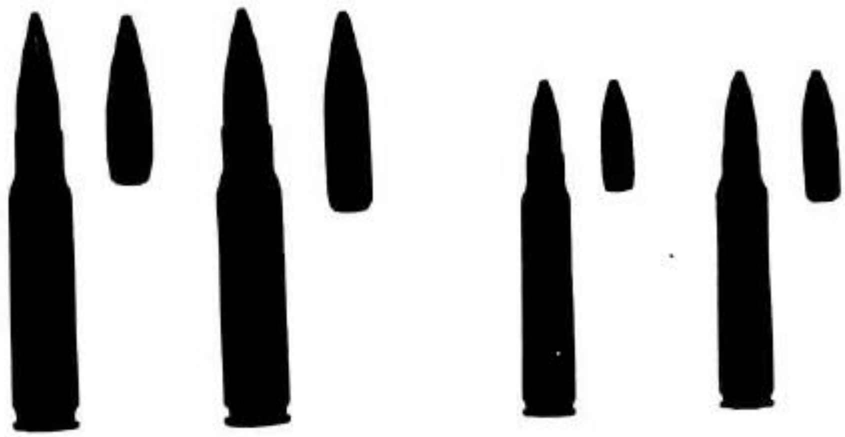
Meanwhile negotiations over the manufacturing rights resumed. However, Colt's President, Paul A. Benke rejects the attempt to push the previous offers for the manufacturing rights and Technical Data Package, and instead puts up a counter offer with more favorable terms for Colt.

What Did You Think Was Going to Happen?

While it took an entire study to confirm, the very issues that the military had been warned about was coming to fruition. In the study*, Study of Current Primer-Sensitivity Criteria for 5.56MM Ammunition,* Frankford Arsenal found that due to the sensitivity requirements that were being imposed on the primers, a high number of them were being rejected for use by cartridge manufactures.

Meanwhile Aberdeen's D&PS was still looking at the XM196 tracer round. In the report, *Final Report of Engineering Test of Cartridge, 5.56-MM, Tracer, XM196*, they detailed the various tests that they put the cartridge though. They found the accuracy of the tracer round was acceptable, with groups measuring in at 1.6 inches at 100 yards, compared to the 1.2 inch groups that the M193 was producing at 100 yards. Additionally, the tracer was able to be seen at well over 800 yards away.

APPENDIX III - PHOTOGRAPH



CARTRIDGE, 5.56-MM, TRACER: XM196

DATA

Standard:	Cartridge, 7.62-MM:	NATO, Ball, M80 (Ord. Dwg. No. C-8599543)
	Cartridge, 7.62-MM:	NATO; Tracer, M62 (Ord. Dwg. No. C-7553705)
	Cartridge, 5.56-MM:	Ball, M193 (MUCOM Dwg. No. B-10523652)
Test :	Cartridge, 5.56-MM:	Tracer, XM196 (MUCOM Dwg. No. C-10534195)

	Standard	Test
Bullet	M80, Wt. 151-3 gr M62, Wt. 141-4 gr M193, Wt. 55 gr	XM196, Wt. 55 gr
Case	7.62-MM: Brass, FA T1-E3 5.56-MM: Brass	5.56-MM: Brass
Propellant	7.62-MM: WC 846.4, 47.1 gr 5.56-MM: IMR-4475, 25 gr	5.56-MM: IMR-4475, 25 gr
Primer	7.62-MM: FA-56 5.56-MM: Remington 9RM	5.56-MM: Remington 9RM
Instrumental Velocity, fps	7.62-MM: 2750 ± 30 at 78' 5.56-MM: 3250 ± 40 at 15'	5.56-MM: 3200 ± 40 at 15'
Chamber Pressure, psi	7.62-MM: 50,000 Max. 5.56-MM: 52,000 Max.	5.56-MM: 52,000 Max.

View showing the M80, M62 and M193 cartridges with sectionalized bullets (standard) on the left and the XM196 cartridge with sectionalized bullet (test) on the right.

818-001-C-P558/AMC-65 ABERDEEN PROVING GROUND 23 February 1965

III-1

Figure 14 - Photograph from the report, Final Report of Engineering Test of Cartridge, 5.56MM, Tracer, XM196.

They also tested the penetration capabilities of the round though materials such as pine boards, helmets, and bullet proof vests of the time.

"The five record impacts, with each type (XM196, M193, M62, and M80) of ammunition, completely perforated the front and rear of the helmet and liner at ranges of 100 and 300 yards. At a range of 600 yards, four XM196 projectiles perforated the front of the helmet and liner and the rear liner; one round perforated only the front of the helmet and liner. Two M193 projectiles perforated the front of the helmet and liner and the rear liner; three rounds did not penetrate the helmet. Four M62 projectiles perforated the front and rear of the helmet and liner; one round perforated the front of the helmet and liner and rear of the liner. All five M80 projectiles perforated the front and rear of the helmet and liner.

The number of pine boards, spaced 1-inch apart, perforated at ranges of 100, 300, and 600 yards using M193 ammunition was 11, 16, and 7; using XM196 ammunition, 24, 17, and 7; using MS0 ammunition, 12, 11, and 14; using M62 ammunition, 42, 34, and 19, respectively.

All rounds (XM196, M193, M62, and M80) perforated armored vests at ranges of 100, 300, and 600 yards. (One thickness of vest was

offered a" a target.)

No malfunctions occurred with either type of ammunition (XM196 and M193) with the weapons held in the various attitudes."

The testing also looked at how easily the rounds could be cooked off and they found that even under rapid fire, it took 140 consecutive rounds for either the XM196 or the M193 cartridges to experience a "cook off".

With the rounds passing these as well as tests to look at barrel erosion, deflection from bushes, and general functioning in the test rifles, the XM196 round would be approved for use in not only the M16 but the XM16E1 variants as well.

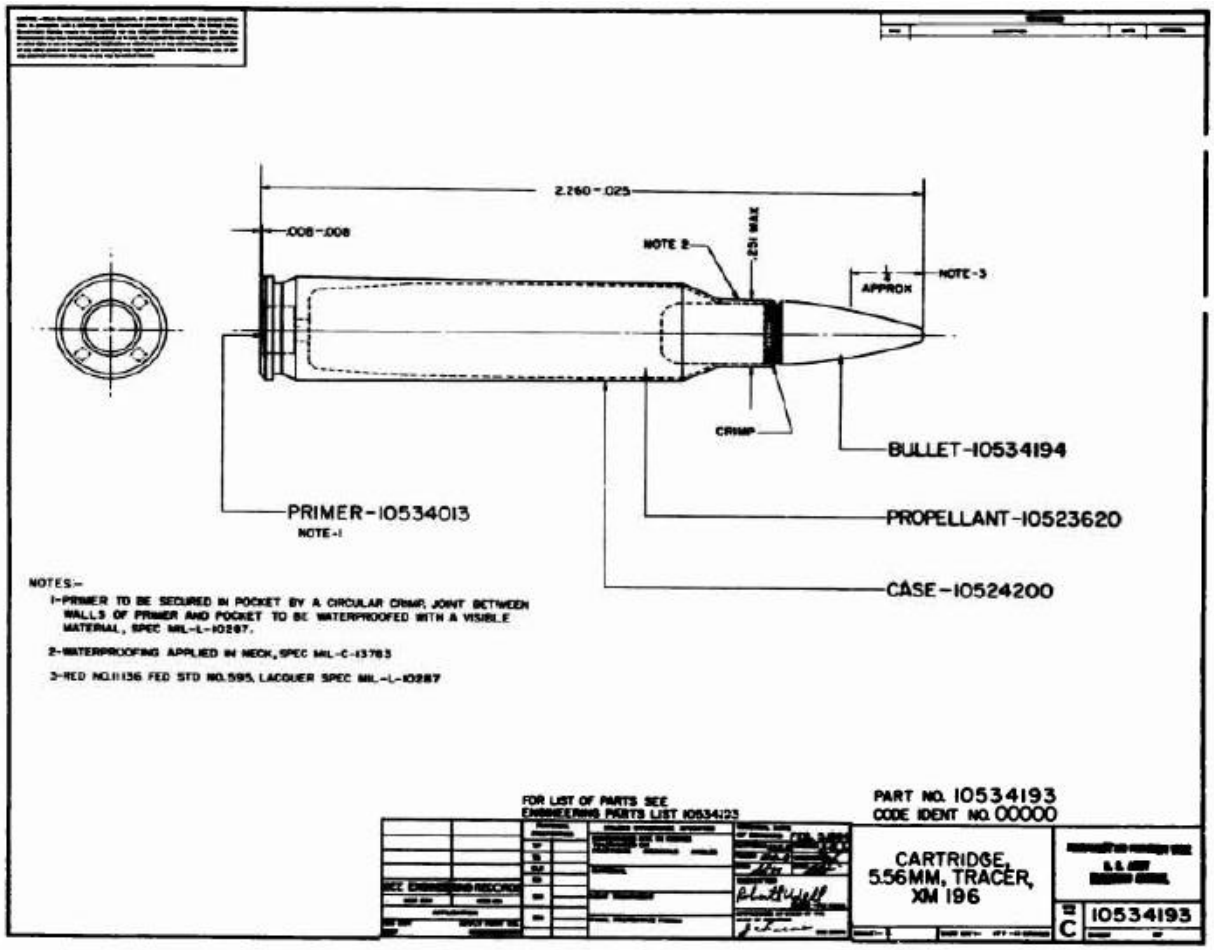


Figure 15 - A diagram from the engineering test report.

An M16 for Everyone

Utilizing his authority as MACV commander, General Westmoreland asked the Army Material command to look at what would be required to give every US troop in Vietnam an M16. Westmoreland was soon given command of the new US Army, Vietnam (USARV).

With this, Westmoreland would soon see support from General Besson in his endeavor to bring the AR-15 to the Army in a much bigger way. Writing to General Abrams, Besson noted that the CONUS stocks of the rifle were running low and would be depleted soon. Besson furthermore praised the rifle for not only having much more controllable, rapid fire, compared to the M14, but for being far lighter as well. Both are characteristics that are much more desirable in the dense jungles of Vietnam. Besson wrote that,

> *"I have just received a TWX from MACV requesting for planning purposes cost and delivery schedule for 50,000 XM16E1 rifles and associated ammunition. In view of this request from Westmoreland, I think the 60,000 figure is too conservative."*

In response Abrams wrote to ACSFOR TLG Theodore J. Conway, saying,

> *"The heat's on! It seems to me that General Besson's line of reasoning might lead to a US requirement for about 8 division forces worth and an initial ARVN requirement somewhat in excess of 200,000."*

While this was going on the SAWS program was gearing up. The USAIB started testing a battery of firearms including the M14, M14E2, M60, XM16E1, CAR-15 SMG, CAR-15 HBAR M1, HK 33, AR-18, and the Stoner 63 rifle, carbine, AR, LMG, and MMG.

As July wound down and August began the last of the Army's planned deployments of the AR-15 model, XM16E1 are delivered to the 1st Cavalry Division (Airmobile). However, the ghosts of the past were still haunting the rifle.

In August of 1965 the OCSA issued a memorandum titled, *Review of M16 Inquiry of 1962-63.* It was a direct response to General Johnsons request that the Inspector General's review of the investigation of the testing done on the AR-15 be reviewed. The memorandum detailed the comparative testing done as well as what events lead up to the Inspector General having to get involved and investigate the testing. The goal of the memorandum was to shed light on how past events would affect any further decisions to purchase more AR-15's.

However, this would not be the only paper published in August of note, two more would come out, first from the US Army Arctic Test Center*, Final Report of Service Test of Cartridge, Tracer, 5.56MM, XM196 Under Arctic Winter Conditions*. This looked at the XM196 tracer cartridge again, however this time under extreme weather conditions. The second report came from the BRL, which published*, Terminal Ballistic Evaluation of the XM144 Fléchette, the 5.56-mm, M193 Ball Bullet and the 7.62-mm M80 Ball*

Bullet. This report compared not only the M193 with the 7.62 NATO, but the XM144 round which was being worked on for the SPIW project which continued to grind away in the background, costing money yet never delivering any promising results.

As September wound down, William C. Davis, who was still at Colt, took a look at a new type of training round. Created by Dynamit Nobel's Geco, these 5.56mm plastic training rounds were intended for use in reloading drills and other types of training where dummy rounds would be used. The hope was that by replacing the typically metal dummy rounds with cheaper plastic ones that a cost savings might be realized.

The Colt Bucks, Again

In 1963 Colt had threatened to stop the production of AR-15's and this helped spur the US Army into its first "one time purchase" of the AR-15. Since the tactic had worked in the past, Colt once again made a threat to the military. Working as Colt's Military Sales Manager, James B. Hall told General Westmoreland and his staff that unless more orders were made for the Army's XM16E1 rifle then Colt would stop producing them.

Around the same time, DCSLOG LTG Lincoln was looking at how many XM16E1 rifles were going to be needed to meet the needs of troops in Vietnam. Over 30,000 rifles were projected to be required by the US forces and this was added to the budget for 1966.

With Colt once again threatening to close down production, the US Army awarded a new contract modification to Colt, worth $597,396. In the modification 5,269 M16 and 100 more XM16E1 rifles were ordered for both the US Coast Guard and the USAF. This also helped to replace rifles that had by provided to Australia as well. The modification continued by adding another $813,138.47 for repair parts.

William C. Davis was still working with Colt in November of 1965 and was continuing to look at the issues of rifle cyclic rates. In his report *Effect of Ammunition Variables on Acceptance Testing of XM16E1 Rifles,* Davis found that due to the use of different powders for both the testing and then in general issue that a rifle might pass testing, however still exhibit high cyclic rates when used with regular issue ammo. In particular, the CR 8136 loaded cartridges would allow the rifles to pass the cyclic rate requirement tests, however they would quickly fail those same tests if used with WC846 loaded cartridges. While Davis proposed that a possible solution might be to simply raise the cyclic rate requirements further past the 900 rpm that the USAF was using to 1,000 rpm this came with its own issues. Davis warned that even if the cyclic rate requirements were raised bolt failures and malfunctions were sure to increase as well.

Soon Davis would be proven right.

Rockwell Malfunctions

After Davis delivered his report, the CDEC phoned TCC to let them know that Davis might be right. They were seeing higher rates of malfunctions and the culprit identified was the powder used. Not only was WC 846 causing higher pressures as well but an increase in fouling in the rifle. This contributed to a cascade effect, jamming parts, wearing them out faster, and causing more and more malfunctions.

Dr. Wilbur B Payne, Chief of Operations Research for the OSA, echoed these concerns. Filing a memorandum with his DOD counterpart, he noted that the use of ball powder loaded ammunition seemed to be the cause of the malfunctions that the AR-15 was experiencing in testing. He further warned that these very issues that had been cropping up in the tests being done by the SAWS program might very well already be happening in Vietnam.

While all of this was going on Colt was applying for waivers on not only rifles that had broken extractor springs at 2,614 rounds but also for 360 barrels that had scored a point lower on the Rockwell C hardness scale.

Less Powder More Production

In December of 1965 the very issue that the military sought to avoid by attempting to not solely relying on one powder supplier came true. Olin's employees at their East Alton, Illinois plant went on strike. Not only was Olin the only source of the ball powder that the military was using but they also were the sole manufacturer of the M196 tracer rounds for the military. While efforts had been made to prevent this from becoming an issue it was now a pressing concern for the military.

Meanwhile General Westmoreland wanted more rifles for his troops. In a cable to General Johnson Westmoreland requested no less than 170,000 more XM16E1 rifles for the troops in South Vietnam. Bypassing the typical chain of command Westmoreland immediately contacted Senator Donald S. Russel who was the Chairman of the Senate Armed Services Committee at the time. Westmoreland wanted 10,000 rifles to be used immediately and any M16 or XM16E1 rifles that were not being used by troops not fighting be moved to troops on the front lines.

With this pressing need the ASA(I&L) Dr. Robert A. Brooks moved to award Colt a contract for accelerated production of rifles. Through General Bession Colt was asked for 100,000 more XM16E1 rifles, with 68,000 going to the Army and another 32,000 going to the USMC. Along with this Bession also was ordered to expand the production of 5.56mm ammo as well. This ended up doubling the production rate that Colt was at, from 8,000 rifles per month to 16,000 rifles per month.

However, Westmoreland was not done.

Only a day after his initial request for the 170,000 rifles he puts in another request for 106,000 rifles for the ARVN and 17,000 rifles for the South Korean troops. This confuses McNamara who wanted to know if the first request for the 170,000 rifles included these request for the ARVN and South Korean troops. Westmoreland responded by revising his request to 179,641 rifles.

Yet, Westmoreland is not alone in his cries for the AR-15 in Vietnam. USMC field commanders were with him, and they too pushed for the USMC to adopt the XM16E1 and drop the M14 from use in Vietnam. With such a strong push for the rifle soon all USMC forces in both the WestPac and CONUS training bases would be slated to receive XM16E1's. Below are the requirements that were projected for 1966 for all Free World Forces.

	Quantity	Cost
South Vietnam Army		
XM16E1 Rifles	100,000	$14.1 million
5.56mm Ammo	535 million	$33.2 million
ROK Army		
XM16E1 Rifles	14,000	$2 million
5.56mm Ammo	76 million	$4.7 million
South Vietnam Marines		
XM16E1 Rifles	6,000	$900,000
5.56mm Ammo	32.3 million	$2 million
ROK Marines		
XM16E1 Rifles	3,000	$500,000
5.56mm Ammo	14.5 million	$900,000
Totals		
XM16E1 Rifles	*123,000*	*$17.5 million*
5.56mm Ammo	*657.8 million*	*$40.8 million*

CINCPAC Admiral Ulysses S. Grant Sharp, Jr. agreed with these numbers and put forth the suggestion that there should be immediate JCS actions to keep up with the demands made. With this the obvious need for more ammunition rose and the DCSLOG LTG Lincoln submitted a proposed change to the January 1966 budget. Adding in funds for 100,000 XM16E1 rifles and 494.9 million rounds of ammunition at a cost of $11 million and $30.7 million respectively. The DOD added even more, adding funds for 123,000 rifles requested for the Free World Forces and another 657.7 million rounds of 5.56mm ammo.

With the ballooning need for ammo, the Director of Procurement and ASA(I&L), Dr. Brooks communicated in a letter called, *Expansion of Production Capacity for 5.56mm Ammunition.* The letter stated that DCSLOG LTG Lincoln wanted production of 5.56mm ammo to be increased to 100 million rounds a month in order to keep up with the expanding demand from forces in Southeast Asia.

Secretary Vance approved this and also gave the go ahead to transform not only the Lace City Army Ammunition Plant but also the Twin Cities Army Ammunition Plant to produce the needed ammo. The cost of converting each plant, which had originally been creating .30 caliber ammo would cost $2 million for Lake City and $3.5 million for the Twin Cities plant for a total cost of $5.5 million.

The WC 846 Issue

With the increased usage of the XM16E1 in South Vietnam Colt wanted to see how well the rifle was doing while in country, however the DOD flat out denied any of Colt's employees access to the troops and their firearms in Vietnam.

However, the same old issue of high cyclic rate was cropping up again, not only in testing by Frankford Arsenal but also in the SAWS program testing as well.

Frankford Arsenal found that when comparing M193 ammo loaded with WC 846 and CR 8136 they found that the cyclic rate of the rifles using the WC 846 ammo was incredibly high. To compare the two powders 18,000 rounds of WC 846 loaded ammo and 18,000 rounds of CR 8136 ammo were fired. What they found with the higher cyclic rate producing WC 846 was that when the AR-15's cyclic rate exceeded 850 rpm the chance of malfunctions greatly increased. The WC 846 powder also produced more fouling than the CR 8136 powder, but of the malfunctions that Frankford Arsenal experienced with the WC 846 loaded ammo, none of them could be attributed to this increased fouling.

In addition to comparing the cyclic rates they also looked at how accurate the two powders were. Despite the higher cyclic rate from the WC 846 the testing found no discernable change in the accuracy of the firearms tested. The conclusion of the testing was that Frankford Arsenal saw no reason to make any changes to either the AR-15 or the ammo as they were currently being supplied to the troops. However, this did not mean that Frankford Arsenal was done with its testing. They wanted to continue exploring the differences between the two powders and specifically their interior ballistics. The end goal of this line of research was to develop very specific specifications for performance and allow for the M193 ball loading to perform the same no matter what kind of powder was used. All of these findings were collected and published in Frankford's report, *Report on a Test of Cartridge, 5.56mm Ball, M193, Lots RA5074 and WCC6089 in M16E1 and AR-15 Rifles.*

The SAWS program had similar findings, despite having different goals in their testing. Released around the same time as Frankford Arsenal's report on the cyclic rate testing, the USAIB published some of the SAWS program's findings in*, Small Arms Weapon Systems (SAWS).*

The USAIB's report found that across the board the M14, M14E2, and the M60 were all more reliable than the 5.56mm firearms such as the CAR-15 family, the Stoner 63, the HK 33, and the AR-18. The found that much of this was because the XM16E1 was more likely to foul up, have excessively high cyclic rates, and because of all of this, exhibit more malfunctions. However, a sizeable change was noted when switching over from WC 846 loaded cartridges to CR 8136 loaded cartridges. Many of these issues were decreased when changing over to the other powder. Despite this the USAIB elected to recommend against adopting any of the 5.56mm replacements to the 7.62mm NATO chambered firearms in their reports. Citing that they were waiting for "significant improvements" before they could recommend a switch.

Despite this the US Army Armor Board begged to differ on the conclusions reached by the USAIB. Particularly when it came to the issue of adopting 5.56mm chambered firearms. In their testing, published in *Service Test of Small Arms Weapons Systems*. They found that the Stoner 63 Carbine and the Colt CAR-15 SMG both offered advantages over the standard issue firearms used by the military in the roles they were intended for. They recommended that, while the ultimate decision rested with the Department of the Army, the Army should adopt 5.56mm small arms.

As 1965 came to a close continued testing of various firearms in the SAWS program would continue and the specifications for the M232 Dummy Cartridge would be released under the military specification, MIL-D-60254(MU).

Expanding Production

In early 1966 Olin's employees were still on strike. Since the military still needed M196 tracer rounds produced they moved production to the Lake City Army Ammunition Plant to fill in the gap caused by the strike. Meanwhile two new 5.56mm designs were coming to fruition; one from an unlikely source.

First, Federal Cartridge rolled out a new, heavier, 68 grain 5.56mm ball loading. Second, General Electric finalized a 5.56mm design of their own. While not normally considered to be a firearms or cartridge manufacturer, GE worked on a new type of armor piercing round for ArmaLite. The new round utilized a tungsten core instead of a standard lead round or steel. As the round would be developed and perfected it would eventually come to be called the P96. However, GE was not alone in looking to tungsten as a potential material for 5.56mm armor piercing rounds. Not to be left out, FN would also release their own tungsten core armor piercing round in 1966.

Despite these changes there was still a need for expanded production of the AR-15. This prompted General MG Roland B. Anderson to not only put WECOM on the task of obtaining licensing rights but also ordered LTC Yount to start working on a plan for gearing up a second source of production of the AR-15 variants, XM16E1 and M16.

On January, 1st 1966, the Army had distributed M16 rifles in the numbers below.

Theater	Number on Hand
USAREUR	1,408
Vietnam	32,068
USARPAC Less Vietnam	481
Other Overseas	1,722
STRAF	23,156
CONUS Less STRAF	2,514
Total Active Army	**61,349**
Reserve Components	*1,197*
CONUS Depot	*19,264*
Total Worldwide	***81,810***

With these numbers compared to what was required and requested by General Westmoreland, the OASD(I&L) came up with two options for expanding production of the rifles. The first option was to press Colt's production, increasing it to 25,000 rifles per month as quickly as possible. The second option was to expand production to include a second source other than Colt. However, there was a problem with this. Without the manufacturing rights or a Technical Data Package from the military it was estimated that it would take roughly 22 months before a second source of production would be able to come on line. With these options on the table the Army goes to Colt and informs them that an order for roughly 400,000 rifles would be coming soon.

In the face of this increased need for rifles, the need for ammo only grew greater as well. DCSLOG LTG Lincoln increased his projections for how much 5.56mm ammo would be needed. Increasing the previous 100 million rounds a month figure to 150 million rounds a month. As proposed the need would be addressed by retooling both Lake City and Twin Cities ammunition plants. However, in the memo, *Expansion of Production Capacity for 5.56mm Ammunition at Lake City and Twin Cities*, Dr. Brooks revised the cost projections for converting the two plants with the following numbers.

Location	Previous Cost	Revised Cost	5.56mm Production Capacity Per Month
Lake City Army Ammunition Plant	$2 million	$1,621,000	40 million rounds
Twin Cities Army Ammunition Plant	$3.5 million	$4.3 million	100 million rounds
Total	***$5.5 million***	***$5,921,000***	***140 million rounds***

Along with these retooling proposals things changed for the better for Olin. Not only did the employee strike end at the East Alton plant, but days before that the Badger Army Ammunition Plant was reactivated. Badger Army Ammunition Plant had sat, maintained but not in use, since 1958 and had been operated by Olin since 1951 for the Army.

A New Design

While the TCC found that while the XM16E1 was experiencing malfunctions at a rate that was high enough to warrant looking into the issue and correcting it, the decision was made that it was not severe enough to affect its use in combat. However, Colt was working on a new design change that would help with some of the issues that they were experiencing.

In January of 1966 Foster Sturtevant developed a new buffer assembly. This particular design had a number of changes from Eugene Stoner's first design. The initial change was the weight of the buffer, increasing it three fold over the old buffer, however the larger change was in *how* this larger weight was distributed. Instead of being a solid mass, Sturtevant's buffer design used multiple weights inside of the buffer. This was intended to give a counter balance to an issue that had been cropping up with the higher cyclic rate produced by the new powders. Eventually Sturtevant would patent this design in 1968.

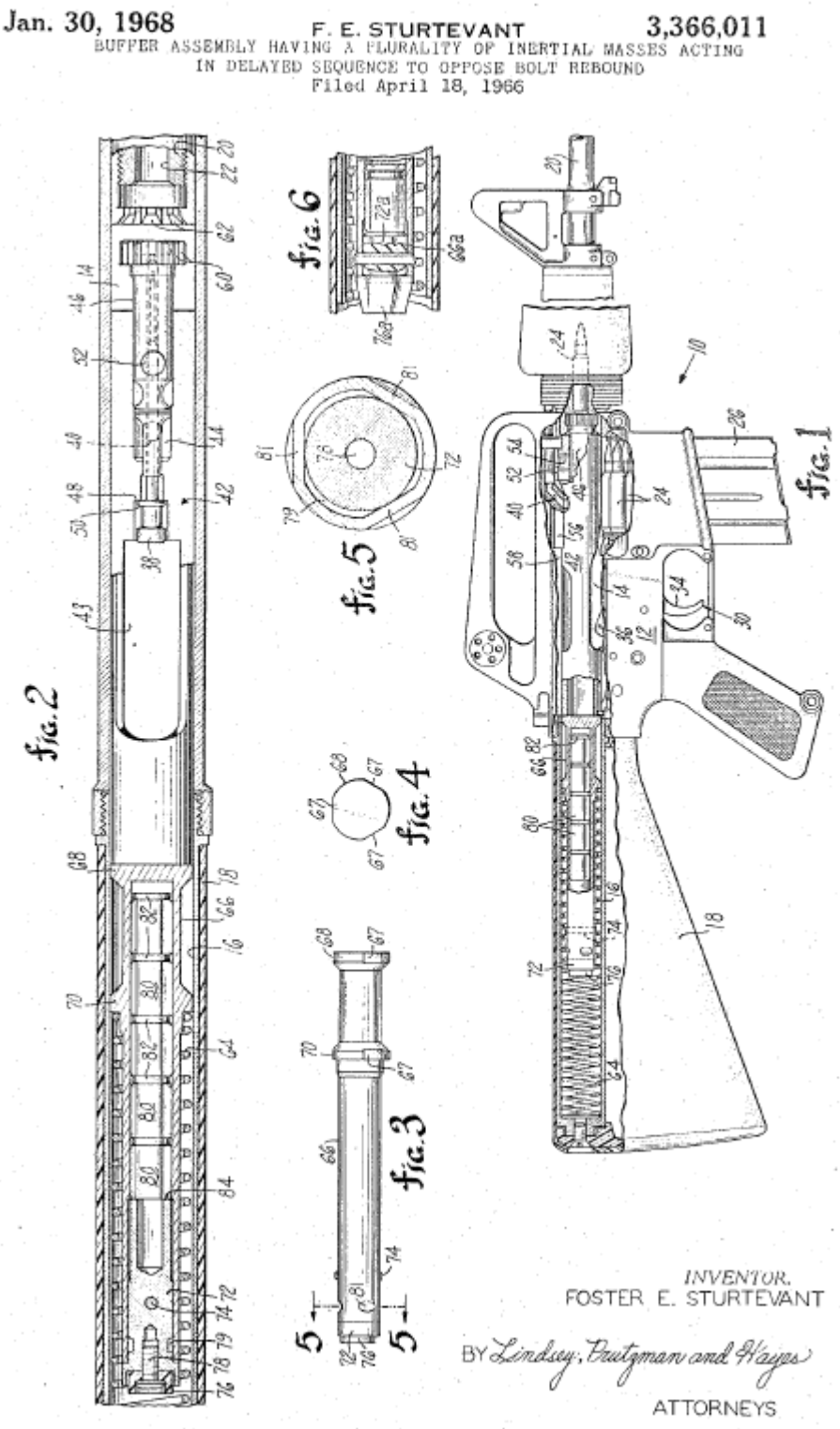


Figure 16 - Sturtevant's new buffer design.

The higher cyclic rate was causing so much backwards force on the bolt carrier group that when it would be returned by the buffer spring there would still be enough residual momentum to "bounce" the bolt back out of battery. This primarily occurred when the AR-15 was used with fully automatic fire and would be referred to as "bolt bounce".

The new design also helps to reduce the cyclic rate over all, in addition to dealing with the bolt bounce issue. The effects of this change were seen almost immediately. The first use of this new design was in the CAR-15 HBAR. When compared to the XM16E1 that used Stoner's design (which would have been fine if not for the changes to the powder used) the CAR-15 HBAR had a malfunction rate of 3.02 malfunctions ever 1,000 rounds fired. The XM16E1, however had a malfunction rate of 11.15 malfunctions ever 1,000 rounds. With the SAWS program delivering these test results, the TCC moved to have Springfield Armory continue to look at the new design and ensure that it was working as intended.

Frankford Arsenal continued to have issues with the WC 846 powder. The found that the M16 continued to have issues with the cyclic rate when using ammo loaded with WC 846. However, this was not the case with CR 8136. While Frankford Arsenal had fired 12,000 rounds through each of the six rifles in their testing, four XM16E1's and two AR-15's, all of these rifles used the older buffer tube design and not the one developed by Sturtevant.

Meanwhile the CDC would begin working on 30 round magazine for the AR-15. While today we think of 30 round magazine's as standard, this was not the case when the M16 was first issued. Instead straight, 20 round, magazines were common. The goal was to have 30 round magazines become the standard, however early attempts were met with failure. The first designs that Colt worked on had a continuous curve to them, not completely unlike that of an AK-74 magazine. However, these were prone to issues because of the tolerances in the mag wells of the lower receiver. The straight design, leading into a curve that we see today on metal "GI mags" we see today would not enter into production for another two full years. Finally going into full scale production in late 1968 or very early 1969.

Determining Barrel Life

While new designs were coming in for the AR-15, Springfield Armory was working on nailing down barrel life. In the report*, Barrel Erosion Study of Rifles, 5.56MM, M16 and XM16E1--A Joint Army-Air Force Test*, a total of 12 XM16E1 rifles were shot until their barrels reached the end of their service life. They used both an air gauge as well as an expanding mandrel gauge to measure the barrel's bore diameter as it was used. The found that bore diameters over 0.2206 inches would be unusable. If the rifling was out of specification up to 3.625 inches from the start of the rifling, then the barrel could be used both in training at home and in combat overseas. If the rifling was out of specification up to 6.625 inches from the start of the rifling, then the rifle would only be used for training. Anything over this would mean that the barrel would have to be replaced. To help armorers Springfield Armory created a gage to measure the barrel erosion, labeled as "Gage, Barrel Erosion C7799792".

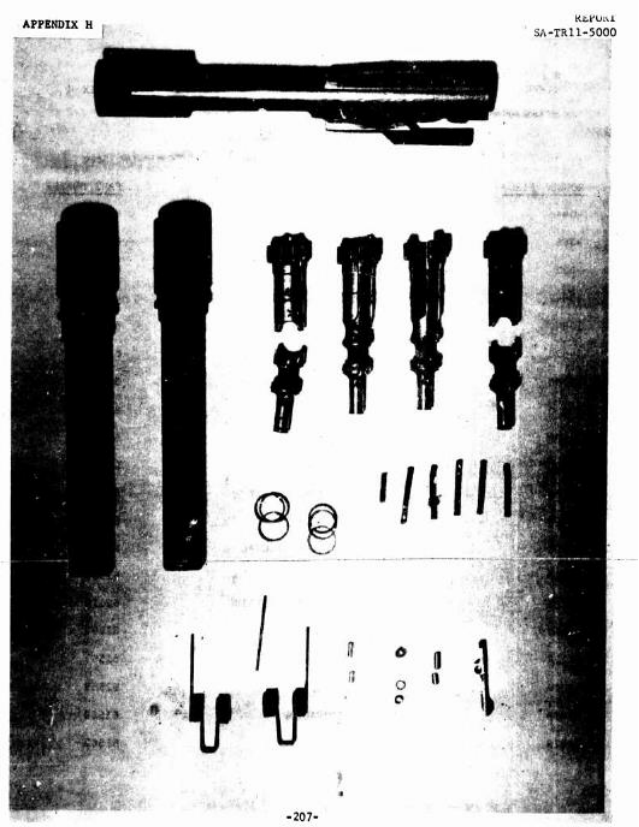


Figure 17 - Worn out and damaged parts from the testing done for the 1966, Barrel Erosion Study of Rifles

In February of 1966 new issues would crop up with the barrels as the USARV put in a priority request for cleaning rods to be sent to Vietnam. Not only are they low on this critical tool, but they also lack chamber cleaning brushes needed to maintain the rifles.

Colt continued to refine its manufacturing process, shot peening bolts to increase their service life. As February continued more changes to the specification of the M193 ammo would come.

Comparing WC 846 and CR 8136 Again

Another change to the specifications of the military's 5.56mm ammo was made in February of 1966 as well, however this time it was not to the powder but to the primers. Testing had found that a particular compound that was being used in the primers was causing excessive fouling and a change to the specification was made to address this issue. Calcium silicide had been used in primers for some time, however it was found that the amount of carbon fouling could be decreased by removing it from use in the primers.

Frankford Arsenal continued looking at both the CR 8136 as well as the WC 846 powders in the report, *Test of Cartridge, 5.56mm Ball, M193, Lots RA 5074 and WCC 6089 in Rifles, 5.56mm, XM16E1, and AR-15.* When comparing the two powders they found that CR 8136 would have higher chamber pressures, yet lower port pressures than WC 846. Additionally, they found that CR 8136 produced lower cyclic rates, fewer malfunctions less fouling, and more consistent velocities. However, CR 8136 did produce more bore erosion than WC 846.

As March began, McNamara appeared before the House Armed Services Committee and spoke to questions about whether or not a second source of M16's would be needed, especially since the Olin East Alton plant had experienced a strike. In response McNamara told the Armed Services Committee that the military was in negotiations with Colt over the licensing rights.

It was in March that the use of ball powder might be the ultimate issue with the AR-15's cyclic rate and malfunctions was more closely examined. Frankford Arsenal was told to not only look at the use of ball powder but also to work out what the acceptable performance would be for both ball powder and IMR powders in 5.56mm as well. Meanwhile the Badger Army Ammunition Plant began to once again produce ball powder for the military. It had previously produced ball powder in 1950, however the current efforts in Vietnam and the demand for more ammo would spur its reopening.

Gustafson's Return

In April of 1966 the USARV looked at how well things were going in Vietnam with the report, *Evaluation of US Army Combat Operations in Vietnam.* The report which would be called ARCOV found that there was unanimous support for replacing the M14 and the M14A2 with the XM16E1. The new rifle was simply better for the kinds of engagements that the troops were dealing with and this was rapidly becoming clear to those who were willing to take a serious and objective look at the issue.

While the final approval from the TCC to use EX 8208-4 powder, a variant of the IMR family of powders, finally come down from the TCC after it had been looked at in 1965 Gerald A. Gustafson came back to the SCHV concept and proposed a new bullet design. His proposal was to bring back the design used in the .30 M1 ball ammo but this time in a .224" caliber, 68 grain form. Going to Sierra bullet once again, he requested 50,000 bullets for testing in barrels with both 1:12" and 1:9" twists. Gustafson, since his work was halted in 1954 had been working at Aberdeen's Test Analysis and Operations Office, and his idea for the 68 grain bullet design essentially picked up where he had left off almost a decade previously.

May of 1966 saw an update of the requirements for M16 rifles for the military. With escalating need for the rifles in Vietnam and more the updated numbers were as follows:

US Army		
	Original Submission	30,134
	USARV	68,000
	In lieu of M14 rifles, plus consumption	115,271
	South Vietnam Army	100,000
	ROK Army	14,000
	Total Army Purchase	327,405
Other Military Branches		
	US Air Force	60,082
	US Marine Corps	91,872
	US Coast Guard	2,000
	Total for Other Branches	1,411
Grand Total		***482,770***

While Colt's President Benke and Secretary Ignatius were meeting to discuss the ongoing negotiations over the AR-15's Technical Data Package and licensing rights, new developments were happening with the 5.56mm ammo.

Not only did production of M193 5.56mm ball ammo start using EX 8208-4 powder but also new testing was being done at Springfield Armory with the new buffer design. While the early tests of Sturtevant's design were promising the report, *Evaluation of Proposed Buffer Designs* found that there were some potential issues with it. They found that when comparing an M16 using the new buffer design and cartridges loaded with WC 846 that it was not working as well as an M16 that used Stoner's original design and cartridges loaded with CR 8136.

As May came to a close a small but desperately needed change was made with a contract for cleaning brushes finally being issued. The fact that it took so long for such a small, yet vital contract to be issue was symptomatic of the kind of attitude that permeated the military at that time.

The Mysterious Case of Lot FC1830

Since the approval of the use of EX 8208-4 for use in the M193 and M196 tracer rounds came in DuPont had been working with the powder and loading the cartridges with them in June of 1966 the first of these rounds would be issued to the troops. Meanwhile the Army proceeded to order a total of 997,410 pounds of the EX 8208-4 for use in the military's ammunition plants such as Twin Cities and Lake City. However, there was a mystery brewing with another type of 5.56mm ammo.

Back in April of 1966 a small but alarming incident occurred with a cartridge from Federal. During testing done by CDCEC, one XM16E1 rifle had a case head rupture. The lot that the case was part of was lot number FC1830. While MUCOM investigated, the entire remaining lot was put on the shelf and held for review. In May of 1966 Frankford Arsenal was able to complete its testing of the lot and found that it seemed to be free from any further issues. Lot FC1830 was then cleared for continued use. Yet more issues with the lot were to come.

The Infantry Rifle Unit Study (IRUS) was being conducted at the CDCEC and another XM16E1 rifle experienced a case head breach. The rifle was damaged beyond repair; however, this was only the third time that a case head breach had happened over the life of the M16/XM16E1 program. The 5.56mm ammunition being used was traced back to, again, lot number FC1830. With the catastrophic malfunction William C. Davis was dispatched to do a more thorough investigation of the lot. Working with a repetitive from MUCOM as well as further testing by Frankford Arsenal and Federal Cartridge, no problems were able to be found with the lot.

It was baffling.

In total roughly 230,000 rounds from lot FC1830 had already been fired without any issues of this magnitude and Davis and those working with him on the mystery were at a lost to explain why the case ruptures had happened. The likely suspect was narrowed down to the case hardness tolerances, however Davis and the others were not able to confirm this. Instead of allowing the lot to return to use, it was decided that lot FC1830 would be destroyed. As an extra precaution the lot after it, FC1831 was suspended in case there were more issues that had not been found during the investigation.

While Aberdeen's BRL was still looking at bullet designs with its report, *The Aerodynamic Properties of a Caliber .223 Remington Bullet used in M16 (AR-15) Rifle,* the problem of case head ruptures would occur again.

In July of 1966 not only would the US Army approve Sturtevant's design for use, but the case head rupture issue would come back. This time it was not Federal's cartridges but instead one from Remington. A fourth rifle would be destroyed in the incident, lost to a case head rupture. Remington tracked down the lot that the suspect round came from and identified it as having come from lot number RA5189.

Eventually in December Frankford and Rock Island Arsenals come together to try to solve the mystery. They find that they were completely unable to replicate what happened during the case ruptures. The only way that they were able to achieve results approaching the damage done to the rifles that had experienced case head failures was to load 5.56mm cases with either handgun or shotgun powder.

The SAWS Program Concludes

As August of 1966 rolled around every US Army combat units in Vietnam had received XM16E1's. However not everyone had an M16 variant yet. Some support units at that time were still stuck with M14's and would not receive replacement M16's until years later.

Yet the SAWS program had come to its close and the CDC was releasing its findings. The CDCIA, instead of conducting more traditional research and testing elected to use computer models from the CARO computer simulation to develop its recommendations. Mind you that today's phones have more processing power than the large "super computers" of the 1960's. However, they came to the following recommendations:

1. *Procure no additional rifles beyond those XM16E1 rifles currently on order until SPIW becomes available in 1970;*
2. *Initiate a program of selective modernization by procuring SPIW, when available, in sufficient quantities to replace rifles, automatic rifles, and grenade launchers for infantry maneuver units only (approximately 192,000);*
3. *Retain the M60 as the future infantry machine gun until the Universal Machine Gun (UMG) is developed, about 1972;*
4. *Improve the effectiveness of SPIW in the automatic rifle role or adopt the UMG with a bipod mount to this role;*
5. *Continue development of the UMG to make it at least as effective as the M60, while preserving the weight-savings of the current conceptual UMG design, and then in 1972, replace all machine guns with the UMG;*
6. *Initiate and fund a vigorous research and development program for the purpose of: a) developing caseless ammunition by 1976 with improved projectiles for use in a redesigned SPIW with a further improved area fire capability; and b) discovering or developing a new lethal mechanism permitting design of radically different small arms systems; and*
7. *In 1976, continue the program of selective modernization by procuring 500,000 SPIW redesigned to utilize caseless ammunition. About half of these will have the area fire capability and half will not.*

Additionally, a number of secondary recommendations were made:

1. *Develop a method of measuring in actual test firing the combat effectiveness of platoon weapon mixes. In particular, assess the interrelations between different types of weapons in a conventional mix and assess the value of fragmenting rounds in comparison with conventional ball projectiles;*

2. *Establish a program to develop a comprehensive and detailed computer simulation models for evaluation than was possible with the computer model used in the current study;*

3. *Procure and issue 7.62mm duplex ammunition to complement the M80 cartridges already in the inventory;*

4. *Reduce the cost of small arms ammunition of current and conceptual systems; and*

5. *Monitor rocket-type small arms systems continually to permit exploitation of any inherent military potential.*

The SAWS program also came to the conclusion that when comparing the 5.56mm to the 7.62mm the smaller of the two was better for so called, "low intensity" warfare while the larger was better for "high intensity" warfare. The SAWS program reached this conclusion though the use of their computer models.

I guess someone forgot to tell them,

"No battle plan survives contact with the enemy"

- *Helmuth von Moltke the Elder*

However, there was almost immediate skepticism of the computer simulations and the conclusions reached. As the SAWS program results were being given to the Army Staff a letter to ACSFOR LTG Polk modified the CDC's recommendations, reading:

- *Rifle Procurement: An increase in stockage objectives or significant decrease in assets by combat loss or wear-out, requiring an additional buy of rifles before 1970, should be satisfied by purchase of XM16E1 weapons;*

- *Adoption of SPIW: The final decision to adopt and field SPIW must be contingent upon results of further experiments and tests. It is understood that some difficulty is being experienced in current SPIW comparative evaluation testing by the AMC. To be acceptable, SPIW should essentially equal the theoretical capabilities used in this study;*

- *Automatic Weapons: The need for an automatic weapon in the squad is recognized. This recommendation does not exclude from consideration weapons other than the UMG and SPIW; and*

- *General: While the 7.62mm systems do provide advantages over the 5.56mm systems against materiel targets, the intensity of conflict is not a sound basis for a clear choice between two weapons.*

Finally,

> *"An environmental distinction, giving due consideration to terrain, existing built-up areas, and estimated equipment resources of the enemy offers a better basis for choice. This minor advantage offered by the 7.62mm system does not, of itself, warrant the maintenance of two different small arms weapon systems in the inventory. It is the position of this command that the total SAWS Study does indicate that the 5.56mm rifle offers the most promise for improved capability for the money spent . . . the concept of selective modernization is an excellent idea whereby the Army takes deliberate advantage of progressive improvements in small arms. Every reasonable effort should be made to insure that Army units are equipped with the best possible weapons. To this end, the indicated timing must not become a constraint; advances in the state-of-the-art must be taken advantage of as they occur."*

September of 1966 saw another hard look at the computer models that were used in the SAWS program's conclusions.

The US Army had just created a new systems analysis group, the Force Planning and Analysis Office or FPAO. Under the leadership of its civilian co-director, Dr. Jacob A. Stockfisch it began looking at the data gathered by the SAWS program. Stockfisch had little regard for the computer simulations that had been run by the SAWS program and looked at their actual test data instead. Reporting to General Johnson in a memo he stated what should have been obvious by now, the SPIW program would, at best, produce results only as a long term project and that the XM16E1 should be the primary focus of the military's small arms procurement.

We Need Cleaning Rods

By September of 1966 the total rounds used by the troops in Vietnam since March 1965 had totaled roughly 99 million rounds of 5.56mm ammunition. Of these, the majority, roughly 89 million had been using the WC 846 powder while the remainder used CR 8136.

With all of these rounds flying the troops in Vietnam were in desperate need of proper cleaning materials and few had actually made it in country. Many troops were writing home to their families and requesting that they be sent .22 caliber bore brushes for their rifles. Because of this the 1st Logistical Command issued a request to General Besson. An immediate air lift of no less than 50,000 cleaning rods and 50,000 bore brushes to be sent to Vietnam.

It was around this time that another change would be made to the M16. However, this had to deal with the flash hider.

The first M16 rifles to be produced featured a three pronged flash hider, often referred to as a "duck bill". While the design worked it quickly became a liability in the dense jungles so an alternate design was created. The "bird cage" flash hider design that we are now used to seeing saw its first incarnation go into production and formally replace the previous design. The "duck bill" design was also blamed for, of all things "assisting the capillary movement of water into the bore". It seemed some issues would never die.

Figure 18 - The three prong design was eventually replaced by the A2 "Birdcage" design.

Of Course It's Malfunctioning

The ongoing issue of proper care and maintenance of the M16 rifles in Vietnam begins to come to a head in October of 1966. Malfunctions and stoppages were becoming common and General Westmoreland called in assistance to get his troop's rifles back up and running. In response LTC Herbert P. Underwood (Colonel Yount's assistant), as well as representatives from WECOM and Colt were all dispatched to assist General Westmoreland. What they found was shocking.

Due to the lack of not only cleaning materials but technical manuals, spare parts, and a simple lack of any kind of training on the M16 rifle, the rifles were in horrible states of disrepair. The situation was so bad that LTC Underwood insisted that Colonel Yount come and see the issues in Vietnam himself. Yount arrived in Vietnam in November and quickly had rifles sent to Rock Island to be examined by Colt's employees. Colt's team included Robert Fremont as well as others from the Technical Assistance Team.

Upon though inspection of the rifles they find that Underwood's initial assessment was correct. Far too much oil was being used on the rifles and they were not being cleaned either, with large amounts of carbon caking the chamber, bolt, and bolt carrier group. Magazines were often loaded to a total of 21 rounds, causing feeding issues, but there was often oil and dirt in them as well, with even the ammunition being oiled in an attempt to make the magazine's work better. Many rifles did indeed have broken or work out parts with extractors and extractor springs being the largest culprits for malfunctions. It was obvious that these issues needed to be addressed, and quickly.

What Twist?

As Colt started work on changing over to chrome plated chambers for the M16, the TCC was asking for a response to the idea of moving back to a 1:14" rifling twist. Colt responded to the TCC that while the, then current, 1:12" twist rate barrels were meeting the physical specifications for the barrels they were experiencing a failure rate of 10% when the barrels were tested for accuracy. Colt feared that if they were to move back to a slower twist that accuracy standards might have to be relaxed in order to accommodate for the change back in twist rate.

In November of 1966 General Johnson made a number of recommendations based on the SAWS program results. In the memo CSM 66-485*, Army Small Arms Weapon System*, he wrote,

"The XM16E1 rifle will be adopted as the standard Army rifle and will be reclassified as "Standard A". The M14 and M14A1 rifles will remain "Standard A" initially. The Authorized Acquisition Objective (AAO) for rifles and automatic rifles will be computed on the XM16E1, rather than on the M14 and M14A1.

Pending the completion of...field experimentation...the XM148 grenade launcher will be issued as the companion grenade launcher for units armed with the XM16E1 rifle. Concurrently, action will be taken to improve the design of the XM148.

The Colt carbine/submachine gun will be adopted in lieu of the XM16E1 rifle in those cases where use of the XM16E1 rifle is impractical as the individual weapon.

A companion automatic rifle will not be adopted.

The M60 machine gun will be retained until an improved machine gun is developed and adopted. Evaluation of the 5.56mm machine gun will continue.

The development cycle of the SPIW will be reoriented to the status of exploratory development and become a part of a broadened small arms research and development program for the future.

The overall procurement objective is a single-family (rather than a multi-family) small arms weapon inventory based on the Colt 5.56mm individual weapons and, for the present, the M60 machinegun; and the first objective will be to eliminate at an early date the caliber .30 family of infantry weapons.

Product improvement...will be incorporated in the new production of XM16E1 rifles and 5.56mm ammunition.

The 7.62mm duplex ammunition will not be produced for other than development purposes at this time."

While Johnson was making his recommendations, Yount and Underwood were visiting II Field Force HQ, the commanders of the 25th Infantry Division and 1st Aviation Brigade, 1st Cavalry Division, 1st Infantry Division, and LTG Walt, Commanding General III MAF. In his meetings Yount took the time to note that repair parts and cleaning kits were vital to the proper functioning of the M16 in order to prevent the situation in Vietnam from happening again.

Stopping The Bleeding

In December of 1966 Colt was still in negotiations with the military over the rights to manufacture the AR-15. However, Colt was now producing 25,000 rifles per month for the military.

Meanwhile, General Besson received the Technical Assistance Team's findings. Once again they hammered home the issue of keeping the M16 well cared for and properly maintained. The fall out of this resulted in the inspection and repair of all of the M16's that were issued. This was carried out by support maintenance teams as well as parts of the 1st Logistics Command. Furthermore, there was wide spread publication of handbooks on how to care for and clean the rifles. Handbooks were issued at the company level or the rifleman level. Additionally, all new troops were to be given no less than two full hours of training on how to service a M16 as soon as they arrived in Vietnam.

Finally, commanders were given the responsibility of making sure that all of the necessary care and maintenance was carried out by their subordinates.

SPIW Who?

It seemed the tide was finally beginning to turn for the AR-15 as 1966 began to come to a close. The Secretary of the Army Resor sent a memo to McNamara that described General Johnson's plans for the rifle program moving forward. Johnson's goal was to limit rifle purchases to just the XM16E1 for the foreseeable future and to replace all of the remaining M1 rifles with XM16E1's as soon as they could be acquired with a long term goal of complete replacement of the M14 with the XM16E1. Johnson also wanted to look for another manufacturer to help add to Colt's supply of the rifle for the military.

Johnson also took the time to state that the SPIW program was unlikely to produce any firearm worthwhile in the near future. Much like the others who had looked at the flechette firing SPIW program with an objective eye, he found that it was a long shot program at best. Finally, Jonson proposed that there should be some minor changes to the M16. The two things in particular that he identified were the powder used in the cartridges as well as the rate of twist used in the rifling.

Towards the end of December, 1966, DuPont delivered another shipment of powder, IMR 8208M. This time the shipment is 187,847 pounds and again it heads for the ammunition plants run by the military. Late in December Yount receives a message from General Besson telling him to *"come to grips at an early date with the 3,250 f.p.s. velocity requirement."*

Subsonic Gilding Metal

With the start of 1967 new projects were being worked on to create new loads for the 5.56mm round.

Nosler began working with Frankford Arsenal to test a new bullet design. Unlike the lead and copper designs of previous rounds Nosler's team takes a different approach and instead starts working on a light 41 grain bullet made from steel plated with bronze. Intended as a new armor piercing round the initial testing includes 500 prototypes that were delivered to Frankford to be tested at their facilities.

Meanwhile the Naval Ordnance Laboratory started work on a sub-sonic load for Navy Seal Teams. Two different designs are worked on, one consisted of a shortened lead slug. The second design considered utilized a hollow point design created by Sierra. Ostensibly both designs were intended for use on "sentry animals", however neither cartridge manages to create the terminal performance necessary to make either round practical for use.

Finally, Lake City and Frankford Arsenals come together to create new jackets for the M196 tracer round. A number of reported instances of the tracer round's jackets being stripped by the rifling prompted them to look at new materials for use in the 5.56mm tracers. They begin working on using gilding metal clad steel (GMCS) for the jackets with promising results.

Once again Yount finds himself fielding requests for more cleaning supplies. Swabs, bore brushes, chamber brushes, and cleaning rods are all needed and supply is simply not keeping up with demand. With this continued maintenance issue going on in the background, PMR Office releases yet another report on the sensitivity of the primers used in the 5.56mm ammo, titled*, A Review of Primer Sensitivity Requirements for 5.56mm Ammunition.*

Ballistics Mismatch?

The US Army continued to look at the internal ballistics of the M193 ball ammo as well as the M196 Tracer rounds. What they found was that there was a large discrepancy in the internal ballistics of the two rounds. As many as 57% of the tracer rounds were mismatched to the ball ammo. However, at that time no effort was made to address this issue and the two rounds remained unchanged.

Meanwhile a German company began working on some new loads for the 5.56mm.

Mauser, though their subsidiary, NWM, started working on a series of rounds, all intended for use in the Stoner 63. The first two were fairly standard affairs, with a tracer round with a 700-meter range and a training blank round. However, the other two that NWM created were more interesting.

NWM developed an armor piercing round, again using a tungsten core bullet with a total weight of 63 grains. The last was the most unusual, with a 77 grain full metal jacket bullet moving at 2,722 feet per second and having a muzzle energy of 1,267 foot pounds of force. The heavier round, however, required a faster twist rate than what had been experimented with earlier and NWM found that it worked best with the highly specific twist rate of 1:7.8".

A Tentative Agreement

With the military still looking to work out a licensing agreement with Colt a tentative agreement was finally reached with the company in early February of 1967. Colt would receive a 5.5% royalty on production as well as a $4 million payment along with a continuing commitment from the military to source their rifles from Colt. With this plan moving forward the previously "experimental" XM16E1 is reclassified as "Standard A" and receives a new designation, "Rifle, 5.56mm, M16A1".

However, there was still a catch. The NATO standardization agreements were still in effect and would not formally expire until January of 1968. In order to keep other members of NATO happy General Johnson comes up with a suggestion in his memo to Secretary Resor*, NATO Impact of SAWS Decision*. Instead of doing a mass change over to the 5.56mm, Johnson suggests keeping all troops stationed in Europe and working with NATO continue using the M14 until 1972. This way there would be a four-year gap between the end of the standardization agreements and the full changeover of the US Military to the M16.

While Colt moves forward with their contract with the military they find themselves on the wrong side of some bad press. The US State Department's Office of Munitions Control allowed Colt to sell 18,000 AR-15's and 2,300 AR-15 HBAR M1's to the Republic of Singapore. Once this became public it created serious outcry as many accused Colt of removing rifles from shipments intended for US troops. While Colt denied all accusations levied against them, it was a losing battle as some South Korean troops were still using surplus M1 rifles, instead of the more modern M14 or M16.

More Problems

New reports were coming out that there were problems with the M16A1. The first inklings of this come from the PMR's office. They found that the M16A1 still had issues with finding alternate sources for the powders they needed, cyclic rates were still very high in testing, chamber corrosion was a continuing issue, the barrel twist rate had yet to be properly nailed down, fouling in the system still remained an issue, tracers were still required, and it was felt that general improvements to the M16A1 were still needed.

The problems would continue, but not from a military report, this time newspaper reports surfaced, claiming that there were still issues with the M16A1. This prompts Colt to begin more closely inspecting the production lines. However, this proves difficult as they would inspect the rifles, find no problems themselves, and then ease up on inspections, only to hear of issues returning again.

Making The 5.56mm NATO Standard

In April of 1967 a survey was conducted, checking up on how well the efforts to improve the maintenance of the rifles in Vietnam was going. The survey team found that while cleaning and maintenance had improved there was still an ongoing issue with deterioration of the rifles' barrels. The hot and humid climate was wreaking havoc on the rifles metal parts and a total of 10% of the rifles were expected to need replacement barrels once every three months. The solution to this was to begin chrome plating the chambers and eventually the entire bore of the rifles. This would not only make them easier to clean but also increase barrel life and resistance to corrosion in the humid environment.

With the NATO standardization agreements around the 7.62mm NATO round expiring soon, a meeting was held, the NATO Standardization Meeting of Panel III. Great Britain's representatives proposed that the American designed 5.56mm round be considered for testing to determine if it was suitable for NATO Standardization. The proposition was met with no resistance and a unanimous vote moved the 5.56mm closer to becoming NATO standardized.

The Beginnings of the Special Subcommittee On the M16 Rifle Program

On May 3rd a new Special Subcommittee was created by the Chairman of the House Armed Services Committee, Representative L. Mendel Rivers. The Subcommittee included Representatives Richard Ichord, Speedy O. Long, and William G. Bray. However shortly after being formed the Subcommittee finds itself having to find answers to some serious questions.

Catherine Leroy was a French photo journalist who was working in Vietnam. She published a number of photos of Marines who were lost in combat during the battles for Hills 861 and 881. The battles took place from April 24th to May 5th in 1967 and Leroy's photos showed that the Marines rifles had been field stripped in combat. The publication of these phots in the May 13th issue of *Paris Match* magazine prompts the Subcommittee to begin hearings on the M16 rifle program on May 15th.

Figure 19 - Leroy's photographs, including "Corpsman In Anguish" depicted the horrors of Vietnam.

Before Congress Representative James J. Howard read out a letter from a Marine who had been wounded during the battle for Hill 881. The Marine alleged that many brave Marines were lost during the battle due to one thing. The M16A1 jamming during combat and forcing the Marines to service their rifles during combat. Howard demanded that McNamara respond to these allegations as Marine Corps Chief of Staff LTG Leonard F. Chapman, Jr. had already attempted to respond to the allegations and Howard was not satisfied with the response.

Chapman reported that the issues experienced by the Marines with the M16A1 were not more than what was expected for a new firearm. LTG Walt backed up Chapman's claims about the rifle. Walt had just returned from South Vietnam where he had served as the commander of the III MAF. To Walt the M16A1 was the best rifle ever issued to the USMC. If the rifle failed or jammed, it was, in Walt's opinion, due to improper care and maintenance of the rifle. Finally, to defend the rifle General Wallace M. Greene held a press conference to rebut the allegations lobbied against the M16A1. Saying that,

"[The M16] has proved to be a reliable, hard- hitting, lightweight weapon for our troops"

In June of 1967 the Ichord Subcommittee went to Vietnam to look at the issues cropping up there with the M16 for themselves. However, a new report would come it that helped to shed light on what was going on.

Retired Army Colonel E. B. Crossman creates his own report and submits it to the Subcommittee titled, *Report of Investigation of M16 Rifle in Combat*. Crossman interviewed 250 Army and Marine units while they were stationed in Vietnam. Upon questioning them, Crossman found that about half of all troops using the XM16E1 rifle were experiencing malfunctions when using the rifle. However, the vast majority, 90%, were reported as failures to extract the case from the chamber. While Crossman was not able to nail down what the exact cause of these issues was, he did reach some other conclusions.

First, the forward assist was necessary, as many found themselves using it, justifying the Army's insistence on including it in the design of the rifle. Second, the extractor and extractor springs would need to be replaced frequently as they tended to wear out. Third, the availability of cleaning equipment had improved, however cleaning rods and chamber brushes were still in dangerously short supply. Forth, with the M16's developing a reputation for malfunctions there was a growing bias to go back to the M14, even though the M16 was an objectively superior weapon for the environment that they were fighting in. Half of those surveyed wanted to return to the M14 over these concerns. Finally, the selector lever was becoming bound and unable to be moved.

While Colonel Crossman was wrong about the need for a forward assist, he did get a few things right.

With all of this information in hand the retired Colonel Crossman makes a recommendation. Take a look at not only the rifle's design and how it was manufactured but also look at the ammunition design as well. Crossman, like others before him also reiterated the need for cleaning and maintenance in the field for the M16. This was critical. The M16 was, and is, a precision firearm, it is capable of excellent performance, however that performance requires that it be maintained and cared for like any precision machine.

As these investigations were taking place both Colonel Yount and Deputy Secretary of Defense Vance leave their positions. Yount was relieved of his duties as the PMR and was replaced by Colonel Alvin. C. Isaacs while Vance resigned his post.

Developing Chrome Lined Barrels

In June of 1967 Springfield Armory put out two reports testing chrome lined barrels.

The first tested the barrel life of the new designs, titled, *Erosion Test on 5.56MM Rifle Barrels, Small Arms Weapon Study (SAWS).* In this first paper they experimented with not only chrome plated bores and chambers but with new materials as well. The tested barrels used AISI/SAE 4150 steel barrels that were chrome plated and compared to barrels made from the same material but not chrome plated. The unplated barrel quickly failed after roughly 1,900 rounds fired at 60 rounds per minute.

As the barrel wore out it was removed from testing after the bullets began to yaw more than 15 degrees. The chromium plated version of the AISI/SAE 4150 steel barrel, however, fared much better. It was able to run though a total of 3,600 rounds fired at 60 and 80 rounds per minute before failing as well.

Another material that Springfield experimented with to use for barrels during this test was Cr-Mo-V steel. Unlike the 4150 steel the results were the same whether or not the bore was chrome lined. Both Cr-Mo-V barrels were also able to withstand 3,600 rounds, fired at the same rate, before failing.

The second report that Springfield put out was *Development of a Stellite-Lined, Chromium-Plated Barrel for 5.56MM Machine Gun.*

This time the testing was done to create a better, chrome lined, barrel for the Stoner 63. This time barrels were created with a Stellite lining in the hope of increasing the service life of the barrel. For the test a similar standard of bullet stabilization was used, and if the bullets began to yaw more than 15 degrees it would be removed from testing.

Standard barrel designs had lasted to a maximum of 12,476 rounds, however the Stellite lined barrels were able to survive as many as 43,994 rounds at a rate of 200 rounds per minute. However, the Stellite lined barrel was not the only design that Springfield tested. One was a more standard barrel, but this particular one had a nitrided bore. The nitrided barrel lasted 29,874 rounds, again at a rate of 200 rounds per minute before it finally failed testing. A second two-piece design was created that was a bit more experimental. The first part of the barrel was made from Stellite, however the rest of it, an 18" forward section, was made using Cr-Mo-V steel much like some of the previous test barrels. However, this two-part design did not produce the results that the testers were looking for and failed in just 990 rounds. A fraction of even a standard barrel.

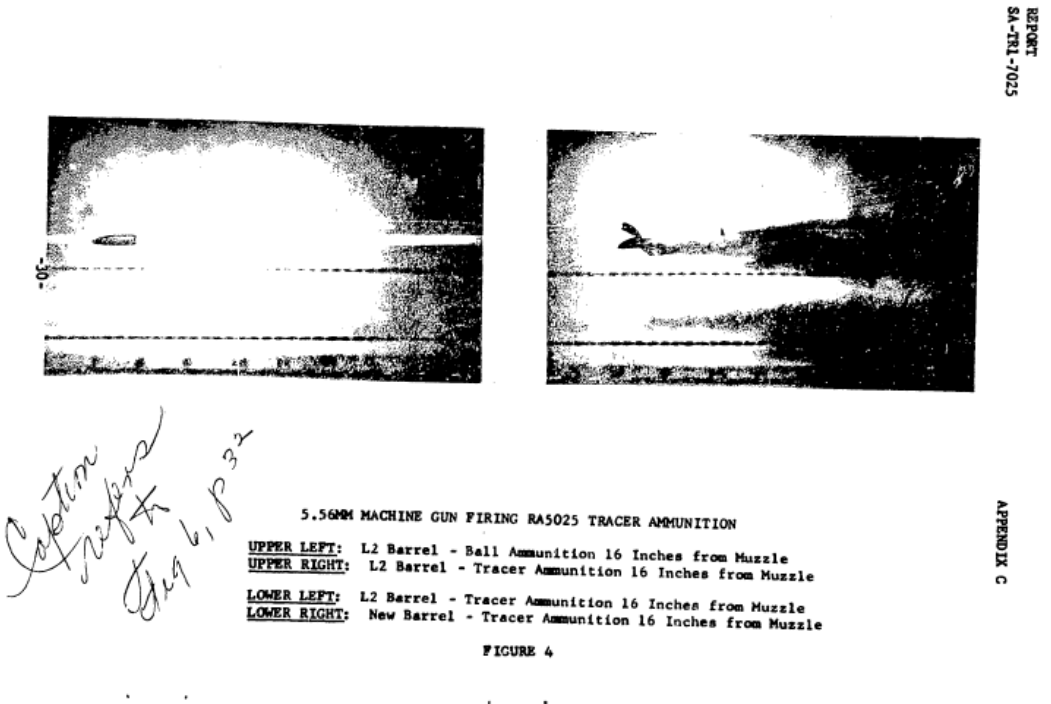


Figure 20 - Photos from the testing done with the Stellite barrels.

Colt's Strike

In June 1967 the US Army was finally able to get Colt to release the Technical Data Package as well as the manufacturing rights to the M16 as well as the XM177 family of small arms. The total payment would total $4.5 million dollars and a 5.5% royalty on all M16's not produced by Colt. The Army wanted to have a secondary source of the M16 and their fears are quickly realized as Colt's entire workforce went on strike the day after the deal the deal was struck. The strike prompted the Federal Mediation Service to bring both Colt and members representing the striking employees to Washington to try to hash out some kind of agreement and bring Colt's production back on line. Negotiations continued and the matter was eventually resolved in August.

During the strike the much needed improvement to the barrels, a chrome lined chamber, was finally sent to Vietnam in July. However, there were only thirty XM177E1's delivered and the number was far too few to make any discernable impact.

As August started, with the strike at Colt over, more comparison testing was done to examine the differences between the 1:14" twist rate and the 1:12" twist rate. To conduct the test 1,000 M16A1's were used, with a 1:12" twist rate, and compared to another 1,000 M16A1's, with a twist rate of 1:14". With the ammo and bullet weights they used the 1:12" twist rate barrels, on average, produced groups roughly half of those created by the 1:14" twist rate barrels.

Later into the month, the XM177E2 carbines were being looked at for possible improvements. These rifles were commonly called the Colt 629 Commando and were part of the CAR-15 family of rifles. WECOM assigned Aberdeen to look at a number of possible improvements to the carbines. The improvements looked at included chrome plating in the chamber, a 1.5" longer barrel, a modified charging handle, changes to the handguard slip ring including cadmium plating it, shot peening the upper and lower receiver, a nylon coated buttstock, and a new buffer design.

Aberdeen's testing also looked at powders once again. They compared performance of the IMR 8208M as well as the WC 846 loaded into both ball and tracer rounds.

As August came to a close Frankford Arsenal finished the needed specifications for case hardness for all of the military's 5.56mm ammunition. This was an important step as the previous case head failures had been suspected to be issues with the case hardness of the brass and standardizing this specification was seen as an important step to prevent any further catastrophic malfunctions.

Frankford Arsenal would also publish a letter detailing some of the steps required in the production of the 5.56mm ammunition titled*, Quality Assurance Provisions for 5.56mm Cartridges.*

Debugging The Rifle and Ammo

In September of 1967 TECOM started to test the results of the changes to the buffer system that had been proposed by Colt, comparing the new design to the older one. Meanwhile the M16 received the much needed upgrade of chrome lined chambers for all of the new production barrels.

At the behest of the USMC Commandant, members from WECOM, Rock Island Arsenal, the Headquarters of the Defense Supply Agency (DSA), Contract Administration Services (CAS), and DCASD Hartford began inspecting the USMC's supply of rifles at the USMC Supply Center in Barstow, California. A grand total of 14,676 rifles were looked over. Of them 2.2% of the rifles, or 320, were found to have defects in their workmanship. Only thirteen of these problem rifles actually qualify as having "major issues".

Meanwhile another, similar inspection done by WECOM and Colt was taking place at Camp Forster, Okinawa. There they respected 172 rifles that the USMC defined as being defective. In total the USMC had 39,512 rifles with them in Okinawa, bringing the total of defective rifles there to 0.5% of the rifles sent to them. Of these defective rifles, only twelve of them were found to have "major defects" with the team inspecting the rifles agreeing with the USMC's initial inspection results.

Finally, the Letterkenny Depot hosted a similar inspection of the rifles produced during that month. Colt, WECOM, and the Defense Contract Administration Services all send members to inspect a grand total of 15,460 rifles. This time 1.8%, or 281 rifles have defects with 20, experiencing "major defects".

Between these three inspections a grand total of 69,648 rifles were inspected for defects. Combined they had a defective rate of 1.1%, 773 rifles and only 45 rifles had "major defects". The rifles themselves were made to the standards that had been created, however the issues with changing powder, and the accompanying pressure curve issues, as well as the criminal lack of proper cleaning supplies would ultimately be found to be what caused the military so many issues in Vietnam.

The next item to be looked at for "debugging" was the ammunition itself.

In the Fall of 1967, Colt had been conducting tests to determine what chemicals were responsible for much of the fouling caused by the powder used in the 5.56mm, M193 ball ammo. They eventually isolated a particular compound in the WC 846 powder that was being used. Colt found that there was a direct connection between the calcium carbonate levels in the powder and the amount of fouling that was building up in the gas tube and causing issues with over pressure and increased cyclic rates.

Despite this, the Ichord Subcommittee was hard at work getting to the bottom of the issues with the M16 and they would soon release a report.

The Real Issue of the Powder

On October, 19th of 1967 the Ichord Subcommittee released a 51-page report as well as a 600-page transcript of the hearings it had conducted. The report was titled*, Report of the Special Subcommittee on the M-16 Rifle Program of the Committee on Armed Services House of Representatives Ninetieth Congress, First Session*.

During their investigation they found that both the Army as well as the DOD had made numerous errors in their handling of the M16. In total 31 different points are held as marks against both organizations. Yet the main thrust of the criticism was levied at the handling of the powder supply. The military was accused of giving Olin preferential treatment and "sole source" status. Furthermore, the use of ball powder, over DuPont's IMR powders was also criticized. However, there was some problems with this.

First Olin owned the rights to "ball powder" and Olin was not the military's sole provider of powder. The issue was not so much that ball powder was being used but that Olin's powder was the only one that was able to meet the velocity requirements that were set forth for the M193 Ball rounds.

Yet it was even more complex than just that. As stated previously, the early development of the AR-15 had been done with IMR 4475. The pressure curve and dwell time it produced was part of how the system was tuned to work. By replacing the IMR 4475 with ball powder that pressure curve changed, and thus the cyclic rate was changed as well. This produced the malfunctions and issues that were seen. However, the decision to make the switch to ball powder was not done in a vacuum. While it was ill advised and caused issues until modifications were made to allow the AR-15 to work with ball powders properly, the decision was not made *entirely* without reason.

There had been a shift in powder preference starting back in the 1950's as not only was ball powder easier to produce but it could be stored longer. DuPont was able to produce a batch of IMR power in two weeks, Olin, on the other hand, was able to deliver a batch of ball powder in two days as the production process did not require pure nitrocellulose, unlike other gun powders. Finally, the whole process was done in water, making the manufacturing process safer.

When smokeless powder is stored it breaks down, however by this time stabilizing agents had been added to the mix to help extend the shelf life of the powder. Yet ball powder had the distinct advantage of neutralizing the excess acids that caused this breakdown during the production process.

With the ballooning demand for ammunition and ignorance of the effects the change would have on the rifle system as a whole the decision was made to shift over the ball powder. It could be produced faster, stored longer, and was able to keep up with the chamber pressure and velocity demands made on the 5.56mm rounds.

Early testing that had established the specifications for the M193 Ball round as a 55 grain, full metal jacket round, running at 3,250 feet per second and using the, Remington designed, bullet with a shorter ogive. However, there were some key differences from the early testing that established this standard and the M16 design. First the bullet used in the M193 Ball round was not the Sierra bullet that Stoner had worked on to perfect. Second, the velocity standard had been established with at 22" barrel, not the 20" or shorter barrels that were being used on the M16 and other Colt rifles for the military.

Essentially the issue was twofold.

Production of the powder that the AR-15 was first built to use could not keep up with demand. Second the velocity standard required for the 5.56mm was based off of a longer barrel then what the military would end up using. Causing them to chase a velocity standard that they would not be able to get without dangerously high chamber pressures. The use of the ball powder may have solved the velocity question, however the change in pressure curve and dwell time in the AR-15 caused a whole new set of issues.

The ultimate failure here was looking at each part of the rifle as a separate system, when in reality, ammunition and firearm had to work as one.

Beyond the issue of Olin's ball powder the Ichord Subcommittee also placed blame on the Army for the modifications and cost increases that the M16 program was experiencing. Pointing out in particular the new buffer design as well as the newly chromed chambers on the M16. Both were needed in the face of the ongoing issues with the rifle. However, the OSD, and their own interference, managed to escape the reach of the Subcommittee and were not mentioned in the report.

For an additional review of the issues as well as some of the changes that the M16 went though over the course of its service in Vietnam, I recommend a look at Chris Bartocci's video on the subject which will be in the *Recommended Watching List* at the end of this book.

I Need More Yaw

In October of 1967 DDR&E John S. Foster, Jr. worked on evaluating the M16A1, along with its new buffer design. He found that when using either WC 846 or IMR loaded 5.56mm cartridges that the malfunction rate of the rifle was roughly equal to that of the M14.

Meanwhile Aberdeen's BRL was working on enhancing the lethality of the 5.56mm round. While the basic principle of the SCHV bullet, to create a high velocity round that could tumble and yaw as it hit, had been around since the 1930's the concept still could be improved upon. To this end Eugene T. Roecker took a look at the bullet's design and attempted to improve upon the SCHV concept with the paper*, The Lethality of a Bullet as a Function of its Geometry*.

> *"The design of a rifle bullet for combat purposes has generally been dictated by interior ballistics, exteri or ballistics, and manufacturing conveniences. Lethality was rarely considered at the designing stages because of a lack of an adequate theory for lethality prediction*
>
> *Bullets can be designed to deform in a dense medium, such as flesh; Geneva Convention [sic] and other rules, however, prohibit their use. To conform to such rules and still maintain a typical bullet shape (ignoring dart-like configurations), the optimum wound ballistics design is often considered to be one that imparts maximum kinetic energy to the flesh by means of high drag"*

With this in mind he worked to create a bullet that would tumble through the target better. Using a number of calculations and models he arrived to the conclusion that the tumbling of the bullet could be further enhanced if the cylindrical section, rear of the cannelure, was shortened.

Around this same time, Frankford Arsenal was also trying to work on ways to make the bullets better. However, they took a different track to trying to improve the 5.56mm. Instead of looking at the shape of the bullet, Frankford in the paper, *Metallurgical Analysis of 5.56MM Bullet, Copper Plated-Lead Cored,* instead looked at the metallurgy of the bullets themselves.

The test was conducted on two lots, Lot A and Lot B. Using chemical, metallographical, electron micro-probes, and hardness analysis they found that between the two lots the electroplating of Lot B was superior. Lot B had not only better cohesion between the copper jacket and the lead core, but also three separate layers of copper coatings. With Lot B showing more work hardening as well. While the actual composition of each lot was essentially the same chemically, the differences in how the bullets were jacketed was enough to present a functional and observable difference between the two.

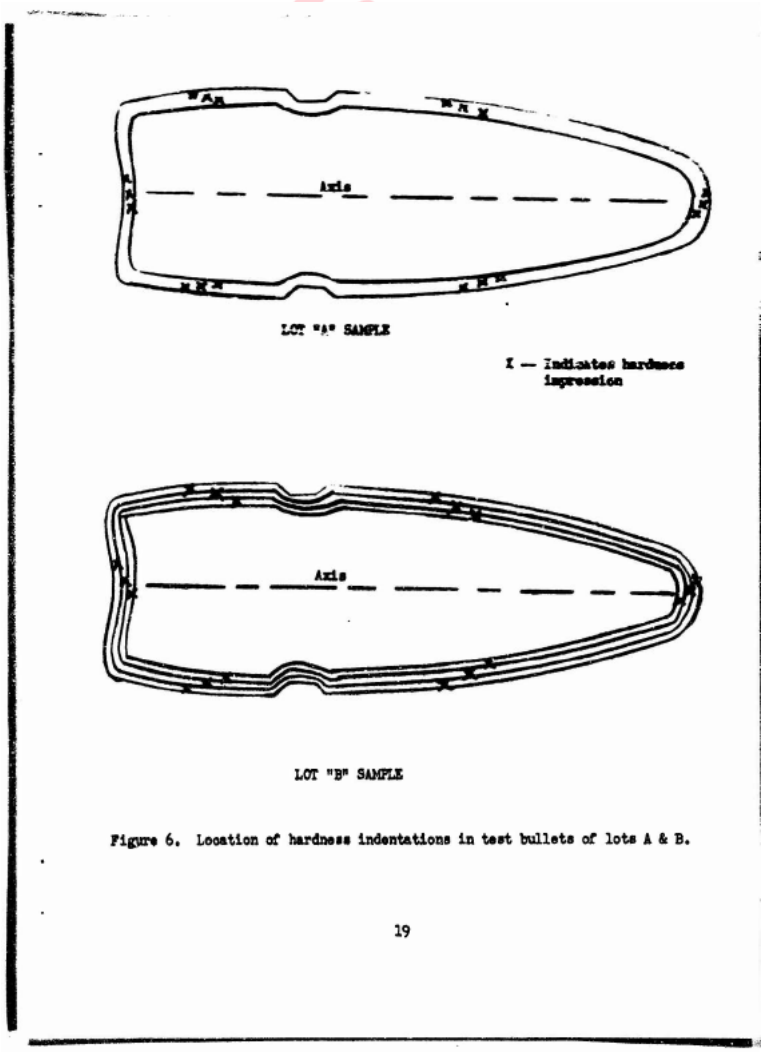


Figure 21 - Note the multiple "layers" found in lot B created by the work hardening

Quality Assurance

In November of 1967 McNamara began planning his leave as the Secretary of Defense, meanwhile new quality assurance programs were being set up with the express intent of making sure that the rifles leaving Colt's production lines are up to par.

The first of these was an "intensive review" of how the Army had managed the changes being made to the M16. Ordered by General Johnson the intention was to do preliminary research before new trials started with the M16, to be conducted by the DOD and the Institute for Defense Analyses.

Next came a new monthly audit of the quality controls at Colt. Parts were shipped to a Government Arsenal to be inspected and ensure that the parts were meeting the standards agreed upon in Colt's contract with the military. This was started specifically because the USMC as well as others in the military had been complaining about malfunctions and other issues.

After this came a brand new program to ensure that the rifles were meeting the contract requirements before they were tested to be accepted by the military. The information gathered by this culminated in a monthly report on the M16A1's.

Then another program was started to obtain further data on the malfunctions that were happening with the M16A1 in the CONUS training stations. These training stations were created specifically to train troops for combat in Vietnam and a team of "quality assurance" would periodically visit them and gather date on site. The data would then be used to create recommendations for further improvements and changes.

Finally, the "M16A1 Rifle System Test Coordinating Team" was created at Frankford Arsenal. They were tasked with looking at the relationship between the M16 rifle and the 5.56mm ammo that the military was using.

In December of 1967, more "quality assurance actions" took place. First Colt sent out a two-man team of quality assurance specialists who would spend two weeks working on the overall adequacy of the rifles inspection process, inspecting the equipment used, and looking at the quality assurance program as a whole.

Additionally, Colt found its contract amended again to address how the rifles needed to be inspected. The new requirements mandated testing of all rifles for functionality, targeting, accuracy, headspace, and trigger pull. High pressure test rounds were to be used on all rifles and then given a magnetic particle inspection. Sample rifles would now be taken to test firing pin indents, part interchangeability, cyclic rate, and reliability. Finally, all rifles would have to be manually and visually inspected.

The use of magnetic particle inspection or MPI was a key step in ensuring that the barrels were up to the standards required by the military. Over the course of the M16's development from the AR-15 a number of markings would appear on the barrels themselves.

Early rifle barrels were not chrome plated and were simply marked with a "12", indicating the 1:12" twist rate used in the rifling. Later barrels would be marked "CMPC" for "Colt - Magnetic Particle Improved Testing - Chrome Chamber". These particular barrels will only have a chrome lined chamber. However, this was soon changed to the "CMPB" marking standing for "Colt - Magnetic Particle Improved Testing - Chrome Bore". These barrels have the entire bore chrome lined instead of just the chamber. This marking would, towards the end of the Vietnam War, be changed to "CMP Chrome Bore".

What was unusual was that chrome plating had been used in the past on rifles issued in humid and wet environments, so the benefits of having chrome plated rifles in Vietnam should have been obvious. The M14, for its part was first issued with a chrome plating however the M16 was not. While there were other issues that needed to be addressed, the use of chrome plating in these kinds of environments was, and should have been, more obvious.

Despite the creation of these programs and teams, new issues were cropping up with the ammo.

In November of 1967, MUCOM was forced to suspend the use of a particular lot of the M193 tracer round. They found that Lot number LC-12081 was experiencing issues with the bullet jacket breaking up and being stripped from the core by the rifling. This particular lot was loaded with the WC 846 powder.

However, the WC 846 powder's days were numbered as in December of 1967 it would be withdrawn from use in the M196 tracer rounds. The powder would be replaced by DuPont's IMR 8208M which had previously been tested as EX 8208-4.

Yet these were not the only issues cropping up for the M196 tracer round. Towards the end of the year, S. A. Doilney, who was the Chief of Aberdeen's Small Arms & Aircraft Weapons Branch notified WECOM that they were experiencing issues with the M196 tracer round. In the message, *Firing of M196 Cartridges in XM177E2 Submachine Gun,* Doilney noted that when using the XM177E2 with the M196 tracer round the round would yaw and tumble, creating large groups and terrible accuracy out of the new gun.

As 1967 came to a close a new patent was granted to Ludwig Six and Rudolf Niemann for a heavyweight projectile to be used in 5.56mm loadings.

However, more trouble was on the horizon.

1968: Report of the M16 Rifle Review Panel

As 1968 began new issues were cropping up and steps were being taken to address them, however all of the mishandling of the M16 program to bring the AR-15 to US troops would eventually culminate in a massive document that detailed the findings and failings of the Army and the military at large to provide the troops in Vietnam with the materials and training that they needed.

Yet before the report was published changes would already be in motion to correct the issues identified.

Intergranular Exfoliation

1968 saw more moves towards making the .223 a NATO standard. By this time most military materials referred to the cartridge under the metric name. However as 1968 began WECOM would issue a new report, *Rifle 5.56mm M16: Selection Process for NATO Standard.*

Meanwhile the jungle climate was wreaking havoc on the M16's parts. Steps had been taken to try to address some of the issues that the rifle was running into in the humid climate, such as chrome plating in both the barrel and the chamber. However other parts on the M16 were running into trouble as well.

The technical term for this was "intergranular exfoliation", in short, the receiver was rusting around the magazine well. This was the place where it would frequently be gripped by the soldier using it. Any thin area of the receiver would quickly show issues as well, such as the area around the front pivot pin hole.

Some examples were rusting so badly that the magazine well would be eaten though, exposing the magazine. The metallurgy of the parts used was so bad that issues would crop up in as little as three months after the rifles arrived in country.

The fix would come from Eugene Stoner, who after being consulted by Colt, suggested that a change be made from the 6061 T6 aluminum, that they had been using, to 7075 T6 aluminum. This would fix the problem; however, it would still take time before the improvements made to the metallurgy of the rifles would make it to Vietnam.

Yet this was not the only metal to have issues in Vietnam. Upon inspection, Frankford Arsenal found that a number of the brass cases for the cartridges that had been shipped to Vietnam were too soft. Once again there was another issue that would take time to fix over in Vietnam.

In 1968 there was also renewed experimentation with duplex rounds. While the concept had yet to provide what testers had hoped to achieve, Frankford Arsenal continued experimentation when them. This time the duplex rounds were a subsonic "low noise" variety referred to as "Low Noise Duplex Cartridge" or LNDC. The first experiments used two 110 grain tungsten core slugs. These slugs had a blunt and rounded nose profile, however this design would later be replaced in experimentation with a potentially more accurate spitzer design.

Quality Control Problems

In January of 1968 Commander Hartford wrote to Colt President Benke about the quality control measures. Benke rebuked the allegations made against Colt, however he did note that Colt was in the midst of an audit of all of their subcontractors and vendors to make sure that what they were delivering to Colt was up to snuff for Colt's contract with the military. Benke wrote,

> *"The only apparent deficiency in our quality control program appears to be the documentation of our quality investigations and the documentation of the follow-up to insure that corrective action has been implemented. This condition has been discussed with several qualified government quality assurance representatives. It is agreed that improvements can be made by the contractor in this area. At the present time, we are conducting a complete quality audit of all Colt vendors to insure that they are complying with contractual requirements. A report of this audit and the corrective action taken will be submitted to the government by 23 February 1968."*

When the audit was complete they found that while all of the 28 venders that colt used did have adequate quality control histories, 17 of them were lacking proper inspection records, and 18 had improper gauge control systems. 16 venders had issues with both inspection records and gauge control systems.

Despite the switch to IMR 8208M, problems with the 5.56mm ammo were cropping up again. In January of 1968 WSEG was testing M16A1 rifles at Fort Sherman, Panama. The M16A1 rifles were equipped with the new buffer design and for the test a mix of both ball powder and IMR loaded M193 ammo was used. However, the IMR 8208M loaded rounds gave the testers the most problems with the highest malfunction rate comparted to the other M193 loads used.

Because of this issue during the WSEG testing, McNamara put the use of IMR 8208M for the M193 round on hold. No more rounds using the powder would either be loaded or shipped to Vietnam and what was remaining was reserved for training in the States only. The lot numbers of the M193 ball ammo using IMR 8208M were compiled and sent to USARV. Despite being removed from the use in the M193 rounds, the powder was still allowed to be used in the 5.56mm M196 tracer rounds.

Testing Suppressors and Machine Guns

While suppressors have only recently been thought of as a potential option for the military at large, with the introduction of the M16 the military in 1968 was interested in creating viable suppressors for their special forces' operations. To this end the Exterior Ballistics Laboratory (EBL) of the BRL started testing the use of suppressors on the new rifle. Since the XM177E2 was in high demand and extras were in short supply a XM177E2 barrel and suppressor were fitted to a M16A1 for testing. What they found was that both the M193 and M196 tracer rounds experienced noticeable point of impact shift.

Wanting to look at this issue further and potentially determine how this was happening three more used suppressors were obtained to measure the point of impact shift. Each suppressor had 1,000, 3,100, and 9,200 rounds fired though them and the testing continued with these worn suppressors.

With the 5.56mm round becoming more and more prevalent, having a viable alternative to the old M60 machine gun was becoming a priority. The USMC had initially rejected the AR-15 because there was not viable alternative. While the Stoner 63 was still being worked on there was much improvement needed. To this end at the first Small Arms Conference at Fort Benning in February of 1968 a new task was added.

> *"Conduct feasibility studies of a 5.56mm, or smaller, successor for the M60 machine gun. Employ new concepts to eliminate sensitivity to variables inherent in normal ammunition production. Explore appropriateness of 5.56mm destructive potential, including possible use of heavier projectiles, in comparison with lethality required for Light Machine Gun successor."*

This lead to new projects being proposed, however there was no money specifically assigned to this task. Instead the BRL continued with a small project looking at heavier 5.56mm bullets. The goal was to try to create a loading that would be more effective at longer ranges.

While new task forces were established to look at both the effectiveness of the quality controls implemented and revise them if necessary, as well as expand any changes to sources other than Colt, more testing was underway on the ammunition.

Frankford Arsenal released a new report in February of 1968. The report*, Special Tests of 5.56mm Ammunition*, detailed the testing of 150, new manufacture, M16A1 rifles. In total 420,000 rounds of 5.56mm ammunition was run through them. Yet, before testing could even begin an issue was found. Prior to testing the rifles underwent a seven-point inspection to ensure that they were all in spec. The examination revealed that 77.5% of these rifles were out of chamber spec in one or more dimensions.

In a rather odd move that raised eyebrows, a report*, Operational Reliability Test M16A1 Rifle System, WSEG Report 124*, was classified and sealed by the OSD. The report allegedly detailed trials conducted in Panama comparing the use of WC 846 and IMR 8208M. The allegation was that the trials showed WC 846 to be superior and the report was sealed due to the findings contradicting what the Ichord report had alleged.

Later in February Aberdeen's D&PS released two reports*, Final Report on Special Study of High Temperature Bore Fouling of 5.56-MM, M196 Tracer Cartridge in M16A1 Rifle*, as well as*, Initial Production Test of Chrome-Plated Chambers for 5.56-MM, M16A1 Rifles*. Frankford Arsenal would also publish*, Interim Quality Assurance Report of 5.56 Fouling Test conducted at Lake City Army Ammunition Plant*, at the end of the month.

More Rifle's Needed

As Clark M. Clifford took over as the Secretary of Defense in March of 1968 new reports were coming out detailing the growing need for M16 rifles.

Command	Number Needed (Less Replacement of M1's)	Number On Hand	Remainder Needed	Number Needed in Vietnam
PACOM	1,568,318	534,706	1,033,612	376,796
Other	943,639	170,559	773,080	0
Total	***2,511,957***	***705,365***	***1,806,692***	***376,796***

With hundreds of thousands rifles needed the required rifles for Vietnam would be distributed as follows

Unit	Number of M16's to Be Issued
USARV Combat Service Support / Maintenance Float	91,258
ARVN	61,938
Potential Army Deployments	72,000
Potential Marine Deployments	36,600
South Vietnamese RF/PF	115,000

With this production of the M16 needed to be increased. Deputy Secretary Nitze had two suggestions on how to do this. First, move Colt to a three shift, seven day, work schedule. Second, award contracts for not just one, but two alternate suppliers of M16's.

During March, testing was still going on and Aberdeen's BRL put out a new report*, Accuracy of Rifle Fire: SPIW, M16A1, M14.* The testing not only looked at the struggling SPIW project, but also the two round burst fire mode developed for the M16A1. When comparing the SPIW prototype to the M16A1 they found that the SPIW was more controllable under automatic fire. However, this was really not surprising as the SPIW prototype was firing flechette rounds. But, the two round burst fire allowed the M16A1 to be more controllable and have a higher hit probability then a fully automatic M16A1.

Despite this the report did come to the conclusion that the M14, using either M80 ball ammo or the experimental M198 Duplex round had a higher hit probability per each target. Finally, when the M14 was used with the M198 Duplex round, it was "competitive" with the SPIW for "per target engagement". Despite this, history would show that both the SPIW and M198 Duplex rounds would eventually be dropped from serious consideration for various reasons.

Procuring More Ammo

In April of 1968 the need for a new 5.56mm machine gun to support the M16 was being redefined. Instead of being looked at as a replacement to the M60 at "machine gun ranges", it was to, instead, be a support weapon for others using the M16.

No matter how the 5.56mm machine gun program would shake out there was still a need for more ammo. With this a new procurement was approved by the DOD for another 658 million rounds of 5.56mm ammo. The cost was to be $57 million dollars for the needed ammo.

However, Dr. Brooks was pushing for a new task force to be created. In a memo to Chief of Staff, General Johnson, ASA(I&L), Dr. Brooks recommended for the new task force to serve a number of function. First, it would be there to conduct analyses of all of the test data that had been collected on the M16, as well as it's ammunition, and magazines. Second, it would critique procedures, specifications, as well as the contract provisions which made up the quality assurance program at Colt. Third, it would serve to create a set of suggested revisions to the quality assurance program.

Yet the quality assurance program would soon come under fire. Shortly after the suggestion from Dr. Brooks, ASD(I&L) Morris would question the efficacy of the program. In particular, he was concerned about the Army's implementation of DOD procurement policies that had been outlined in Section XIV of the Armed Services Procurement Regulations (ASPR). In addition to this he was concerned about how the Army was applying the data collected to develop the contract specifications.

Oiled Ammo?

In May of 1968 a new report was published on the M16's performance in Vietnam. Titled, *M16 Rifle Survey in the Republic of Vietnam*, troops serving in Vietnam were surveyed about how the M16 was preforming. In total over 2,000 troops were surveyed and many users still like the weight and rapid fire of the M16, but many troops were still worried about the reliability of the rifle. It was still giving troops issues, particularly failures to extract with enough frequency to cause many to be concerned. While the changeover to a chromed chamber did seem to be having the positive effect intended the modification had not been in country long enough to gauge its impact properly.

Yet there were other problems noted in the survey. First, of those surveyed, 23% were oiling their ammunition in the hopes of increasing the reliability of the M16. The retrofit of the buffers with Sturtevant's design was still not complete, 16% of those using the M16 still did not have the new design. To make matters worse, 28% of the troops had no training in the use of the M16, despite it being mandatory for all in country troops when they arrived in Vietnam. 24%, meanwhile, were not trained with the M16 before arriving in theater.

Testing of the M16 when it arrived was also lacking. 10% had never even zeroed their rifles, and 33% had not rechecked their zero in the last three months. 18% of troops reported that the rifles were also never even test fired when they arrived. Furthermore, despite the emphasis on cleaning the rifle that had been pressed, the magazines and ammo were only inspected and cleaned once a week. On a positive note, however, the rifles were receiving daily cleaning. With this there were still distribution problems causing supply shortages.

With the survey complete a meeting was held at Colt with Frankford Arsenal and WECOM personnel. The meeting was set up to talk about and agree upon changes to the chamber dimensions. There was a concern that the new chrome plating of the chamber would create a reverse taper in the neck of the barrel after the chroming process was competed. To address this possible issue, the chamber drawings and specifications were revised to prevent this from becoming an issue before it could crop up.

Yet, there were new issues cropping up. The original magazine design was intended to be somewhat disposable, with the original design of the aluminum magazines, used as far back as the first AR-10. The magazines were designed to be loaded, then discarded. Steps had been taken to make the magazines more durable but there were reports of issues with them. In May of 1968 quality assurance personnel were sent out to a testing sight to look at reported issues with both the 5.56mm ammo as well as the magazines. This resulted in a number of changes to not only the test procedures but the reporting procedures as well. The goal of these changes was to ensure that the quality assurance program was getting the accurate data that it needed to be effective.

Finally, two more noteworthy events would happen in May. Frist Rock Island Arsenal and Winchester started looking at new designs for the M16's gas system. Ideally this would have been an improvement over the gas key system that Stoner designed, however the merits of any changes to the AR-15's gas system is debated to this day.

Second the MACV commander General Westmoreland advised CINCPAC Admiral Sharp that with the increasing numbers of M16 rifles being issued to the ARVN and RF/PF that more 5.56mm ammo would be needed as well. A rifle without ammo is just a heavy club and to address this Sharp and Westmoreland both recommended to the JCS and the Department of the Army that the production of 5.56mm ammunition be increased to keep up with the demand.

Squandering Money and Yawing Bullets

In June of 1968 Colt was awarded yet another contract for 740,803 M16A1 rifles. Along with the M16A1's 1,000 of the new 30 round magazines were also requested to be tested as well. However, the political issues cropping up around the M16 were far from over.

The Ichord Subcommittee was again pointing a finger at the Army for wasting money. Ichord himself would go on to accuse the Army of "squandering" at least $40 million dollars on the M16 rifle program. With this allegation Ichord moved to slash the Army's R&D budget by $20 million as a reprisal for refusing to accept lower bids during the hunt for second source contracts to build the M16A1.

Even with the R&D budget on the line, testing continued in earnest on the Colt Commando's as well as how well they performed with the current 5.56mm ammo. Aberdeen's D&PS had published a report titled, *Final Report on Product Improvement of Submachine Gun, 5.56-MM XM177E2.* A number of changes and improvements had been made to the SMG since it was first looked at during the SAWS trials in 1965 and 1966. While it was a test to see the performance of the rifle it was not intended to lead to type classification and official adoption, hence the Colt Commando was still a "XM" for its status as an experimental small arm.

The changes that had been made since the SAWS program tests included the new buffer design, longer barrel length, a charging handle latch made from a plastic called Delrin, chrome plated chambers, cadmium plated slip rings, shot peened upper and lower receivers, and nylon coatings to sever parts. Most of the testing provided positive results, but the Delrin charging handle presented a problem. The replacement of the charging handle latch with the plastic material was intended to reduce wear on the upper receiver. Yet, in the cold weather testing, -65° F, it broke. Furthermore, the amount of wear on the upper receiver was unchanged.

When it came to corrosion resistance the addition of shot peening the upper and lower receiver seemed to make little difference. The same happened for the nylon coatings on the other parts. Yet the chrome plated chambers did reduce malfunction rates and the changes to the handguard slip ring were praised.

A kinematics study was also done on the buffer's end cap. It was found that the urethane end cap had its energy absorbing characteristics change because of the repetitive impacts it was placed under, especially during burst fire. This caused the cyclic rate to change wildly.

The 5.56mm ammunition used suffered problems as well. The suppressor that was added to the SMG would become progressively louder and would have its flash signature increase as unburnt powder and carbon fouling built up in the baffles. This affected the stability of the bullet as well. M193 ball rounds were yawing as much as 20 degrees in some instances and the M196 tracer rounds yawed even more. This yawing effect was exacerbated in cartridges loaded with WC 846 powder.

When comparing the WC 846 powder to the IMR 8208M, it was found that the IMR 8208M produced less fouling and fewer malfunctions. However, Both the XM177E1 and XM177E2 rifles tested had subpar performance in the cold weather fouling test conducted. Numerous malfunctions were recorded, but the improvements that the XM177E2 did have were recommended for further use as well as application to the MC16A1 as necessary.

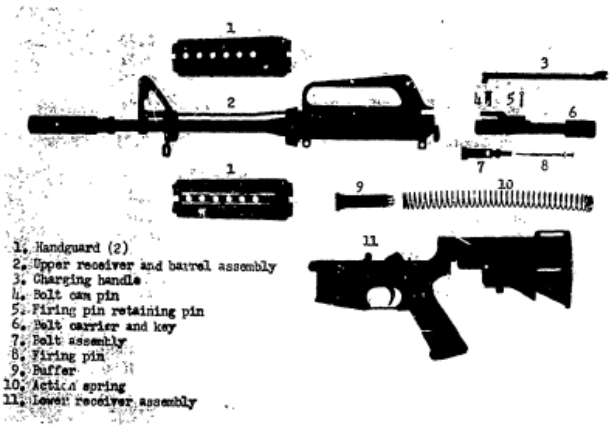


Figure 2.2-3: Field-Stripped XM177E2 Weapon.

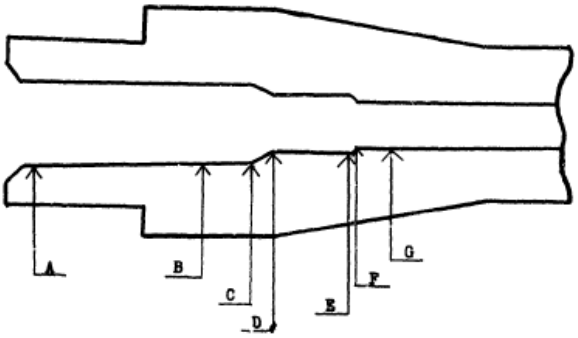


Figure 2.2-4: Sketch of Chamber for M16A1 Rifle and XM177E2 Submachine Gun. Letters Indicate Positions of Diameter Specifications as Shown on Standard Operation Instruction Sheet Used by the Manufacturer.

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Figure 22 - Photo of the submachine gun broken down in the report, Final Report on Product Improvement of Submachine Gun, 5.56-MM XM177E2

Report of the M16 Rifle Review Panel

A massive report would be issued by the OCSA's Weapons Systems Analysis Directorate. The massive report consisted of twelve volumes, one main volume and eleven appendices.

- *History of the M16 Weapon System*
- *Appendix 1: Small Arms Test Policies and Procedures*
- *Appendix 2: Audit Trail and Analysis of M16A1 Weapon and Ammunition System Tests*
- *Appendix 3: Review and Analysis of M16 Rifle Training*
- *Appendix 4: Ammunition Development Program*
- *Appendix 5: Procurement Production and Distribution History of the AR-15-M16-M16A1 Weapon System*
- *Appendix 6: Review and Analysis of M16 System Reliability*
- *Appendix 7: M16 Surveys in the Republic of Vietnam*
- *Appendix 8: Review and Analysis of the Army Organizational Structure and Management Practices*
- *Appendix 9: Audit Trail of Chief of Staff - Army Actions and Decisions Concerning the M16*
- *Appendix 10: The Army Small Arms Program*
- *Appendix 11: M16 Product Improvement Modifications*

Within this massive series of documents there were two particular points of note. First were the conclusions reached by the volume *History of the M16 Weapon System,* and *Appendix 4: Ammunition Development Program.*

In *History of the M16 Weapon System* the conclusions reached first blamed the lack of a definitive rifle program for the uncoordinated nature of the procurement process of the M16. Furthermore, the fact that the lack of a proper type classification was also blamed as another problem, creating quality issues with the rifle. The lack of type classification for the M16 was denoted by its name, "XM16E1" with the "XM" standing in for "experimental".

While the report continued to state that there had been no significant problems with rifle production in terms of numbers, the production of the ammunition was hampered by both material shortages as well as the lack of meeting specifications set for the ammunition. To address some of the issues the report recommended that there be more stringent control measures placed on the ammunition producers as the production expanded.

The report also took issues with both the Army's changing requirements for the rifle as well as the delays in obtaining the proprietary rights. It continued to critique the fact that there had been very little reduction in the cost per unit after the first 100,000 rifles had been purchased. With most production once the 100,000 mark had been reached it should have resulted in a more streamlined and cheaper production process, however this did not initially happen according to the report. But when the secondary sources came online, the report criticized the lack of a reduction of cost per unit from the additional sources.

The next section of the conclusions looked at the changes made to the rifles and concluded that the modifications made were both not only not supported by test data when they were adopted, but were also relatively minor. The report also noted that there were a series of modifications to make the rifle more reliable, and that Colt had noted the issues with the cyclic rate and the WC 845 powder. Furthermore, it criticized the fact that it took five months before the new buffer tube design would be approved and put into production.

When looking at the ammunition the report noted that there were no metallurgical requirements for the brass case. This was seen as a major oversight and had been something that had been included with the specifications for the 7.62mm NATO. Yet there were still issues with the design of the bullets being used. A problem noted as far back as 1963, by Frankford Arsenal, who requested the BRL to look at the issue. Yet at the time the report was published the issue remained unaddressed for about five years. To add to this, the bullets used were still not standardized yet. Furthermore, there was a continuing issue with fouling. The primers were suspected, but the report found nothing to suggest that they could be definitively called the primary issue. Finally, the primers at this time did not have a standardized design.

The Army was also accused in the report of playing favorites when it came to procuring powder for the 5.56mm cartridges. The decision to emphasize availability over ensuring that the powder would function with the M16 was also cited as a major issue. When it came to the tracer rounds the report firmly stated that the M196 tracer round was allowed to still be loaded with ball powder, yet there were reports that showed the IMR powder performed better with the round. Finally, the report directly criticized Yount for not complying with the order to *"come to grips at an early date with the 3,250 f.p.s. velocity requirement"*.

When it came to testing the M16, the report singled out the biased and rigged testing done on the M16 for scrutiny as well as need for improvement of the ongoing testing.

In the recommendations of the report, the need for establishing both a standard design for the primers as well as more testing to look at bullet design, velocity, and barrel twist for any improvements, if possible.

The volume, *Appendix 4: Ammunition Development Program,* also had a number of conclusions as well. Here the issue of the lack of standards for the metallurgy of the brass was again brought up. It noted that Frankford Arsenal had the data to create this standard but the Project Manager did not create them. When the issue of case hardness did come up the Appendix's conclusions found that the remedy was not put in place quickly enough.

When looking specifically at the M193 ball round it found that it was created out of a compromise between several designs. While it was understandable that Remington would use their own design since they had "broader" knowledge of small caliber ammunition, the lack of response to the request for a new design was seen as an issue. Yet the report would later note that if any changes were to be made to the bullet design, the possibility of needing new barrels with a new twist rate would have a major impact on logistics.

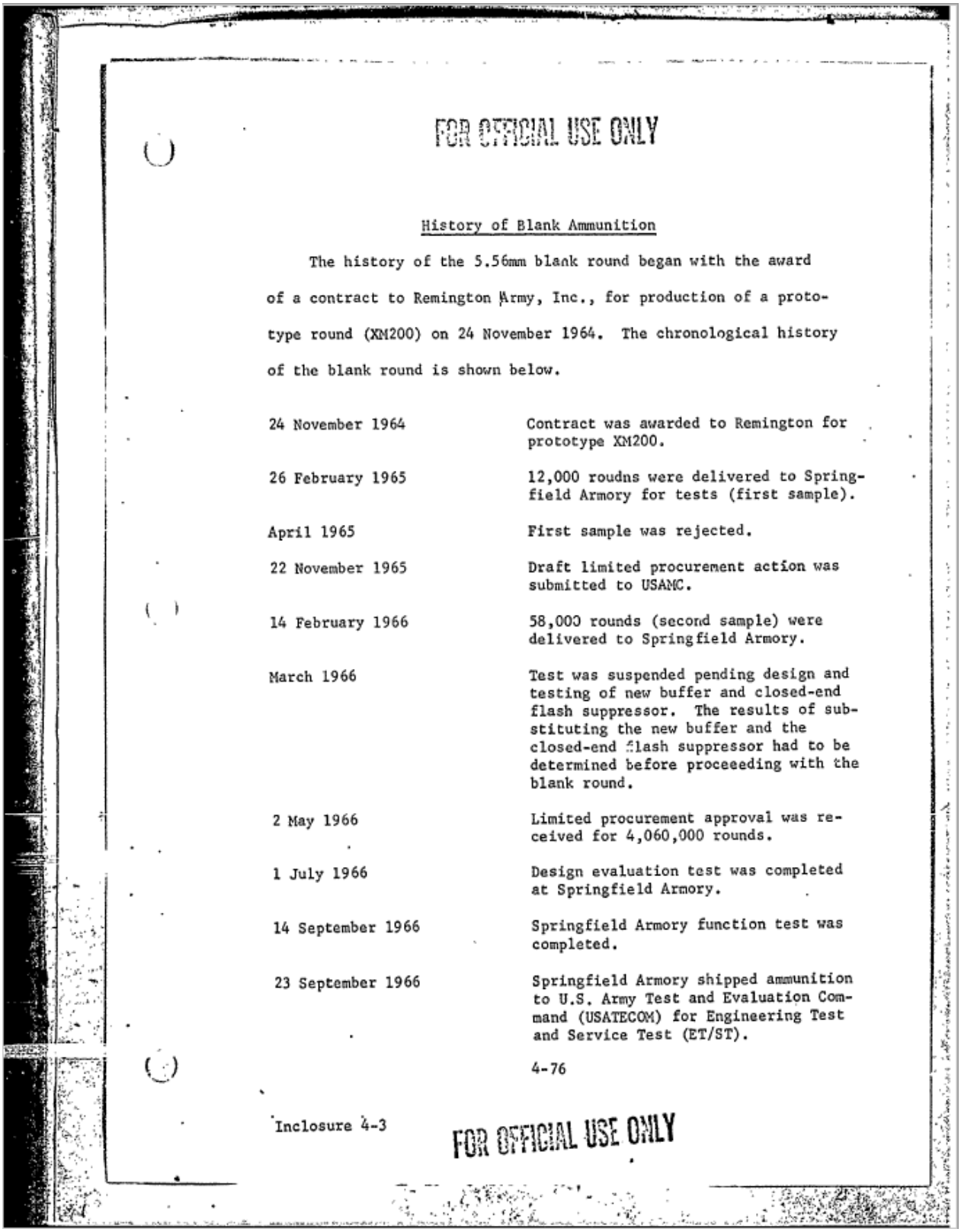
Despite this, the primer sensitivity limits were considered to be fine, yet the overall primer development was decried as having *"failed … to standardized the basic design of the primer."* There were three different designs of primer used in the M193 ball ammo and this was pointed at as a possible cause for many of the inconsistences experienced. The conclusions after this echoed much of what had already been said in the main volume.

After this the appendix moved on to looking at the analysis of the propellants that were being used in more detail. The appendix detailed the criteria needed in testing such as smoke produced, flash, barrel erosion, and more. How lot to lot testing differed from the acceptance testing for a new powder needed to be more expansive then standard lot to lot testing. For lot to lot testing the primary testing was chamber pressure, gas port pressure, and muzzle velocity, while acceptance testing included this as well as what was listed above.

The appendix noted the chamber pressure limit had been set at 58,000 pounds per square inch and how this was created to limit the variation in chamber pressure and guard against high pressures in single cartridges. Furthermore, the appendix detailed how the pressures at the gas port was measured, using a copper-crusher gage, and the limit for it at 15,000 psi, plus or minus 2,000 psi. The report also detailed the muzzle velocity requirement, 3,250 fps, plus or minus 20 fps.

The last section of the appendix detailed the history of the 5.56mm blanks up to that point. From the initial contract given to Remington for the XM200 on November, 24th in 1964 to initial testing, and procurement of blank rounds up to that point.

Below are images from this history.



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History of Blank Ammunition

The history of the 5.56mm blank round began with the award of a contract to Remington Army, Inc., for production of a prototype round (XM200) on 24 November 1964. The chronological history of the blank round is shown below.

24 November 1964	Contract was awarded to Remington for prototype XM200.
26 February 1965	12,000 roudns were delivered to Springfield Armory for tests (first sample).
April 1965	First sample was rejected.
22 November 1965	Draft limited procurement action was submitted to USAMC.
14 February 1966	58,000 rounds (second sample) were delivered to Springfield Armory.
March 1966	Test was suspended pending design and testing of new buffer and closed-end flash suppressor. The results of substituting the new buffer and the closed-end flash suppressor had to be determined before proceeeding with the blank round.
2 May 1966	Limited procurement approval was received for 4,060,000 rounds.
1 July 1966	Design evaluation test was completed at Springfield Armory.
14 September 1966	Springfield Armory function test was completed.
23 September 1966	Springfield Armory shipped ammunition to U.S. Army Test and Evaluation Command (USATECOM) for Engineering Test and Service Test (ET/ST).

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Inclosure 4-3

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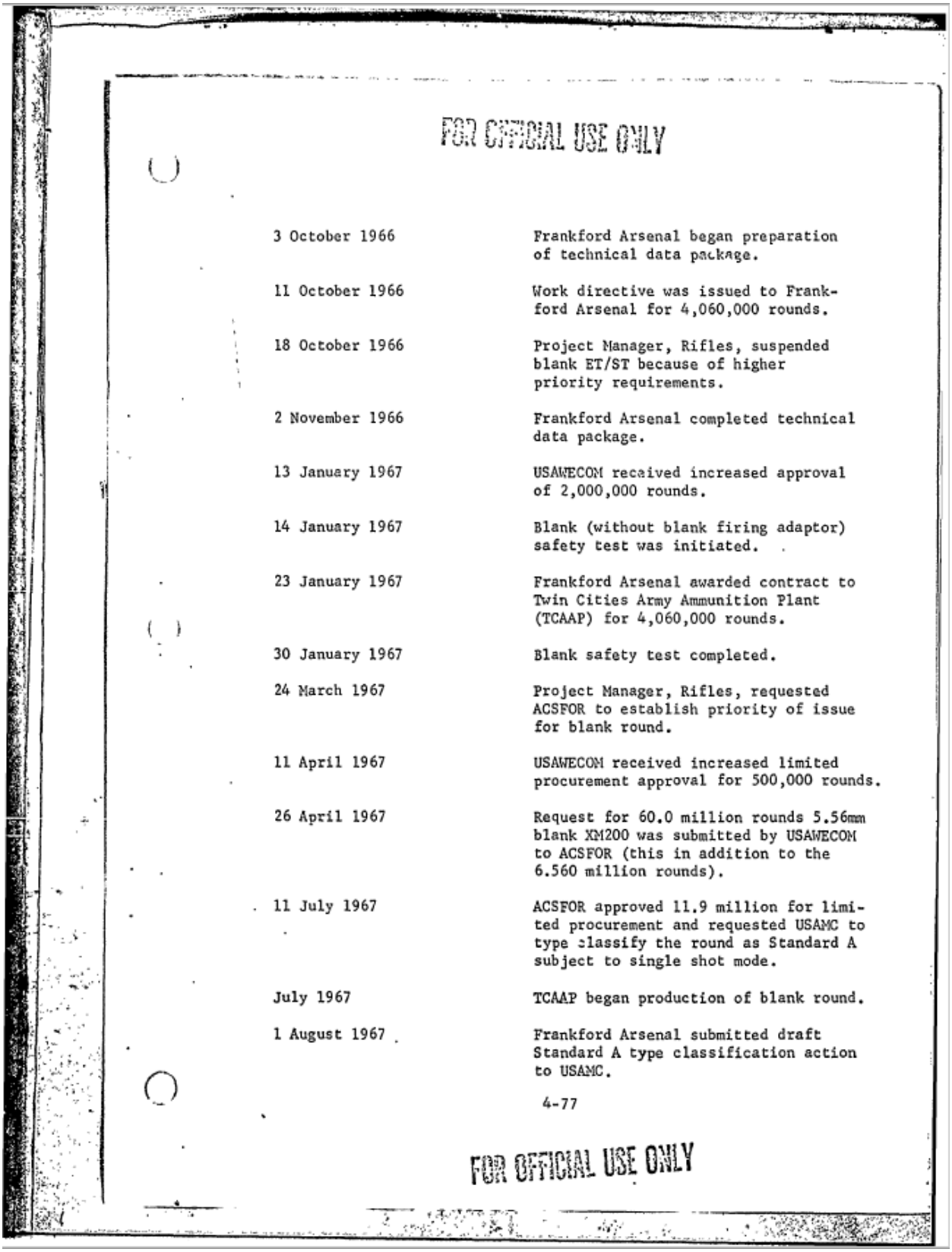
Figure 23 - History of Blank Ammunition.



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3 October 1966	Frankford Arsenal began preparation of technical data package.
11 October 1966	Work directive was issued to Frankford Arsenal for 4,060,000 rounds.
18 October 1966	Project Manager, Rifles, suspended blank ET/ST because of higher priority requirements.
2 November 1966	Frankford Arsenal completed technical data package.
13 January 1967	USAWECOM received increased approval of 2,000,000 rounds.
14 January 1967	Blank (without blank firing adaptor) safety test was initiated.
23 January 1967	Frankford Arsenal awarded contract to Twin Cities Army Ammunition Plant (TCAAP) for 4,060,000 rounds.
30 January 1967	Blank safety test completed.
24 March 1967	Project Manager, Rifles, requested ACSFOR to establish priority of issue for blank round.
11 April 1967	USAWECOM received increased limited procurement approval for 500,000 rounds.
26 April 1967	Request for 60.0 million rounds 5.56mm blank XM200 was submitted by USAWECOM to ACSFOR (this in addition to the 6.560 million rounds).
11 July 1967	ACSFOR approved 11.9 million for limited procurement and requested USAMC to type classify the round as Standard A subject to single shot mode.
July 1967	TCAAP began production of blank round.
1 August 1967	Frankford Arsenal submitted draft Standard A type classification action to USAMC.

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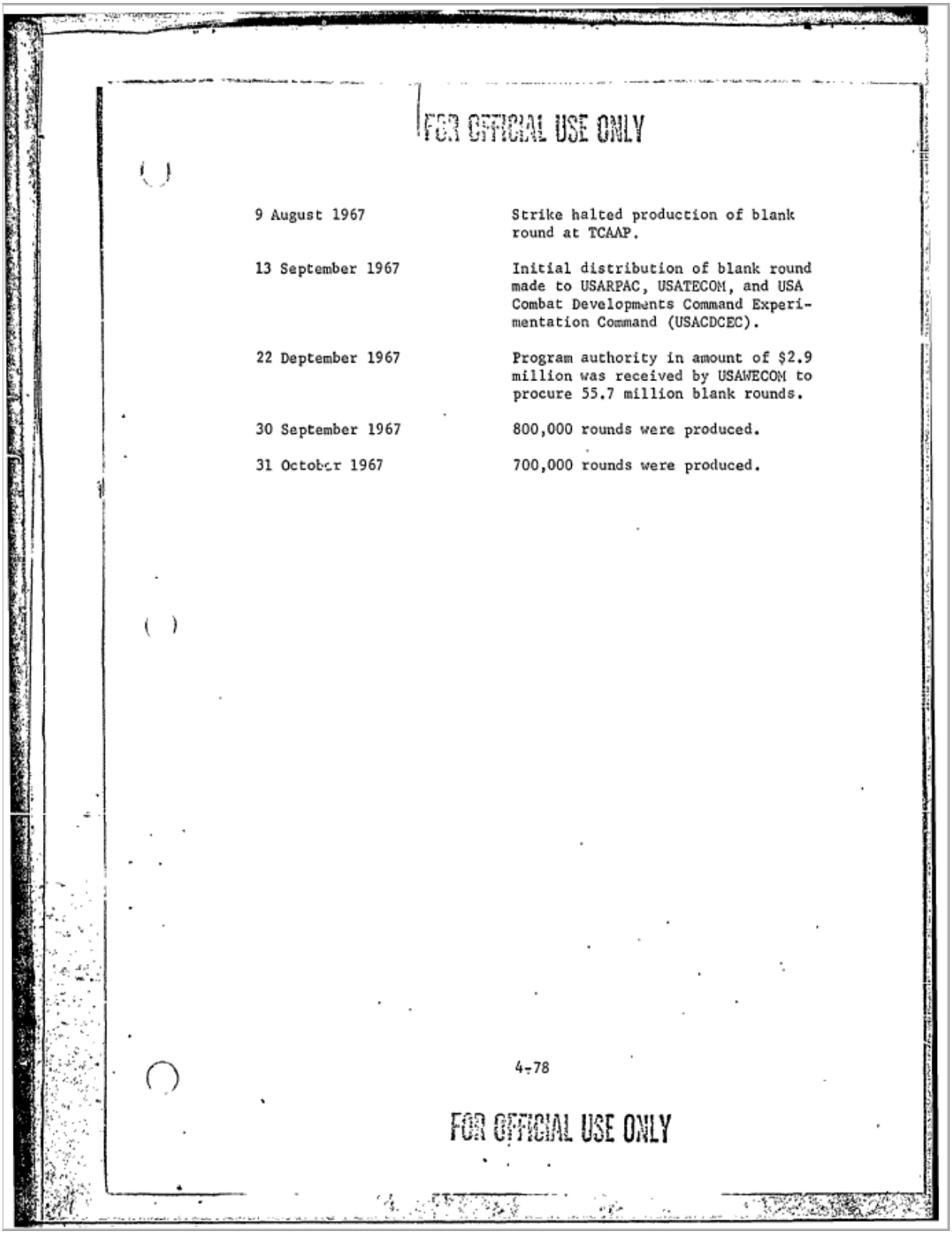
Figure 24 - History of Blank Ammunition



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9 August 1967	Strike halted production of blank round at TCAAP.
13 September 1967	Initial distribution of blank round made to USARPAC, USATECOM, and USA Combat Developments Command Experimentation Command (USACDCEC).
22 September 1967	Program authority in amount of $2.9 million was received by USAWECOM to procure 55.7 million blank rounds.
30 September 1967	800,000 rounds were produced.
31 October 1967	700,000 rounds were produced.

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Figure 25 - History of Blank Ammunition

Many books have been written about this whole scandal and how the M16 program was handled. Additionally, the complete report can be found on occasion in print. I have managed to track down a copy of the 51-page initial report. And I will link to it in the recommended reading section at the end of this book. What I am covering here is only a fraction of what happened with the M16 rifle as much of this is devoted to more of the relationship between the rifle and its ammunition. This document would be truly massive if I went into more detail. However, for those so inclined, the history is fascinating and richly rewarding for any student of small arms history. I highly recommend that you take a look at some of the additional resources that I will provide at the end of the book.

Is The M16 Really Reliable?

In July of 1968 Aberdeen published a report titled*, M16 Rifle System Reliability and Quality Assurance Evaluation*. The report was to look at how reliable the M16 actually was. The report looked at the whole rifle, from the ammunition used, to the cyclic rate, cycle time, magazines, and how the environment affected the rifle. When looking at the requirements and standards that the M16 was put under one of the main questions that the report wanted to answer was whether or not these standards were valid. By the end of the report, the M16 was found to be reliable when compared to the M14. However, there was one caveat. The initial reliability of the M16 was better than the older rifle during the first part of its service life, but this decayed as the rifle was used. Furthermore, the M16 had more sensitivity to both environmental effects and lack of maintenance. The study concluded that there was room for improvement of the reliability of the M16, despite being currently acceptable for military use.

A Most Inept Performance

In September of 1968 the Senate's Special M16 Rifle Subcommittee once again takes the Army to task. This time the cost of the contracts with GM-Hydramatic and H&R are put up for criticism. The cost of the miniguns was attacked and the award process for the Army's contract process was called, *"a most inept performance"*. The Ichord Subcommittee piles on also calling the contracts, *"an exercise of extremely poor judgement"*.

Despite this, the research continued with the BRL publishing a new report. This time, instead of just collecting data from the field, the new report, *Computer Simulation of 5.56mm Propellants,* also added computer simulations into the mix to look at the propellants being used in the 5.56mm rounds in both the M193 and M196 cartridges.

In October of 1968, Colt had produced it's one millionth M16 rifle, a massive accomplishment. However, the twist rate to be used in the M16 was still being looked at. Aberdeen's BRL published another report, *Comparison of the Exterior Ballistics of the M193 Projectile when Launched from 1:12 In. and 1:14 In. Twist M16A1 Rifles*.

The testing was conducted with four barrels total, two with a twist rate of 1:12" and two with a twist rate of 1:14". Five temperature tests were run, at 125, 70, 0, -30, and -65 degrees Fahrenheit. M193 ball ammo, loaded with ball powder was used, and was designated LC-SP-412, produced by Lake City Arsenal in June of 1967.

There was one caveat with this testing however.

While the 1:14" barrels were new and had only a handful of rounds fired though them to proof them before being used in the testing, with an estimated total round count of less than 100 though the barrels. Colt had already tested the 1:14" barrels and rated one as grouping at 7.5" at 100 yards, with the other grouping at 4" at 100 yards. The 1:12" barrels were, however, much older, and there was not round count of how many rounds had been shot though them before testing.

For the 1:14" barrels there was a larger yaw in flight that only got worse as the temperature of the testing went down to a range of 70 meters. When the testing was done at 125 degrees Fahrenheit, the yaw was roughly the same at about 8 degrees.

Yet when the temperature was decreased to -65 degrees there began to show a separation. At this subzero temperature the highest recorded yaw in flight was 36 degrees, yet the 1:12" twist rate barrels did not have the same issue. At 70 meters out, the 1:14" twist barrels were producing even more yaw then the 1:12" twist barrels had at the muzzle.

Across the board the rounds fired from the 1:12" twist rate barrels stabilized with a maximum yaw of roughly 3 degrees when they reached a range of 70 meters. However, there was another issue. With the greater instability in the projectile's flight, the 1:14" twist rate barrels were causing the rounds to lose their velocity faster.

For the accuracy, the 1:12" twist rate barrels slightly produced better accuracy until about 40 degrees Fahrenheit, after this, the 1:14" twist rate barrel rapidly lost to the 1:12" twist rate barrels. At -65 degrees, the spread of the 1:14" twist rate barrels was four times that of the 1:12" barrels.

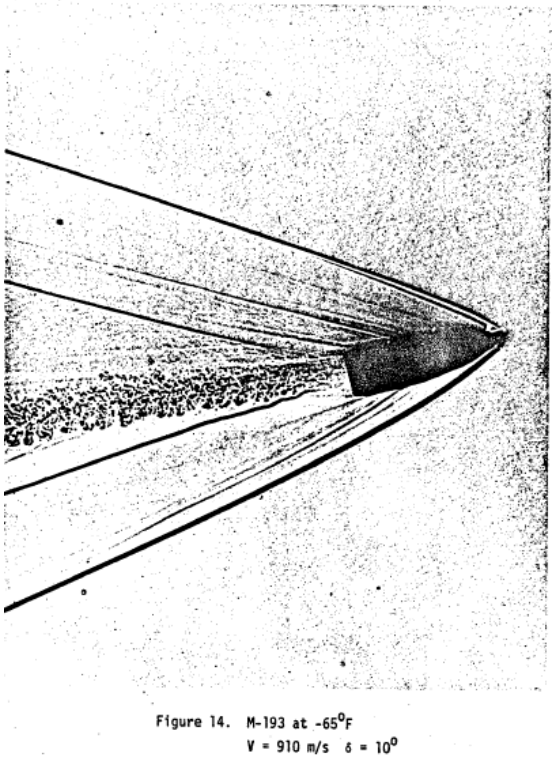


Figure 26 - A 5.56mm bullet yawing as it struck the target in the exterior ballistics testing.

Excessive Fouling and Expensive R&D

The XM177E2 was running into issues in November of 1968. The suppressor that Colt had created for it did not only foul up quickly but it became less effective at flash and noise suppression as it did. To make matters worse the M193 ball round would tumble and yaw through the air because of the fouling. On occasion this would lead to the round simply breaking up in the air, instead of hitting the target. Yet there were still more issues. The cyclic rate on the XM177E2 was even higher with ball powder than the M16. To address this Colt estimated it would take $400,000 and six months to run the needed ballistics studies to solve the problem. The Army, meanwhile, thought it could do it better. With a grossly more expensive $635,000 R&D study.

The projected cost to fix the issue proved to be more than anyone was willing to spend and the XM177E2 would leave production in 1970.

Yet new issues would crop up with the ammo and there would be another investigation into the 5.56mm ammo done by Frankford Arsenal. Accusations had cropped up that a particular lot of ammo was "dirty" so the report, *Investigation of 5.56mm, Cartridge Lot LC-12387 in Standard 5.56mm, M16A1 Rifles* looked to confirm or deny these allegations. In a test of suppressors, the USAHEL had run into issues with the lot and encountered issues in as little as 300 rounds. Frankford was given the task of investigating the issue and seeing if it had to do with the ammo, or some other factor.

In total 10,000 rounds were fired for the test, however the report's author, Andrew J. Grandy, was unable to duplicate the issues that had been previously reported about the ammunition. This was likely due to the previous tests being done with suppressors, causing back pressure and more build up. The ammunition was, in all likelihood, not "dirtier" however the design of the suppressor was the source of the issues.

With 1968 coming to a close another report from Aberdeen's BRL would be issued, again looking at the differences in twist rate between the 1:12" and the 1:14" titled, *Effectiveness Comparison of 1:12 and 1:14 Inch Twist Rates for M16A1 Rifle.*

New Year, New Rounds

With the start of 1969 new loadings were being introduced for the 5.56mm. First Lake City started to use gilding metal clad steel jackets for the M196 tracer round. This was intended to improve the performance of the round, however there were side effects. With the new, harder jackets, barrel erosion increased and the rifling began to wear out faster. After only a few years in production the GMCS jackets were dropped from the tracer rounds to prevent the issue from growing.

With Canada starting to look at the 5.56mm cartridge as well, Industries Valcartier Inc. or IVI started to produce a 68 grain version of the 5.56mm ball cartridge. As a sister round, a tracer round, with an 800-meter range was also introduced by the company. The US Army would experiment with these designs and give them the experimental designations, XM287 ball and XM288 tracer.

Yet there was still experimentation at home as well. Nosler began working on a solid steel bullet that was cheap to manufacture, yet hopefully effective. However, in the testing done by Frankford Arsenal, the rounds did not perform as well as Nosler had hoped. Yet the low cost of the bullets was attractive to the military and the reports on them suggested that they be retained for further study to see if the design could be changed to perform better.

In January of 1969 both Aberdeen and Frankford Arsenal were continuing to look at both the cyclic rate of the M16 as well as the waterproofing measures used on the cartridges. With the humid climate waterproofing was an important step to keep the 5.56mm and other cartridges from becoming bogged down with moisture and misfiring. Yet, the water proofing compound was thought to have some effect on the fouling of the rifle, so Frankford investigated this with the report, *A Study of the Effects of Cartridge Case Mouth Waterproofing Compound on Fouling in the 5.56MM, M16A1 Rifle.*

Meanwhile, the question of the twist rate remained. So William C. Davis and James B. Ackley continued to look at the issue and follow up on Aberdeen and other's results with the report, *Results of a Dispersion Test of 2,000 1:12 and 1:14 Twist M16A1 Rifle Barrels.*

A Lethal Lemon?

1969 would roll on, testing would continue to improve the 5.56mm rifles, carbines, and SMG's that the military was both using and looking to adopt. Yet the major issues with the M16 were more or less behind it. Corrections to the rifles had been made, and new improvements were coming down the line.

So in September of 1969 a small change in the specifications for the 5.56mm was made. The allowable level of calcium carbonate in the ball powders that the military was using was dropped from 1% to just 0.25%. It was hoped that this change would decrease the amount of fouling in the rifles after extended firing.

The following month of October, 1969, saw more reports, and some of the last major political rumblings about the M16. Dr. Carten, the newly appointed Chief of the Technical Evaluation Branch of the AMC's Research, Development, & Equipment Directorate submits a new report. *The M16 Rifle - A Case History*. Dr. Carten's report was submitted to the Blue Ribbon Defense Panel and attempted to put all of the blame for the issues of the M16 on the lack of case hardness specifications. However, this was not the only cause and as we have already seen, a rather narrow take on the rather complex subject of just why the M16 had encountered difficulties in Vietnam. It was a multitude of issues, not just one. But this did prompt one change that we see today in the AR-15. The use of the extractor spring buffer.

Colt had first decreased the strength of the extractor spring to attempt to deal with the issue of rim shear. Yet, this caused its own problems and would soon be scrapped. The final solution was to add the rubber buffer under the extractor spring that we see in use today.

The last major political maneuvering over the M16 that we will discuss was two years later in 1971. Ralph Nader and the Connecticut Citizens Action Group issued their own, independent, report, titled, *The M16: Colt's Lethal Lemon*. Instead of placing any blame on the military, as the previous investigations had done, it instead charged Colt themselves with deliberately circumventing the Army's quality controls. This would eventually lead to a FBI investigation in 1972, however, from my research, nothing seemed to come of it and the DOD responded by saying in a 1972 interview with the *York Daily Record*,

> *" "So far as the Department of Defense is concerned, it's all cleared up," said a Pentagon information officer."*

Ichord did attempt to once again make an issue of these allegations, however with little to stand on, the charges seemed to have simply drifted away. By the time the FBI's investigation was launched, Colt had already produced 2.5 million rifles and the previous few years had lacked the major reliability and function problems of the M16's initial excursion into Vietnam.

Alternative 5.56mm Loadings: Plastic, Aluminum, And Beyond

In January of 1970 Olin admitted an issue with the use of ball powder in the 5.56mm.

Before the WC 846 powder had a wider range of tolerances in its production, leading to variation in the way that the powder burned and worked with the smaller cartridge. After examining their manufacturing process, they found that if they used WC 846 powder from one end of their tolerance range it would be better suited for use in the 5.56mm cartridge. Because of this refinement in manufacturing, Olin was able to spin of a new powder type, named WC 844 to be used in the 5.56mm cartridges. The rest of the WC 846 powder that fell outside of this new specification would continue to be called WC 846 and used in other cartridges.

In February of 1970 Frankford Arsenal was finally able to track down what was causing some of the fouling in one type of 5.56mm loading. Examining the M200 Blank round, they found that the pigment used in the lacquer to seal the crimp of the blank round was causing excessive fouling. The titanium dioxide formula of the pigment interacted with the rest of the powder as it burned and created more fouling than normal rounds. Frankford in the paper*, Elimination of Gas Tube Fouling in the M16A1 Rifle when using the M200 Blank Cartridge,* found that if they swapped this pigment with an organic one the fouling was almost eliminated.

Frankford Arsenal also did an analysis of the fouling deposits that built up in the M16's gas tube. The report, *Metallurgical Examination of Fouled Gas Tube and Flash Suppressor from an M16A1 Rifle,* was specifically interested in determining the chemical composition of what was building up in the gas tube. It's worth reading if you are interested in the chemistry of what's left behind by the combustion of the powders and primer's used in the M193 rounds of the era.

New Materials

In March of 1970 two new concepts for cartridge casings were coming out with possible application to the 5.56mm. One an older design, the other, completely new.

The older design was one that used steal instead of brass cases. Two reports were created, both titled, *Product Improvement Test of Cartridges, 5.56-mm, Assembled with Steel Cartridge Cases*. One was from Gerald A. Gustafson and the other was from Larry J. Regan and Michael L. Kuczinski. What they found was that the steal cases ended up just as, if not more reliable than the brass cases. However, there was some case splitting noted in the report.

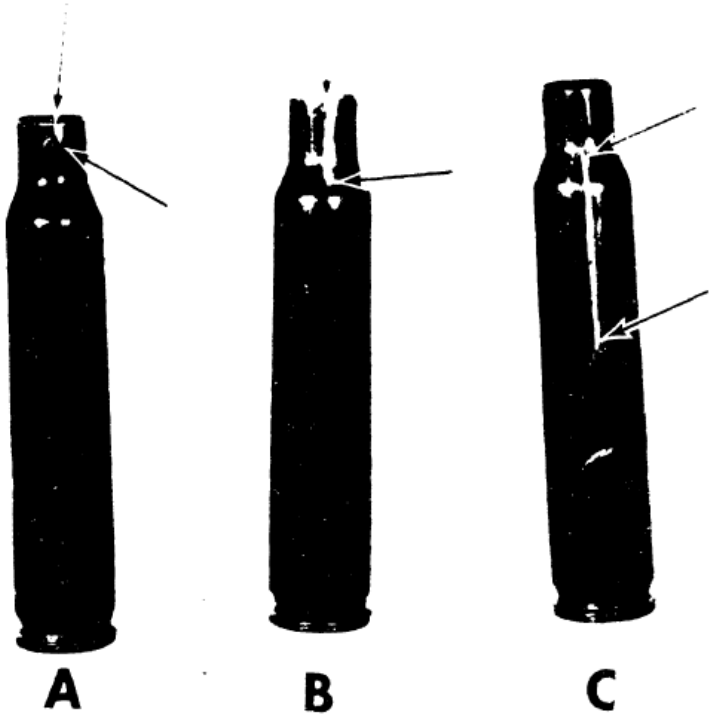


Figure 2

Cartridge Case Casualties for Cartridge, 5.56-mm, Steel Cased

A - Arrows indicate splits in mouth.

B - Arrows indicate splits in neck and shoulder region.

C - Arrows indicate splits in shoulder and case region.

Figure 27 - Despite the low quality of the photos you can still see the places where the steel cases split.

In Regan and Kuczinki's report at total of 21,624 steal cased rounds were fired with 53 malfunctions. The test cartridges meanwhile had 71 malfunctions. There were 47 instances of split steel cases but not of these damaged or affected the rifles used in testing. In just about all ways the steel cased rounds were comparable to the brass cased ones. However, there was one major caveat.

Steel could rust.

Figure 28 - Example of a polymer cased .308 round failing, causing a "Ka-BOOM".

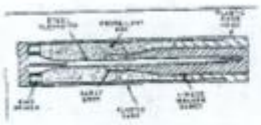
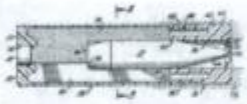
So while the rounds were fine for use in temperate climates, anything too humid would require the use of brass cased ammo. While the steel was cheaper, the combined benefits of brass over steel, such as the rust and ease of reloading would see brass cases continue to dominate.

The second design to come up in March of 1970 was a patent from Remington's John J. Scanlon for a composite plastic and metal cartridge case much like some of the polymer cased ammo from PCP Ammunition. However, the design has not gotten far today for a reason.

Despite this, in 2000 the Office of Naval Research (ONR) would award a $2,226,176 contract to Amtech, Inc. to create a polymer cased 5.56x45mm round. In 2004 the concept would come back again with the ARDEC working with Frontier Performance Polymers Corporation to create 100 5.56mm, unprimed, plastic cartridge cases.

A year later, in 2005 a new report, *Alternative Cartridge Case Material and Design,* would be released by Frontier Performance Polymers' Jerry S. Chung and ARDEC's Lucian Sadowski, looking at once again trying to make a polymer cartridge case work. The report looked at the issues presented to a polymer cased round and tried to come up with solutions to make a 5.56mm polymer case viable, however as of this writing, it seems that the idea has yet to gain any ground over traditional case designs.

Table 4
(continued)

Case design	Unique features	Failure Modes and Deficiencies
	• Aluminum-plastic hybrid with snap-fit 5.56-mm Flechette case design is similar to other metal-polymer hybrid design • Used 50% glass filled PA12 for case body	• Case cracked and split
	• 5.56mm polymer cased Flechette design	• Flag formation due to the flow of the plastic material
	• Developed by ARES for ACR program and .50 caliber • Telescope case design with internal bullet support and no extraction groove • Used ultrasonic welding to weld cap with case body • Used Noryl GTX (PA/PPA Blend) or glass fiber filled PC material	• Circumferential cracked formed at 140°F • Degraded performance, crack and extrusion seen at 115°F and 85°F
	• Designed for 50 caliber blank ammunition cartridge, although drawing is for ball round • Used PE material for case body	• Lost more than 20% of interior volume • Stress cracking in PE case body occurred during storage • No report of case cracking • Tendency to blow the nose off (blank .50 cal design) at low temperature
	• Two-piece all-polymer design • Spin welding jointed both component together	• Designed for low pressure shot gun • Would not survive under the pressure of typical military tactical cartridge
	• Three-piece all-polymer design	• Designed for low pressure shot gun • Would not survive under the pressure of typical military tactical cartridge

Review of Brass M855 Case Design

Brass cartridge cases have been used for more than 100 yrs. Despite its shortcomings, the brass case has been the most popular choice for most weapons. Therefore, it is worthwhile to first understand the brass cartridge case design and how it performs during the ballistic cycle.

The brass M855 case design has a tapered contour that allows it to be extracted easily from the firing chamber after firing. While the brass cartridge case of a conventional round typically undergoes some permanent deformation, specifically radial expansion as a result of the

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Figure 29 - Several designs shown in the report, Alternative Cartridge Case Material and Design.

Which Primer to Use?

In November of 1970 the military had yet to finalize one standard primer design. The pros and cons of doing so was looked at by the Institute for Defense Analyses in the report*, Primer Selection for Small Arms Ammunition.* The whole debate could be boiled down to one question, should the military continue using primers with basic lead styphnate in them? Lead styphnate is a compound that is explosive and used to help trigger the initial detonation in the primer.

At this time there were two competing primer formulas being used. The military and the ammunition production plants they ran used basic lead styphnate in their primers, however other 5.56mm producers used normal lead styphnate in their primers. Sticking with basic lead styphnate would have a lower cost and could be safer to produce. However, the normal lead styphnate had better performance in the primer and would reduce the amount of testing needed for future changes to the cartage.

Unsolicited Aluminum

In the spring of 1971, AAI wanted to make a plastic cased blank cartridge for training. Despite being an unsolicited proposal the idea began to gain some ground. By the end of August, the report*, Military Characteristics for Plastic 5.56mm Blank Cartridge*, was published and by November they had a contract with the Land Warfare Laboratory at Aberdeen to develop the cartridge further. In 1973 the idea of a plastic training round would be expanded upon and Gulf + Western Industries Inc. who introduced their own ball version of the same basic concept, again for use in training.

In July of 1971 Reynolds Metals was looking at another alternative case design for the 5.56mm. They released a report*, Development of Aluminum Alloys for Cartridge Cases* that looked at what would be needed to make an aluminum case viable for use in the cartridge. They found that there were two specific things that an aluminum case needed. First when annealed, the aluminum alloy needed to be able to be formed easily. This was so that the drawing and cupping process used to manufacture brass could be done without introducing defects into the metal. Once the case had been heat treated it needed to be strong, able to hold up to 80,000 pounds per square inch of pressure. While they looked at three aluminum alloys; 7075, 7178, and 7001, none of these had the properties that were needed. So further study and experimentation was needed.

In the interim the ballistic standards for the 5.56mm ammunition for the military. The specification, MIL-STD-1453(MU), introduced in July of 1971 furthering the separation between the commercial .223 Remington and the 5.56mm round used by the military.

By August Frankford Arsenal was looking at aluminum Cartridge cases. With the alloys that they had the aluminum cases were failing and they were attempting to find out why. The report*, An Analysis of Local Temperature Profiles Encountered in the Aluminum Cartridge Case Drilled Hole Experiment* attempted to figure out what changes needed to be made to make the aluminum alloy work as a casing. The researchers found that the best way to approach this issue was to see how the cases were failing by intentionally causing the 5.56mm aluminum cases to fail.

The work would continue in 1972 with another report from Frankford Arsenal with the report, *An Analysis of 5.56mm Aluminum Cartridge Case Burn-Through Phenomenon*. Previous attempts to make an aluminum cartridge case dated back to the 1890's and had mostly resulted in failure. The "burn though" issue had persisted for almost 100 years at this point and they found that either the gas was escaping from the case and causing this issue. Once this was discovered they were able to start working on solutions for this issue and the idea of an aluminum case was able to move forward.

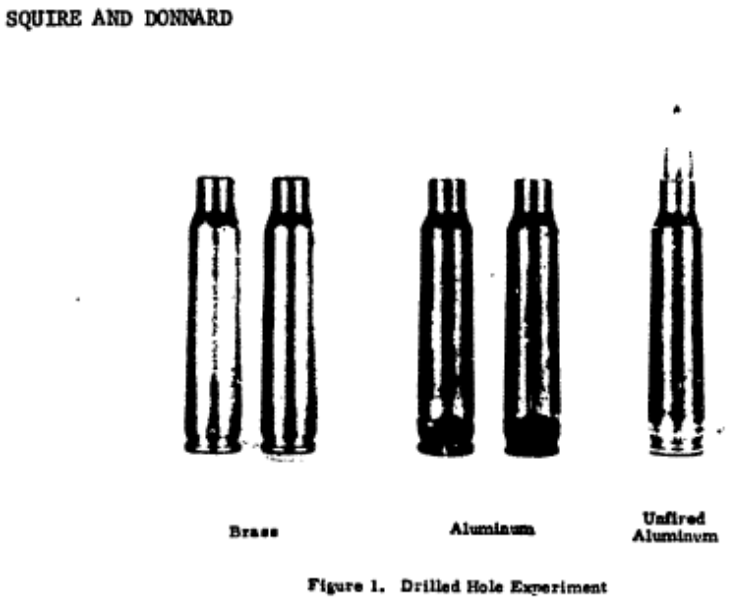


Figure 30 - Images of the cases used in the Case Burn-Through Phenomenon paper. While difficult to see the aluminum cases ruptured at the base while the brass ones did not.

Match Grade M16A1 and More Aluminum Experiments

In February of 1972 the US Army MTU was working on plans for a new National Match M16A1. This rifle was slated to use a 1:9" twist rate, heavy barrel. To pair with the faster twist rate bullets as heavy as 70 grains were looked at for use in the rifle.

April of 1972 saw another experimental 5.56mm round be produced. This round was a tracer that used infrared lasers to ignite the tracer compound in the bullet. The testing was detailed in the Remington report*, Tracer Simulation Study.* However, there was an issue with this that cropped up quickly, tracking a bullet in flight with the laser proved to be more difficult than they initially thought and the live fire tests did not work as well as had been hoped.

While Frankford Arsenal continued investigating other projects such as, *Effect of 5.56mm Primer Components on Ballistic Performance of the M16A1 Rifle/Ammunition System* and *Effect of Propellant Additives in Reducing Fouling and Erosion in the M16A1 Rifle,* testing of aluminum cases continued. Released in November of 1972, the report found that if they used newer, higher-strength aluminum alloys, as well as newer case manufacturing techniques a functioning aluminum case could be made. With these changes they were finally able to create a 5.56mm aluminum case to function without any issues in a live fire demonstration.

In March of 1973 the US Army Arctic Test Center once again looked at gilding metal clad steel jackets for use in the 5.56mm. The testing was done for Frankford Arsenal and was compiled in the report*, Product Improvement Test of Gilding Metal Clad Steel (GMCS) Jackets for 5.56MM Projectiles.*

In September the next phase of testing on aluminum 5.56mm cartridges were done. Frankford Arsenal published its report*, Stress Corrosion Susceptibility of Aluminum Cartridge Cases*, and they found that the newer alloy was working. The new, 7475 aluminum alloy cases were tempered to a T6 or T73 condition to make the experimental case material work.

Testing would continue into October at Frankford Arsenal and the next series of results would be published in the report*, Analytic Study of Extraction Forces in the M16 Weapon*. Using the 7475(TMT) aluminum cases for the 5.56mm in the M16 they found that the new aluminum cases were actually easier than brass to extract from the chamber.

In March of 1974 Aberdeen continued the testing with*, Product Improvement Test of 5.56-MM Steel-Cased Ammunition*, and then again in June with the report, *Product Improvement Test of 5.56-MM Cartridge Case with Optimized Hardness Gradient.* With the testing continuing on alternative cases the plastic blank round concept continued to move forward.

In June of 1974, the US Army Land Warfare Lab published*, Plastic 5.56mm Blank Cartridge*. The new plastic design was created with a four cavity mold and they were able to use the standard blank firing adapters that were used on other blank rounds with the new design. The new plastic training round preformed excellently, beating out the standard, M200 blank cartridge in reliable feeding and was equal to it in all other regards. However, this new round was not meant to be.

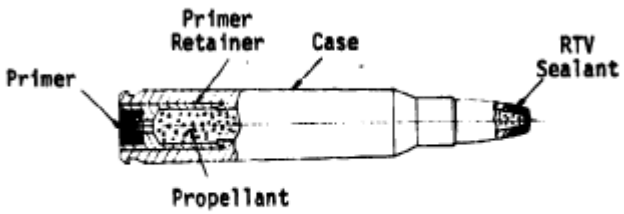


FIGURE 2. Cutaway of Plastic 5.56mm Blank Cartridge

Figure 31 - Cutaway of the proposed plastic blank round.

The Land Warfare Lab that was working with AAI to bring the plastic 5.56mm, training, round to the military was shut down shortly after the testing was completed. With no one left to pick the idea back up and keep it up and running the promising design died in R&D before it was ever put into full scale production.

Outside Experimentation with Aluminum

In 1975 experiments with aluminum cases continued. The Thiokol Corporation published another report titled*, Prevention of 5.56mm Aluminum Cartridge Case Burnthrough*. Meanwhile Frankford Arsenal continued to look at the case burn though issue in more detail. In Frankford's *Prevention of 5.56mm Aluminum Cartridge Case Burn-Through*, they found that some case coatings could help solve the issue. They used five different materials. A red grip core paste, a polyimide varnish from DuPont, 45B3 intumescent coating developed by NASA, and RTV-734 created by Dow Corning. After testing two of the coatings produced the best results, NASA's intumescent coating and the polysulfide sheeting. Both were used on the inside of the case, instead of the outside of it. With these results Frankford concluded that the best way to deal with the burn though problem was to use a coating on the inside of the casing instead of attempting to coat the exterior of it.

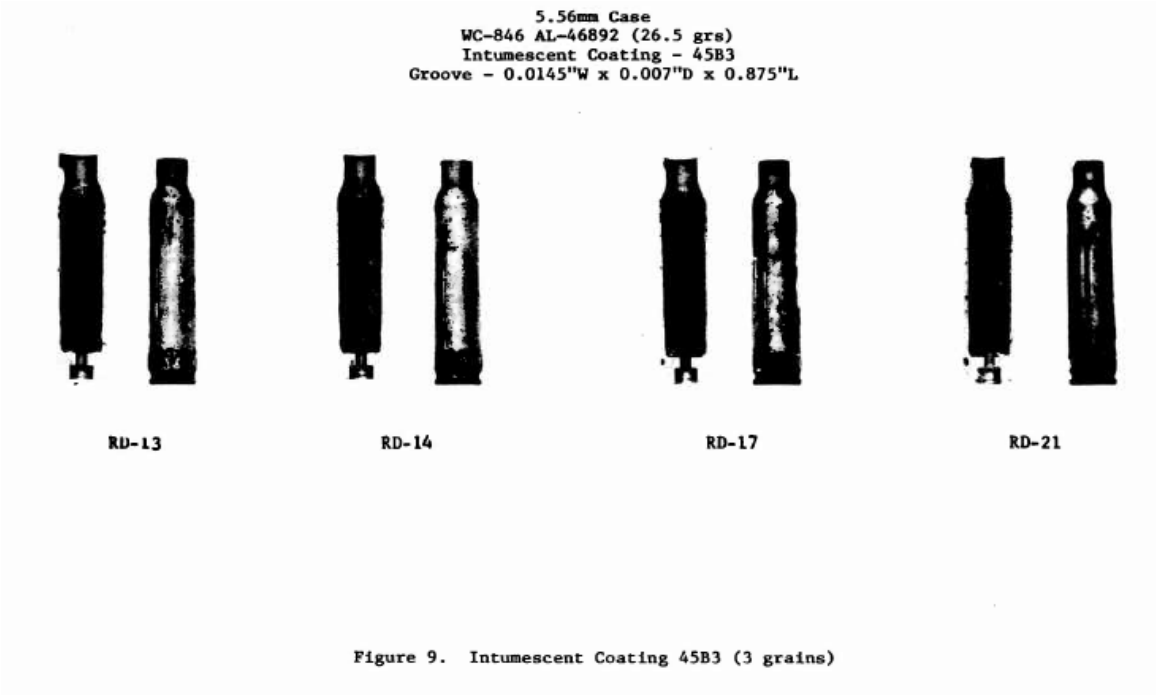


Figure 32 - Some of the aluminum cases used in the testing.

However, the Thiokol Corporation was also continuing their experiments. They published a report in January of 1975, looking at a similar way of addressing the issue. The report*, Development of a Flexible Internal Element (FIE) for Aluminum Cased Ammunition*, found that the could achieve similar results with a preformed material that could be inserted into the aluminum case instead of sprayed into it like the Frankford tests. Thiokol found that three formulas for this material could work, known internally as, P10, P18, and P28.

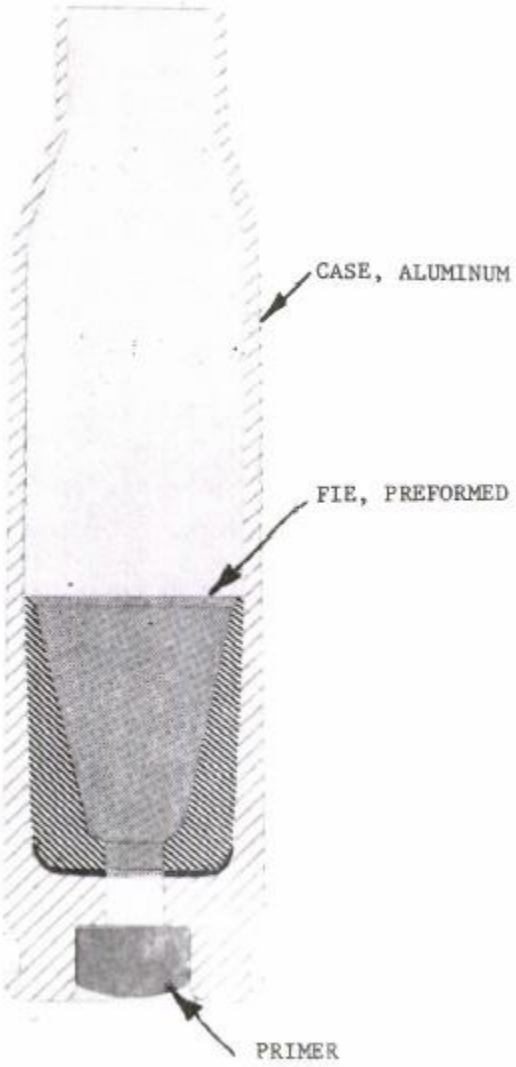


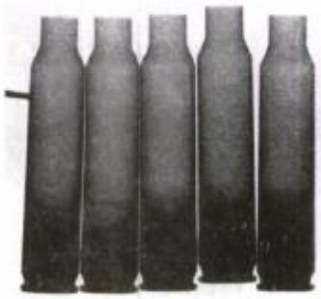
Figure 1. Cutaway View Showing Preformed FIE in Place

Figure 33 - The FIE was placed at the base of the cartridge where most "burn through" happened.

Test Group C

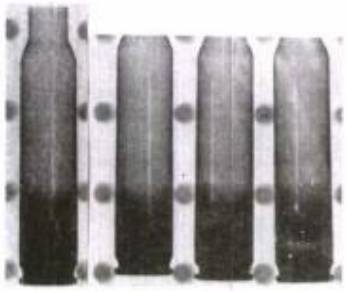
Formulation: P10

LP-32	68.0
C5500	12.0
Thermax	20.0



7 5 3 2 1

Case X-Ray Before Loading



1 2 3 7

Case X-Ray After Firing

7 3 2 1

Case Exterior After Firing

7 3 2 1

FIE Cups After Firing (2X)

Figure 9. Test Group C, Formulation P10

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Figure 34 - The P10 formula was one of a number experimented with in the report. In the X-Rays you can see the FIE after it had been placed in the case.

Later, in February of 1975, Aberdeen's HEL was experimenting with new kinds of tracer ammunition. Traditional tracer rounds worked with a small cup in the back of the bullet to hold a tracer compound that would ignite and allow the trajectory of the bullet to be tracked. This had a few downsides, however the main issue was that the bullet weight had to be lighter than a standard round to accommodate for the cup for the tracer compound. This meant that the tracer round would have, normally small, but increasing at range, trajectory difference compared to the standard ball round. The use of "external" tracers looked to solve this problem by coating the ball rounds with a chemical to trace its trajectory instead.

Aberdeen's experiments were documented in*, Observation Test of External Tracer Ammunition*, and while the initial idea was solid, in testing other factors came into play. First the coatings used left vapor trails instead of illuminating the target, this lead to the observers who were trying to identify which target was being engaged to have far lower accuracy in calling the shots, especially in low light situations. It was only during the day and when the observers were directly behind the firing line, instead of off to the side, were they able to track the experimental tracer rounds with any real degree of accuracy. Furthermore, it is likely that if any strong cross winds were encountered that the vapor trails would have dispersed even faster.

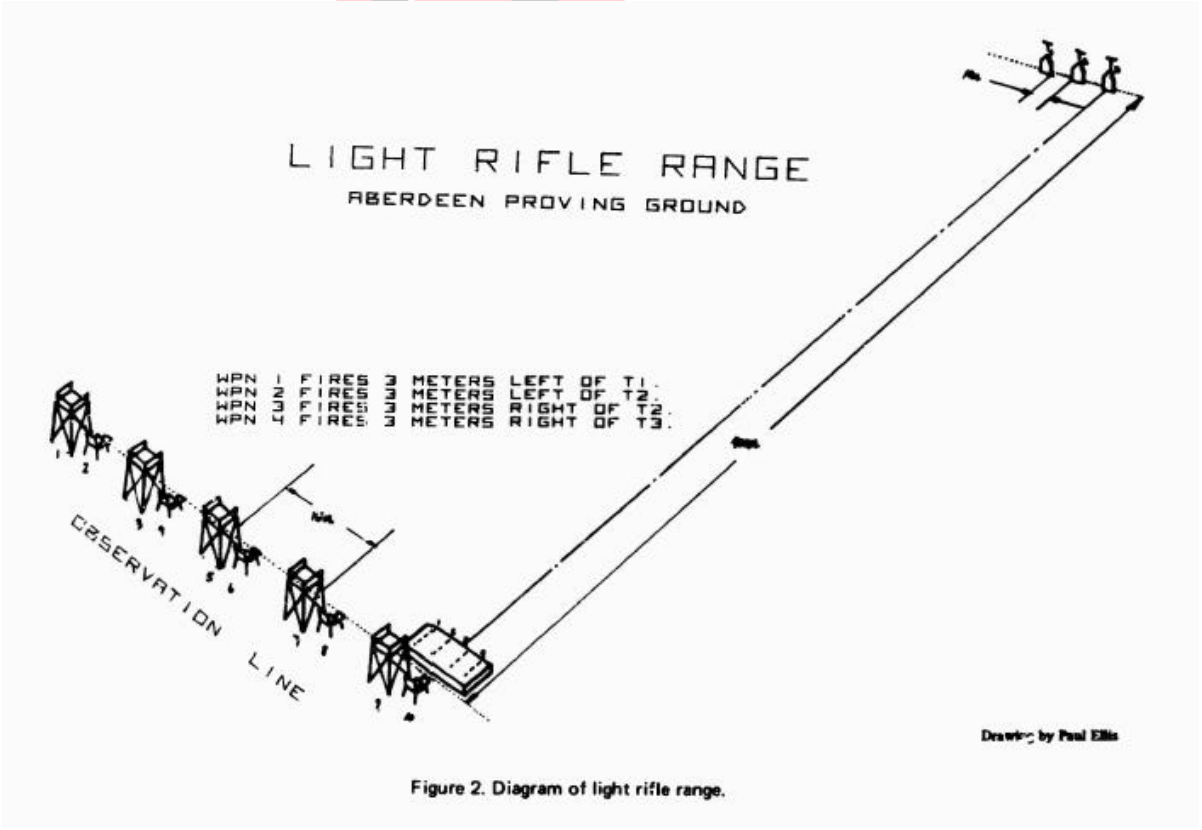

Figure 35 - The set up for the testing of the external tracer rounds.

In June of 1975 Rodman Laboratory was asking an interesting question about the accuracy of the 5.56mm. Could you determine how accurate a barrel would be just by looking at the way it marked the bullet? In the paper*, Projectile Engraving Mutations and Their Relationships to Accuracy of the M16A1 Rifle*, the found that there was a correlation coefficient above 0.7 between the widening of the groves in the bullet and the accuracy of the rifle. However, one has to ask, you're firing a bullet anyway, why not just run normal tests for accuracy?

M200 Malfunction Rate and 5.56mm NATO

In 1976 ARMCOM's Systems Analysis Directorate published a report titled*, Analysis of Proposed Solutions to the 5.56mm Blank Cartridge (M200) Malfunction Rate*. Since the M200 blank round was having issues, ARMCOM looked at a number of solutions to this. The first idea was to redesign the whole cartridge to use a different case material with both aluminum and steel being considered. Yet, the most effective change seemed to be with replacing the 20 round magazines with the newer 30 round design. In the 30 round magazines the "stubbing rate" dropped to 3%. While this seemed to solve the problem, the report did recommend following up on the testing done to ensure that the fix was indeed to change over to the 30 round magazine.

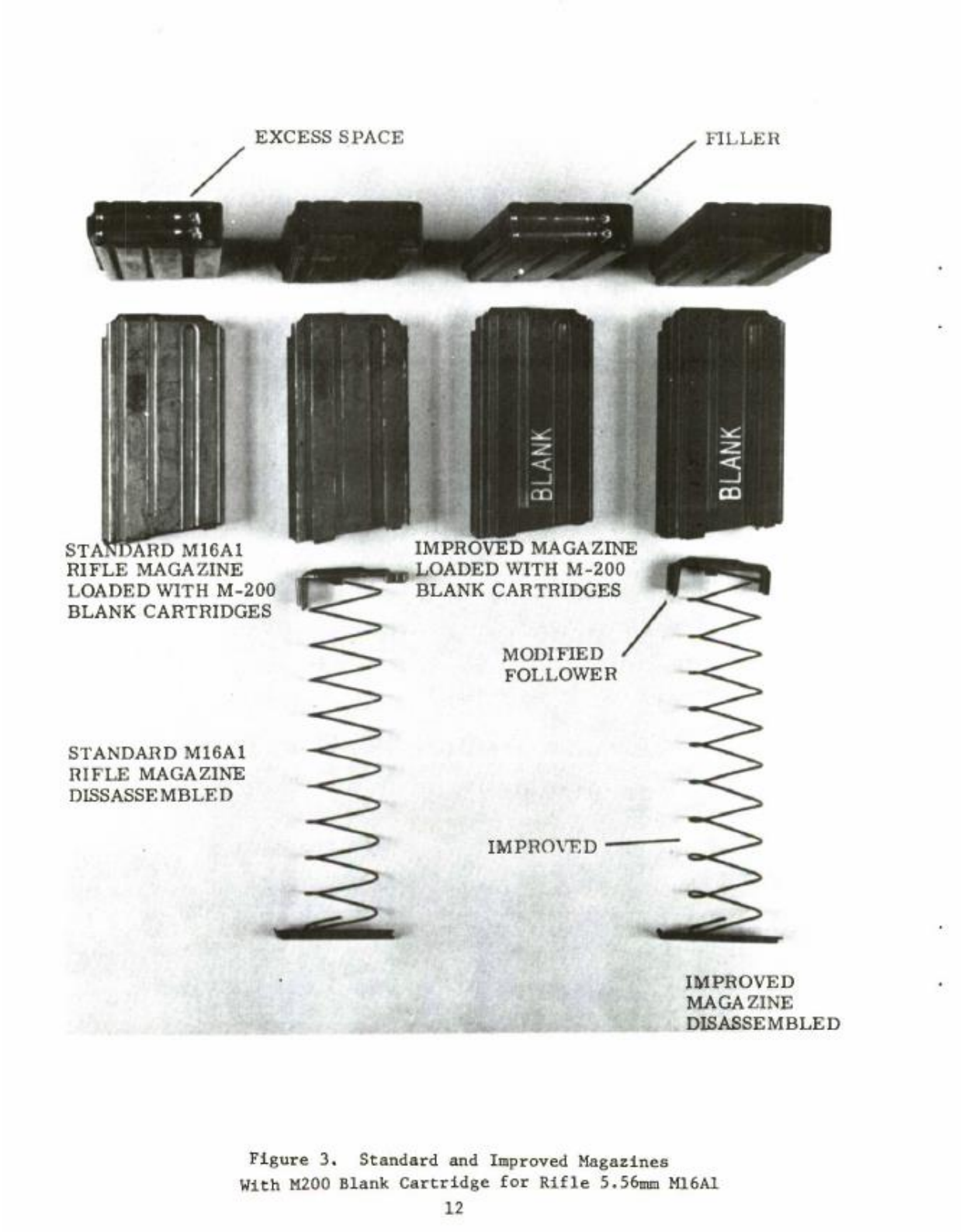

Figure 3. Standard and Improved Magazines
With M200 Blank Cartridge for Rifle 5.56mm M16A1
12

Figure 36 - Modifying the standard 20-Round magazine was another idea that was looked at in Analysis of Proposed Solutions to the 5.56mm Blank Cartridge (M200) Malfunction Rate

In February of 1976, both the Army and NATO were shooting down the idea of standardizing around a third caliber and the beginnings of the NATO standardization for the 5.56mm had not started yet. So along with some new weapon designs from FM and Rodman, the Minimi and XM235 were accepted for testing. With these new firearms, new 5.56mm designs were introduced as well. First was the XM777 ball round, a lighter design meant for 1:12" twist rate barrels. The second was the XM778 tracer round, with a tracer range out to 750 meters.

While NATO was just starting to look at potentially bringing the 5.56mm on board as a standard, Frankford Arsenal was investigating how ambient temperatures would affect the 5.56mm in the report, *Study of the Temperature Effects on the Ballistic Performance of 5.56 mm Ammunition.*

Meanwhile, testing of aluminum cases continued in March of 1967. Frankford Arsenal released yet another report on the issue of case burn though in aluminum cases. Titled*, A Critical Assessment of the Aluminum Cartridge Case Failure Mechanism*, the report reached a number of conclusions that turned some of what was thought about the issue of "burn though" on its head. They found that the term "burn though" was a misnomer and that the previous findings about a gas path being created though the case wall was the result of a defect in the materials used. They found that case failure happened as molten aluminum oxidized during the burning of the powder. The report would go on to say that,

"From a mechanistic point of view, the aluminum cartridge case "burn-through" may be considered the result of:

a. Propellant gas flow through an otherwise restricted gas path,

b. Forced convective heating of exposed aluminum surfaces to the point where melting and/or vaporization occurs.

c. Entrainment of this conglomerate in the boundary later,

d. Initiation of a vapor-phase reaction (primary reaction zone),

e. Augmented heat flux to regions downstream in the flow field,

f. Extensive removal of aluminum in the molten state, and

g. Generation of the secondary plume resulting from an exothermic reaction of molten and/or vaporized aluminum with available oxygen.

h. The primary vapor-phase reaction is caused principally by the oxidation of aluminum vapor by both carbon dioxide (CO2) and water vapor (H2O) which are present as the result of propellant combustion."

With all of this the report reached the following recommendations,

"1. A bomb be designed, fabricated, and ballistically tested to allow an investigation of the effect on different atmospheres at ballistic temperatures and pressures on the erosivity of aluminum test specimens.

2. An experiment be conducted to devise novel propellants having reduced adiabatic flame temperatures and lower oxidizing potential of the combustion products than is now available in standard propellants.

3. A fundamental study be conducted to identify the basic processes occurring in the primary reaction zone.

4. A more detailed metallographical examination be performed of aluminum surfaces which have witnessed "burn-through"."

Below you can see and image from the testing conducted for the study.

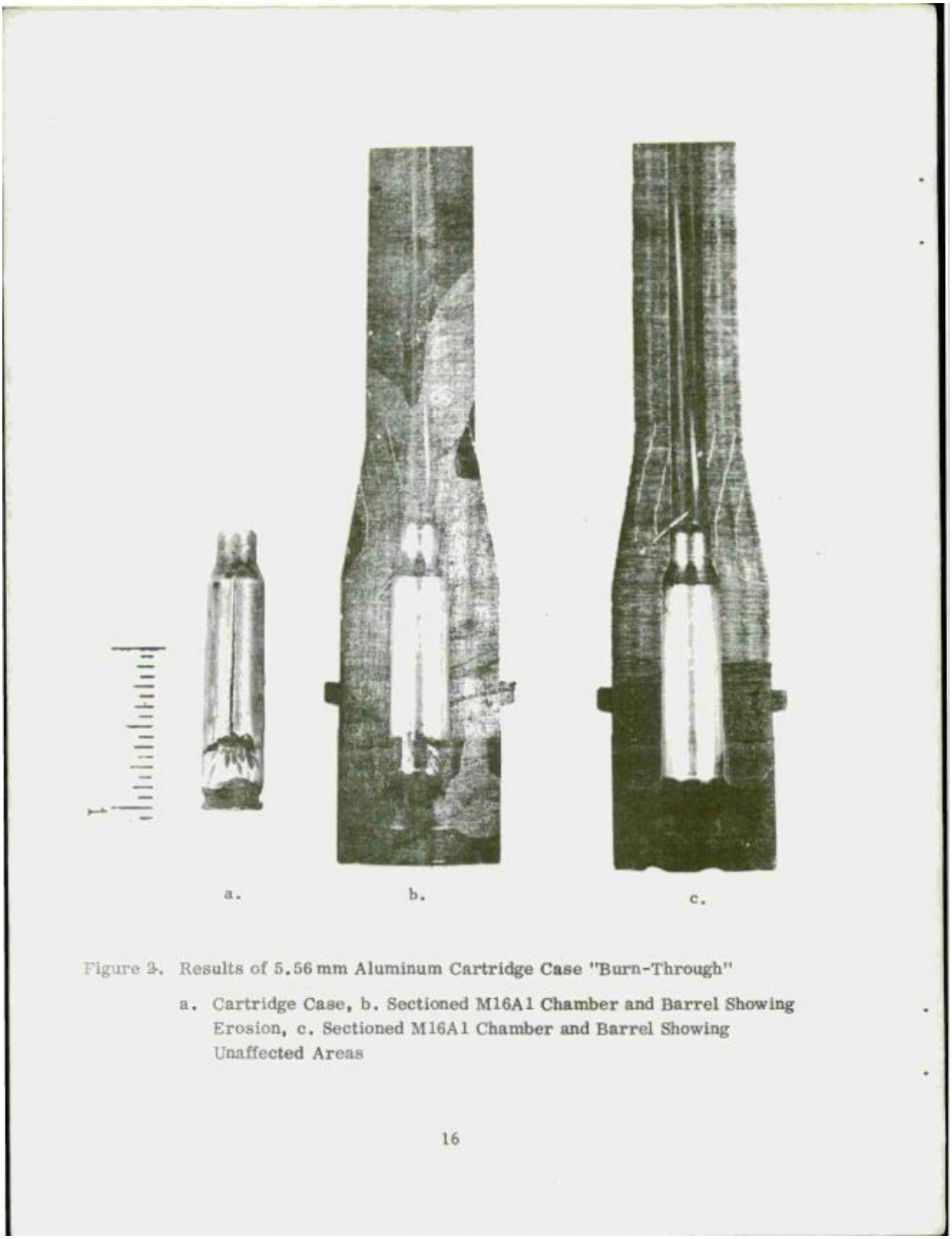

Figure 3. Results of 5.56 mm Aluminum Cartridge Case "Burn-Through"

a. Cartridge Case, b. Sectioned M16A1 Chamber and Barrel Showing Erosion, c. Sectioned M16A1 Chamber and Barrel Showing Unaffected Areas

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Figure 37 - Note how the 5.56mm aluminum case "burnt through" and split.

Making A Better Bullet for NATO

In 1977 Aberdeen began to test the new experimental designs that would eventually be looked at by NATO. The experimental rounds, XM777 ball and XM778 tracer, were both found to be superior in their performance by Aberdeen, this eventually resulted in a report being published in June of 1977 by Aberdeen called, *Product Improvement Test of Cartridge, 5.56-MM Ball, XM777*.

A year later, June of 1978, the first field tests for the NATO individual weapon entries were conducted. The testing was done at primarily at the West German Infantry School in Hammelburg along with additional testing at the European Regional Test Center at Cold Meece in northern England, the Meppen Proving Ground in Meppen, West Germany, the McKinley Climatic Hanger at Eglin AFB, and Camp Shilo in Canada.

The rifles tested included Colt's M16A1, RSAF's Enfield 4.85mm XL64E5 IW, FN's FNC, the French FAMAS, HK's 4.7mm G11, and the IMI Galil SAR from the Dutch. For the cartridge designs, the XM777 and the XM778 rounds were used in Colt's offering for the trials along with the standard M193 for the other weapons that used 5.56mm rounds. In addition to this FN brought out a new experimental design of their own, the SS109. This was a dual core design that had a steel penetrator tip with a rear core of lead. FN had been working on 5.56mm bullet designs and were slowly evolving them over the course of the SS92/1 and the SS101 before finally getting to the SS109. Another experimental design was the L110 tracer round, however if either of these rounds were to be adopted some changes had to be made. The SS109 needed a 1:19" twist rate and the L110 needed a 1:7" twist rate due to its longer size. However, there were two contestants that used other cartridges, the G11 and the XL645E5, using 4.7mm and 4.85mm rounds respectively.

Of course being a program run by multiple government agencies politics had to get involved at some point. A number of countries, led by Sweden, balked at the "damage" done by the 5.56mm rounds in the slower twist rates. So they took the opportunity to push for the faster twist rates as a way of making the 5.56mm a more "humane" round.

In May of 1980 the testing had reached its conclusion and NATO's International Test Control Commission and Panels of Experts began looking at the collected test data. They came to the following conclusions. First the 5.56mm round, using the Belgian designed, SS109 bullet, would become the standard for the 5.56mm NATO round. This would be the basis for the 5.56mm STANAG (Standardization Agreement). Second, at that time no recommendation would be made for the standardization of an individual or light support weapon. The cartridge loading had been agreed upon, but what rifle to use would be left up to the individual governments.

By October of 1980 these plans would move forward and the 5.56mm officially became the 5.56mm NATO. With the SS109 ball round being the standard round, each country would be able to take this design and adapt it for their own, home based, production. For the standard tracer round the FN L110 tracer was adopted as well. Yet the P112 AP and the L102 tracer cartridges were dropped from consideration for NATO standardized loads. For the US, the new NATO standard rounds would first be adopted as the XM855 ball and the XM856 tracer. While these would eventually become the M855 ball and the M856 tracer rounds, our neighbors to the north, Canada adopted them under the names XC77 and XC78. While a specific rifle was not agreed upon by NATO in all of this cross magazine compatibility with the M16 was agreed upon for all future 5.56mm NATO firearms.

In June of 1981 the first production of the XM855 and XM856 rounds would start at Aberdeen along with testing of the new rifles with the increased barrel twist rates to accommodate for the new bullet designs. However early testing would run into issues, and by February of 1983 Lake City's XM855E1 rounds were being pointed at as having poor quality controls and causing malfunctions. These issues and more would be summarized in the Aberdeen report*, Technical Feasibility Test of M16A1E1 Rifle.*

In March of 1983 the BRL and members of the Squad Automatic Weapon Project Office went back and forth over these issues, arguing what the problem was. Some blamed the high rejection rates and poor quality of the early production M855 ball and the M856 tracer rounds, others pointed to the government furnished test barrels. Despite the debate, testing continued and in May of 1983 the BRL continued its testing at their free-flight range facility. Lots of both the M855/M856 as well as lots of Belgian made SS109/L110 were used along with handloaded 52 grain Sierra Benchrest bullets. Both Lake City and commercial grade match grade cases were used in the testing to try to iron out the problems and bring the M855 and the M856 up to the same standards as the M193 and M196 rounds used in the past.

This testing continued through September and into March of 1984. When the military specifications for the M855 ball round was published as, MIL-C-63989(AR) along with the specifications for the 5.56mm Heavy Bullet Reference cartridges, MIL-C-70460(AR), and the new M857 Dummy Cartridges, MIL-C-70468(AR). Finally, in October of 1984 the specification for the M200 Blank round was changed to MIL-C-60616B(AR) along with other minor revisions to the other specifications for the M855, M856, and M857 rounds.

Improving On The NATO Standard

April of 1985, Randall G. Habbe filed a patent for a new round. Habbe was working for Olin and created the Olin "Penetrator" bullet, this was the trade name for their version of the M855 projectile and it showed marked improvement over the standard, FN made, SS109 rounds. Olin's Stephen J. Bilsbury, William G. Dennis, Jr., and Stephen K. Kernosky would later follow up on Habbe's work with a patent of their own to bring down the cost of fabricating the M855's steel penetrator in July of 1989.

In October of 1985 testing on improving the M855 above and beyond the reference SS109 cartridge continued at Aberdeen's BRL. They found, in the report, *Aerodynamic and Flight Dynamic Characteristics of the New Family of 5.56mm Ammunition,* that the US made M855 and M856 rounds would have greater dispersion than the reference cartridges. Upon closer examination of the issue the problem was identified as being related to the tolerances in both the bullet jacket wall thickness and the bullet seating alignment. With these issues identified the M855 and the M856 were able to be improved upon and the accuracy of the rounds increased.

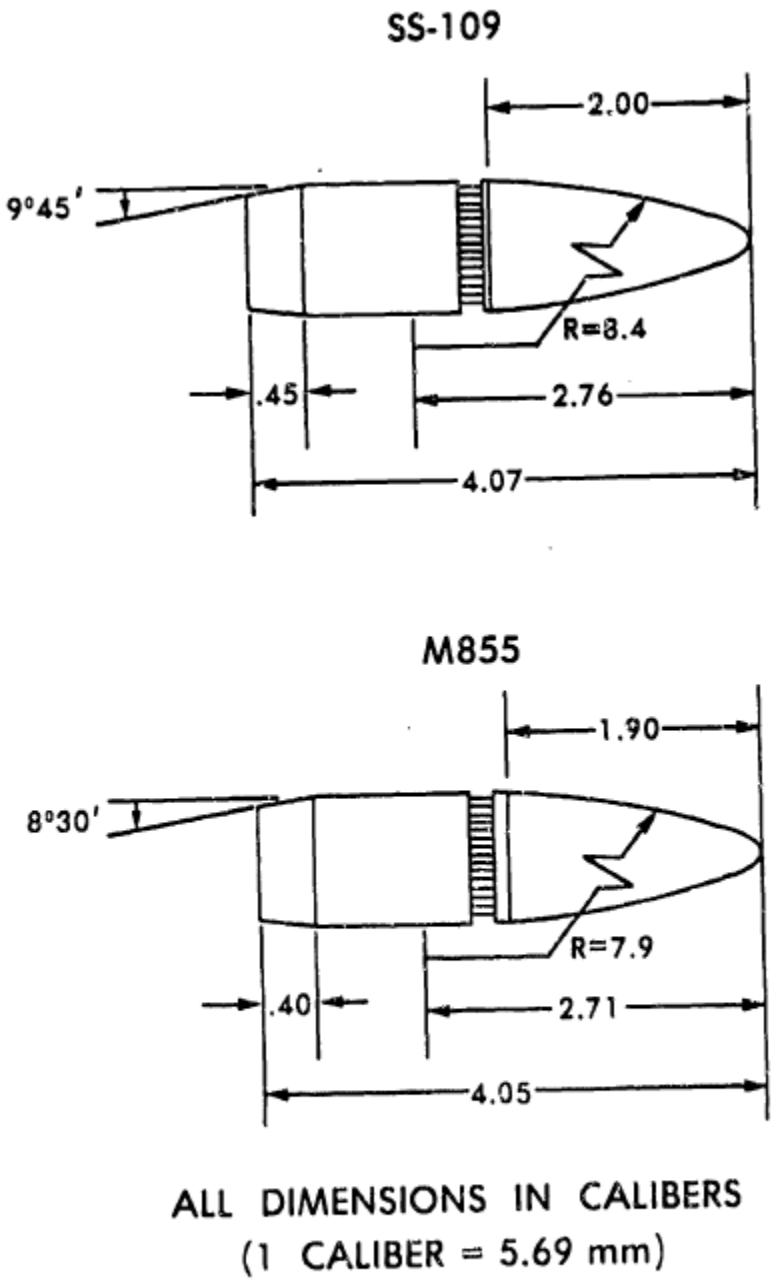

Figure 2. Sketch of SS-109 and M855 Ball Projectiles

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Figure 38 - Drawing comparing the M855 and SS109 bullet designs from the report, Aerodynamic and Flight Dynamic Characteristics of the New Family of 5.56mm Ammunition.

Training Rounds and Going "Green"

In 1988 the some of the first rumblings about a short range training round would crop up from Aberdeen as the started testing a new training round. Tentatively dubbed the XM858, aluminum cased round from Omark and plastic training rounds from Federal, Winchester, and the United States Ammunition Company were all considered. Yet soon we would see the first "green" initiatives come out of the military.

In July of 1988 the Army Biomedical Research and Development Lab published a report called*, Comparison of Particulate Lead Levels for Different Ammunition Types Used with the M16 Rifle*. The report looked at the M193 ball rounds, M862 plastic training rounds, as well as .22 rifle cartridges to see how much lead they were emitting at both the breech and the muzzle. This would mark the beginnings of the continuing idea that military ammunition needed to be "green". While the initial goal was probably to ensure that our troops were not being exposed to dangerous levels of lead in the air as they were training, this would eventually lead to the introduction of a new version of the M855.

As 1990 rolled around the M855 and the M856 cartridges were still being scrutinized for their accuracy, while the M193 ball round held to a standard of a 2" spread at 200 yards, the M855 round was, comparatively head to a standard of 7.8" at 600 yards. Working backwards, if we assume a constant spread over the longer distance, we get an accuracy standard of 2.6" at 200 yards for the M855. So if nothing else the accuracy standard was slipping a bit.

In 1992 a new program was developed that would eventually result in a new bullet design for the 5.56mm round. The Soldier Enhancement Program or SEP was tasked with creating a tungsten core projectile. The bullet would be manufactured by Bofors and would be given the designation M995. The goal was to create a round that could pierce armor better than previous designs and the M995 looked to do just this.

Through May of 1992 and into April of 1993 the specifications for the M197 High Pressure Test round, 5.56mm Reference Cartridges, the M855 Ball, the M200A1 Blank, and M197 tracer rounds would all receive small changes and updates to their military specifications. These specifications would continue to be updated and tweaked though 1994 and February of 1995.

Meanwhile in August of 1993 the "green" initiatives would continue to roll forward.

President Clinton signed Executive Order #12856 to insure that all Federal agencies, the DOD included, were conducting their operations in a manner that reduced the amount of toxic chemicals in the environment. This prompted the DOD to start seeing how viable replacements for the lead used in, not just the 5.56mm but, all of their ammunition could be. In October of 1995 a Joint Working Group would be formed to "pursue elimination of toxic materials from ammunition". All branches of the military as well as the USCG, DOE, FBI, and FLETC all would send members of their agencies to participate.

With the green initiatives in action the ARDEC was trying to keep the standards for ammunition production the same across the ARDEC, Lake City Army Ammunition Plant, and Olin Ordnance. They found that each was doing a remarkable job in keeping up with the others and while there were some issues that might lead to "larger variations in the future", the three ammunition plants had a variation of less than 2% among themselves.

In December of 1995 the first solicitation for a NDI 5.56mm non-toxic training cartridge was made. Put out by ARDEC, the solicitation called for the new training round to be compatible with all 5.56mm military weapons and not require any weapon modifications. The round also needed to be a ballistic match to the M855 out to 100 or more meters, have a maximum range of 1000 meters or less, not penetrate a 1/8" steel plate, and finally have no toxic materials according to the EPA.

At this time the specifications for both the 5.56mm reference and the 5.56mm heavy bullet were both “deactivated” by the military.

Making the M855 Green

With 1996 starting the first work started on making the M855 ball cartridge "green". The military wanted to make the round lead free and find a suitable material to replace it with. However, with both the new "green" initiatives and the M855 ball round now preforming to acceptable standards, the older, M193 ball, M196 tracer, M197 high pressure test, M200 blank, M855 ball, and M856 tracer rounds are all moved to "inactive" in the military's specifications. Only to have the M855 and M856 specifications be amended again in September.

In March of 1996 the still "green" M995, 5.56mm Armor Piercing Cartridge was officially type classified by the military and with the start of June ARDEC put out another request. In the new "market survey/sources-sought" announcement they stated that they were looking for lead free and or non-toxic primers to use in their 5.56mm, 7.62mm, 9mm, and .50 caliber cartridges.

For the M995 the first Live Fire Test and Evaluation (LFT&E) was approved in November of 1996 and further details were approved the following month. Along with the approval for testing came the need for a manufacturer, so in December of 1996 TACOM-ARDEC started looking for someone to produce 1,150,000 5.56mm M995 AP rounds. The request for a manufacturer included that any contract could be extended for up to four years and total as many as 4,375,000 rounds. In April of 1997 the LFT&E would finally be completed and approval for the use of the round would be given in 1999.

Nonlethal 5.56mm?

In March of 1997 the US Army Research Laboratory started looking at ways to make a standard M855 round "nonlethal" with the report*, Venting Propellant Gases to Obtain Nonlethal Projectile Velocity*. To accomplish this a series of holes were drilled into a barrel of an M16 and were plugged and opened to experiment with decreasing the velocity of the M855 round.

Figure 39 - A "less lethal" bullet is still trying to be pushed.

While initially the tests aligned with the models that were created before any real world experiments were done, this quickly broke down and the authors concluded that the whole concept was a flop when used with the 5.56mm round. Instead they posited that a .50 caliber conversion of the M16 might work better.

This would eventually stall out as the idea of trying to take a "lethal" round and turn it into a "non-lethal" one by any means was a non-starter. While some attempts have been made to resurrect the idea of a "non-lethal" bullet, it has been consistently met with criticism.

Green Ammo and Tactical Paint Balls

In August of 1998 the first "green" prototype M855 rounds, using a tungsten core would be tested. In total 72 riflemen participated in the test, firing 5,200 rounds of the new M855 design at Stewart River, Alaska. With the early tests proving successful, in October of 1998 another test would be done at Camp Edwards, the range had been closed due to environmental concerns and the use of the new M855 rounds allowed the range to be used again.

As an aside, in my research I found this particular anecdote about a, "Tactical Paint Ball System". Tested in March of 1999 by the Army Research Laboratory and created by a contractor as another non-lethal weapon. The testing was documented in the report*, Ballistic Evaluation of the Under-Barrel Tactical Paint Ball System*, the design replaced the typical under-barrel mounted grenade launcher with a "Under-Barrel Tactical Paint Ball System (UTPBS)", on the M16 or M4 carbine. Looking at the report, exactly how paint balls were supposed to incapacitate someone is unclear, even when filled with a bismuth powder. However, at 100 yards the ability of the UTPBS to hit a target was zero. They found that the paint balls they were using generated an unstable spin because of the empty space in them and this threw them wildly off target. Eventually research into non-lethal weapons would move towards baton and rubber ball rounds and away from "tactical paintballs".

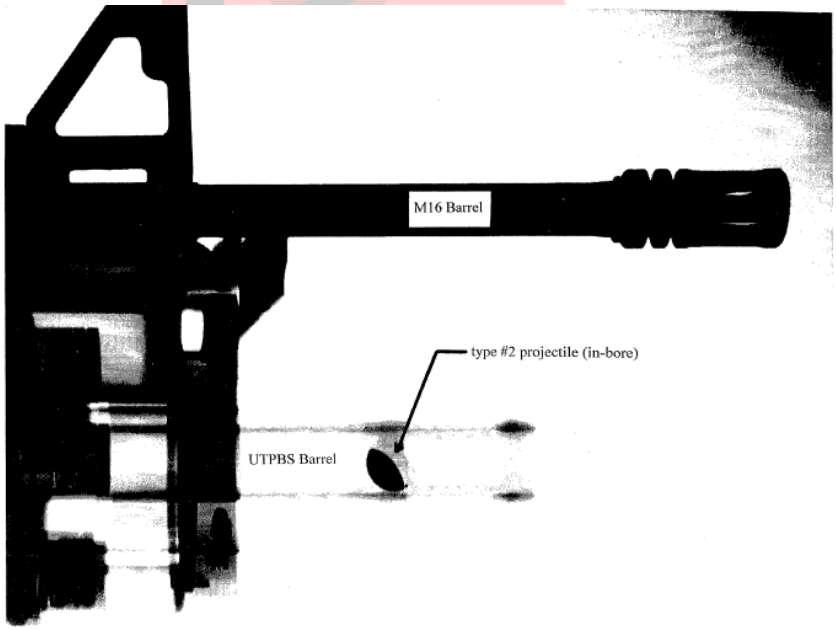


Figure C-2. Through Barrel X-rays for Type No. 2 Projectile.

Figure 40 - Looking at the X-Rays you can start to see why the UTPBS system could not hit anything.

Training Ammo and Depleted Uranium

In December of 1999 TACOM-ARDEC started looking for engineering and manufacturing support to research and develop new materials for bullets. They were looking at using depleted uranium, tungsten, molybdenum, tantalum, copper, and other alloys to create bullets that would work in the 5.56mm and other small arms. However, the use of depleted uranium would eventually find itself on the opposite side of the growing move towards "green" ammo.

In February of 2000 TACOM was looking for a 5.56mm Short Range Training Ammunition (SRTA) for the M16A2 and other 5.56mm small arms. This particular request had some other requirements to keep up with the new "green" initiatives.

What TACOM was looking for was a lead free round that was also, hopefully, toxin free as well. The ammo needed to work, again, without any modifications to the rifles being trained with, and allow for training within 25 meter to be the same as the M855 round. This meant that the trajectory and dispersion needed to be the same out to 25 meters. However, the maximum range of the new training round had to be no more than 250 meters.

While the new SRTA ammo was being looked for, the military continued looking at frangible ammo. Yet, the ammo given to the military for testing in March of 2000 displayed the same issues as with the previous tests. It over penetrated hard targets, accuracy did not match, the waterproofing was not sufficient, and the malfunction rate was high.

Because of this, in April of 2000 the purchasing of 5.56mm frangible rounds was put on hold until a new design could be worked on. This new design, the RRLP, or "Reduced Ricochet Limited Penetration" was meant to replace the frangible rounds. What would eventually be produced was the 5.56mm Mk 255 Mod 0 RRLP round. It would be used for close quarter combat and would have the added benefit of being able to be shot at a steel plate from as close as 15 meters. A report on this new ammo, *5.56mm Mk 255 Mod 0 RRLP*, would be published by NAVSEA Warfare Centers on May 16th, 2006.

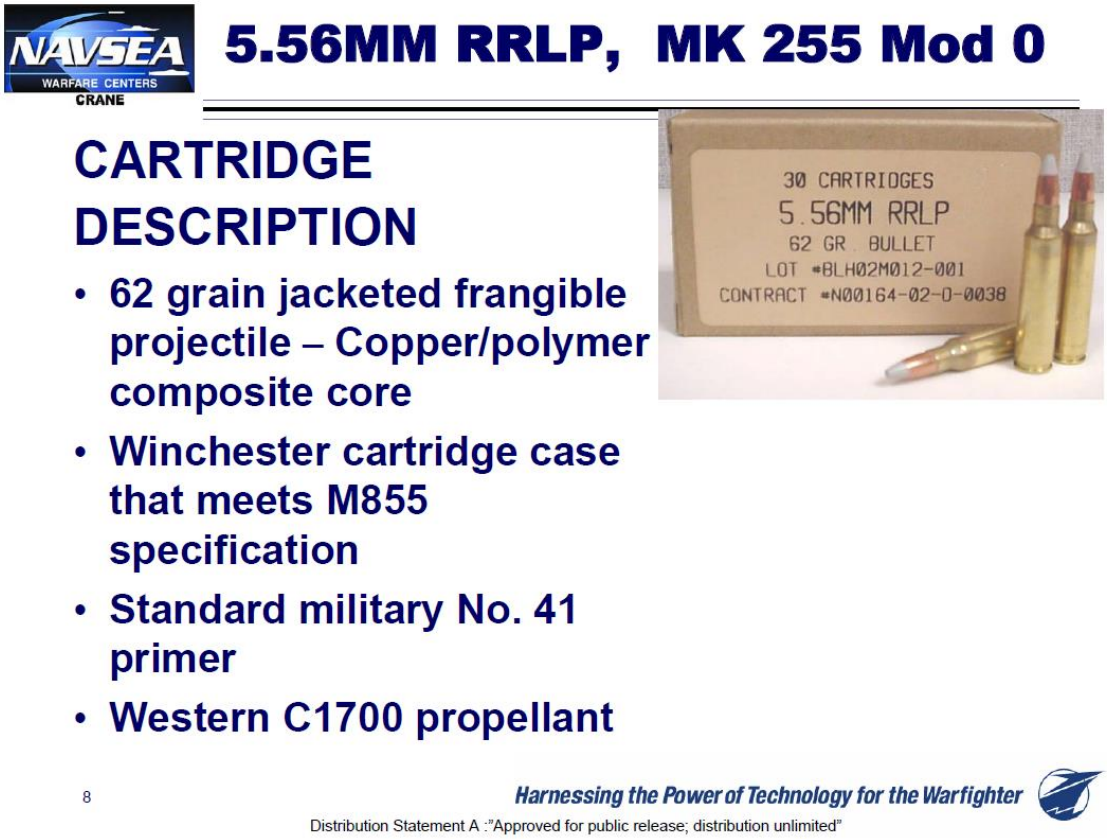


Figure 41 - Image from NAVSEA's release on the Mk 255 Mod 0 RRLP loading of the 5.56mm NATO.

Keeping it Green

While the NSWC-Crane was looking for subsonic 5.56mm rounds for USSOCOM, for use with and without a suppressor, Henry J. Halverson and Anthony F. Valdez received a patent for their work on a new non-toxic penetrator projectile. Their new patent went along with yet another request from TACOM-ARDEC looking for non-toxic primers for the 5.56mm as well as 7.62mm, 9mm, .50 caliber, and 40mm. The military was trying to go green in more ways than one.

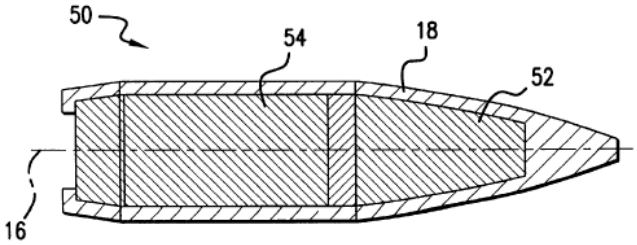


Figure 42 - Drawing of Halverson and Valdez's patent.

But a new report would show that the worries, at least about lead in the air during training, was much ado about nothing. The US Army Center for Health Promotion and Preventative Medicine published a series of reports called, *Training Munitions Health Risk Assessment.* Essentially what they found was there was no potential for any health risks to residents due to inhalation of the emissions from cartridges like the M855 round.

Black Hills Ammo

In April of 2002 NSWC-Crane was looking for 40,686 boxes of Black Hills Ammunition 5.56mm, 77 grain long range SPR Ammunition. Black Hills ammo had, three years previously, won a contract with the military for their match grade ammunition. This would result in multiple contracts with the military and many special forces operators preferring the round for long range shooting when the 7.62mm was not an option. By June of 2002 the MK 12 SPR rifle was hitting an important milestone in its development and the ammunition pared with it was the Black Hills 5.56mm Special Ball, Long Range Mk 262 Mod 0. The loading would use a 77 grain Sierra MatchKing bullet and bet out both the 73 grain Berger Length Tolerant Bullet, and the 87 grain Powell River Laboratories bullet. As recently as 2012 the Mk 262 Mod 0 was revised as the Mk 262 Mod 1 to use a cannelure in the bullet to prevent bullet set back, to quote Black Hills President Jeff Hoffman,

> *"It was tough convincing Sierra to put a cannelure on that bullet. They were really concerned about destroying accuracy, but we didn't want a bullet stuffed back into a case to render a rifle inoperable. We are big believers in Murphy. If he can get involved, it won't happen in training; it will happen when some SF guy kicks down a door in Afghanistan."*

Since the introduction of the Mk 262 USSOCOM and others in the military have been using the round and it seems to have many fans still in the military and even civilian markets as the loading was eventually released to the public by Black Hills.

In March of 2003 another, new, bullet design would come from Hugh A. McElroy and Michael R. Harris. This design featured a monolithic, heat treated, steel core, with a plated jacket. McElroy and Harris' design looked to improve both accuracy and "knock down power" while allowing for better penetration of light barriers when compared to the M855 round that the military was, and still is using.

Computer Modeling the M855

In September of 2004 the ARL published a new report*, Finite Element Modeling and Analysis of an M855 Cartridge.* This report was created with the express purpose of creating a model to use for the testing of new materials. Computer models of the function of the M855 5.56mm cartridge as it went thought the firing process were created for the report and for further use. Computer Aided Drafting or CAD models were created along with 2D and 3D models. While previous attempts had been made to make computer models of ballistic behavior, such as the previous attempts in with the CARO computer simulations in the 1960's.

However, this time, with the advancements in computer technology the predictions made by theses computer models were much closer to what they found would actually happen in real world testing. Using these new computer models testing continued to find new, lighter, materials that could be used with the 5.56mm round.

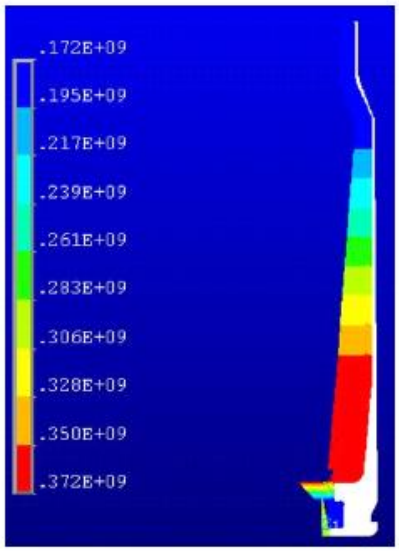


Figure 7. Plot of the internal pressure gradient in Pascals applied to the M855 cartridge.

Figure 43 - An image from the computer models created.

More Aluminum Cases

In May of 2005 another stab at the aluminum case idea for the 5.56mm was made by Brian Tasson and Lucian Sadowski. Working for ATK and ARDEC respectively they released the report*, Aluminum Cartridge Case Concept*. What they found was that a switch to aluminum cases could reduce weight for a M249 gunner by 26.8%. The report went into detailed descriptions about the design of the potential case, production methods, and ballistic testing done with 5.56mm aluminum cartridge cases. However, there was a problem with this, cost. While the weight savings would have been dramatic, production of the 5.56mm aluminum cases en masse would have been more expensive with cost increases coming from the need for the cases to be coated with specialized materials to prevent corrosion and burn though.

Figure 44 - Aluminum cases in the various stages of being formed from the report, Aluminum Cartridge Case Concept.

In August of 2005 the ARL released a paper that was sure to appeal only to the very nerdy. *Instrumented Indentation of M855 Cartridge, Core, and Jacket Materials,* summarized a series of tests on the mechanical properties of various 5.56mm bullet designs. In short, how hard or soft they were, with an eye to informing future development of deforming or fragmenting projectiles.

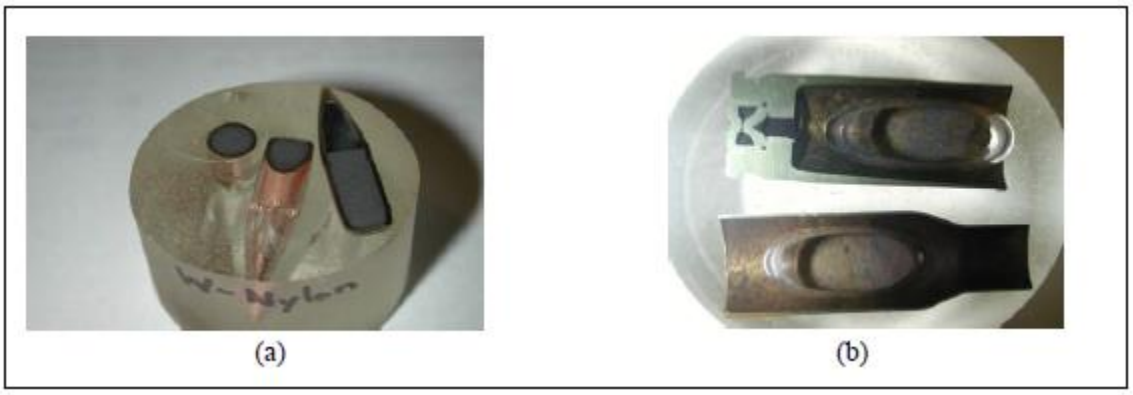


Figure 45 - Bullets and cases being prepped for testing.

Barrier Blind 5.56mm

If one particular criticism could be levied at the 5.56mm NATO it is that it does not always perform well when dealing with barriers. To this end in June of 2006 MARCORSYSCOM Infantry Weapons Systems started looking for a "barrier blind" bullet design for the 5.56mm. The M855, M955, and even the Mk 262 can have issues with glass, doors, and walls in buildings. With testing from the FBI showing that it could be possible to create a barrier blind bullet MARCORSYSCOM went to companies looking for a new design that would meet these requirements.

However, with all things government, there were political considerations to look at as well. While the ideal projectile would behave the same as a M855 ball round, after passing through a barrier, in a gel test, before this concept could go forward the Office of Judge Advocate General, the CMC-JAO, and even the DOD General Council would have to conduct a "legal review" of any potential design.

While the concept of a barrier blind bullet was being tossed around, the PM-Maneuver Ammunition Systems announced something interesting. In their research they found no effective difference between the M855 ball round and other commercially available 5.56mm rounds when it came to close quarters combat distances.

Of Course It Was the University of Texas, Did You Really Think UC Berkley Was Working On That?

In September of 2006 Aberdeen's ARL put out a new report*, The Effect of Slug Material on the Behavior of Small-Caliber Ammunition*. This particular report looked at alternative, "green", materials to use in the core of the M855 round. The testing done compared the original lead and steel core design of the M855 to alternative designs using tungsten-nylon and tungsten-tin compositions. They found that with the harder, tungsten cores, the amount of force exerted by the bullet as it traveled down the barrel was greater. The paper posited that this could lead to "effects" on the barrel wear and performance of the round.

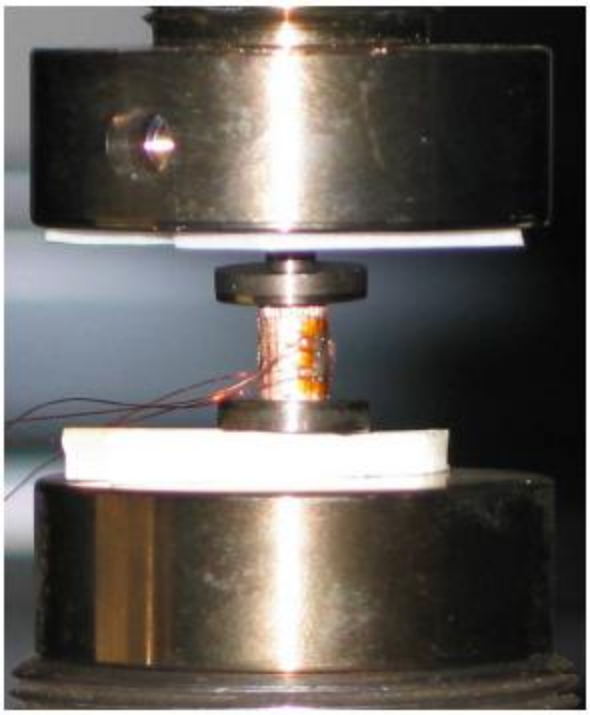


Figure 46 - Image of a bullet being placed under extreme pressure for the testing done for the report, The Effect of Slug Material on the Behavior of Small-Caliber Ammunition.

A year after Aberdeen's report, the University of Texas' Institute for Advanced Technology published their own report looking at alternative materials. Published in September of 2007*, Preliminary Design and Analysis of an Environmentally Friendly 5.56mm Bullet to Replace the M855*, looked at other alternatives to replacing the lead core in the M855 round. One promising design they came up with was the use of LQMT, or LiquidMetal Technologies to replace the penetrator core. They found that with the high density of the LQMT core they were able to easily penetrate steel targets, while the truncated boat tail design of the round allowed for more consistent tumbling and yawing in soft targets. The tip of the bullet design proposed was intended to be “self-sharpening” with parts of the jacket sheering off when impacting a hard barrier.

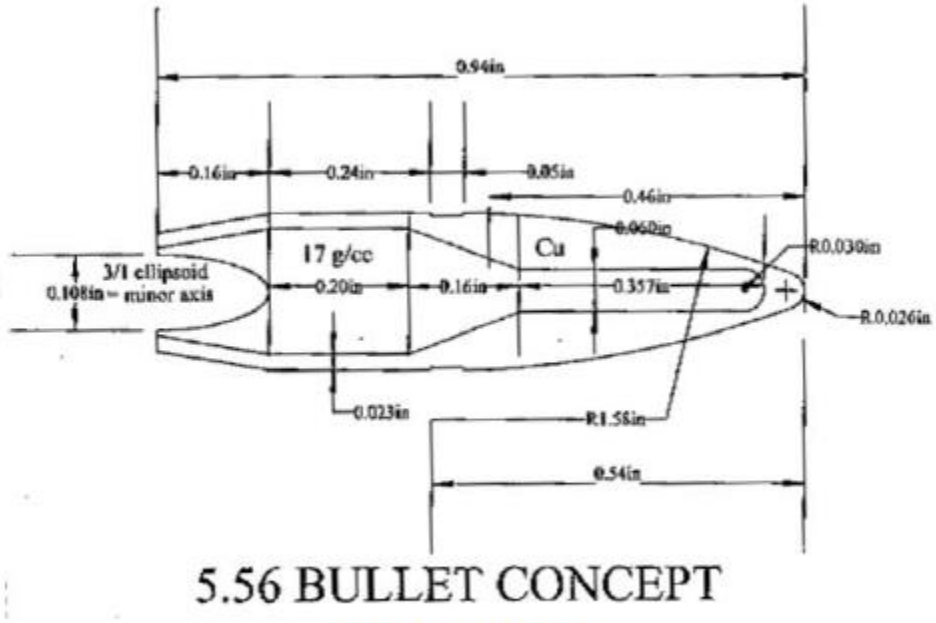


Figure A-1. Alternate Design 1.

Figure 47 - One of two alternate designs proposed by the University of Texas' report, the second design was similar with slightly different dimensions. Note the non-uniform jacket thickness around the core.

In May of 2008 the M995 AP round was attempting to be standardized and JM&L, soliciting for PM-Maneuver Ammunition Systems, started looking for someone to create the designs and specifications for the M995 AP round. In 2008 there was no Technical Data Package for the M995 AP round, and I currently cannot find any reference to one. However, in 2010 the specification for the M995 AP round was revised under the label, MIL-PRF-71208A.

Aluminum M855?

In December of 2008, JM&L LCMC put out a new request. This time they were looking for someone to design, produce, and test a new type of 5.56mm M855 ball round using aluminum cases. From the information provided it looks as if the production was going to be in conjunction with the Lake City Ammunition Plant, however, it seems that either production of aluminum cased M855 rounds stalled with the M855A1 round being introduced or remains behind the scenes and not publicly available.

The Introduction of the M855A1 and the M855A1 EPR

With the testing and R&D going into "green" projectiles a new round was on the horizon. While the first testing of the M855A1 had taken place in 2007, it was not until 2009 when the first large scale production of the round would happen. However almost as soon as the round was about to go into full scale production, high temperature testing found a glaring issue with the M855A1. When exposed to high ambient temperatures the accuracy of the round would suffer greatly because of the bismuth-tin alloy core. This forced another year of testing and development to come up with a completely new core material that would not have the same reaction to hot environments.

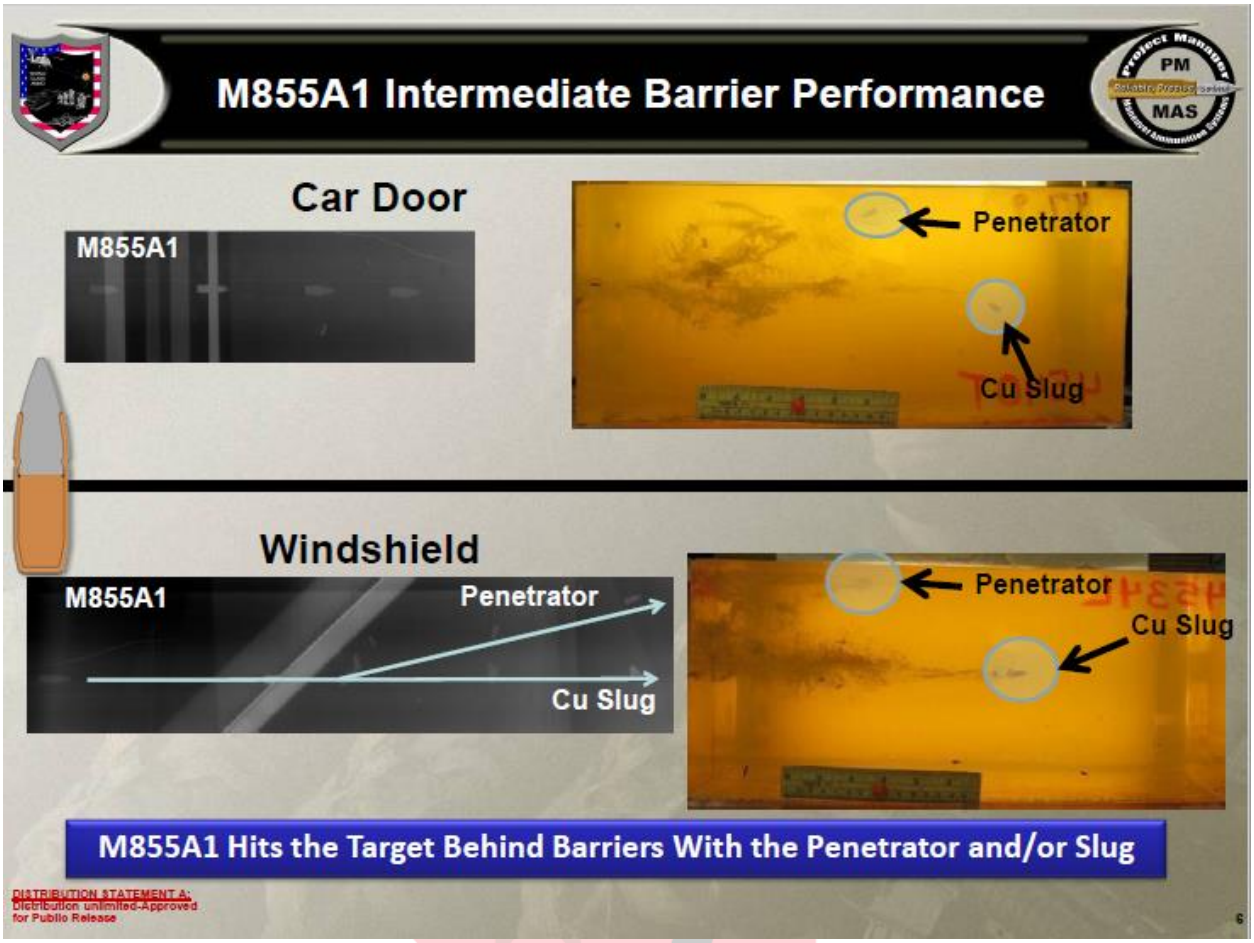
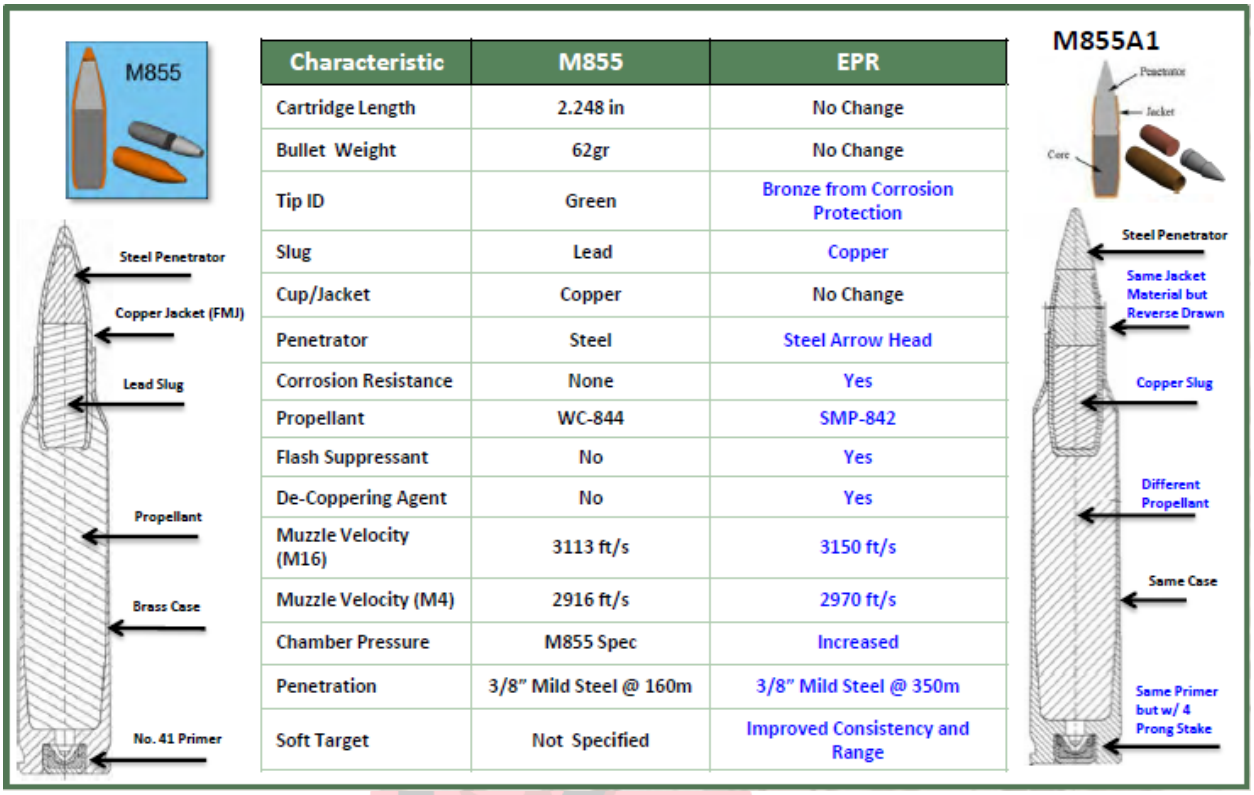


Figure 48 - The M855A1 in ballistics testing done by the military in the report, M855A1.

The final design, designated the M855A1 EPR, or Enhanced Performance Round would be a 62 grain bullet with a steel penetrator tip. The tip itself is 19 grains, and held in place by the jacket which is reverse drawn over the core of the bullet. The M855A1 EPR when it was first introduced on June 24th, 2010, was touted as being "yaw independent", meaning that it would perform well without the need to yaw in flight.

This was one of the major criticisms of the M855, depending on the angle that the bullet struck the target the way the bullet would tumble in the target might change, leading to, at times, inconsistent performance. However, the M855A1 EPR was supposed to iron out this issue and still be able to deliver the same or superior damage to the target, regardless of the angle it strikes at.



Characteristic	M855	EPR
Cartridge Length	2.248 in	No Change
Bullet Weight	62gr	No Change
Tip ID	Green	Bronze from Corrosion Protection
Slug	Lead	Copper
Cup/Jacket	Copper	No Change
Penetrator	Steel	Steel Arrow Head
Corrosion Resistance	None	Yes
Propellant	WC-844	SMP-842
Flash Suppressant	No	Yes
De-Coppering Agent	No	Yes
Muzzle Velocity (M16)	3113 ft/s	3150 ft/s
Muzzle Velocity (M4)	2916 ft/s	2970 ft/s
Chamber Pressure	M855 Spec	Increased
Penetration	3/8" Mild Steel @ 160m	3/8" Mild Steel @ 350m
Soft Target	Not Specified	Improved Consistency and Range

Figure 49 - Comparison of the changes from the M855 to the M855A1, from the report, M855A1 Enhanced Performance Round (EPR) Media Day

The powder used in the M855A1 EPR, meanwhile, was changed to, SMP-842, a faster burning powder. This was done because the military is moving more and more towards shorter barred rifles such as the M4 Carbine. This also allows for higher muzzle velocities and improved performance in the shorter barreled rifles.

For a media day at Aberdeen Proving Ground on May 4th, 2011 the new round was shown off to the general public. It was shown to be able to pierce a 3/8th inch steel plate at 300 meters, as well as a cinderblock at 75 meters. In comparison the old M855 round would have been unable to do this. The potential of the round was further pushed as Rob Harbison used the round in the 2012 National Rifle Association's National High-Power Rifle Championship at Camp Perry, Ohio in August. During the event he was able to score two perfect ratings in the completion, hitting a 12-inch target 600 yards away in one event.

Despite the positive initial reception there were sever criticisms being levied against the new M855A1 EPR round. First the new powder was blamed for causing excessive fouling in rifles. However, this was dismissed as testing showed no difference. However, the round was degrading barrels faster than the old M855 round. While the Army blamed the degraded barrel life on issues with the primer, redesigning it to use a four pronged anvil, the issues remained.

The Army's carbine testing found accelerated bolt wear, and testing done by Special Operators found cracks in the locking lugs of the bolt and cam pin holes after 6,000 rounds on average. Furthermore, the exposed penetrator of the M855A1 EPR round is liable to wear out and damage the feed ramps as they are made from a softer metal than the penetrator tip.

For the issue of the barrel life there is no getting around the fact that not only is the core of the round a much harder material that puts more pressure and wear on the rifling as Arrow Tech Associates in June of 2007 had already found in their testing, compiled in the report, *Final Report of the Rifling Profile Push Test,* but the M855A1 EPR round is a much hotter round.

Figure 50 - The testing set up used in the Push Test report that warned of some of these issues with the M855A1 back in 2007.

At 62,000 psi the round's standard loaded chamber pressure approaches that of the proof rounds that are used to proof test the barrels before being accepted. For reference the highest acceptable pressure for a 5.56mm NATO round maxes out at 62,366 psi. These high pressures also have the likely hood to wear out the gas port faster, increasing its size, increasing the cyclic rate and causing malfunctions. Once again putting us back in the position where we saw the M16 when it was first being fielded in Vietnam.

But, that is not to say there have not been rumblings that the pressure specifications that the military's rifles need to be changed. In June of 2016 an Army RDECOM and National Defense Industrial Association released a series of slides discussing the development of a new, even higher pressure proof load titled, *5.56mm High Pressure Test Cartridge Development: How to ruin a perfectly good weapon.*

The document discusses the need for newer, higher pressure proof loads with the increasing pressures of the standard military loads such as the M855A1 EPR rounds.

With these issues cropping up and legitimate criticism being levied against the M855A1 EPR the US Marine Corps elected to take a different route in 2010.

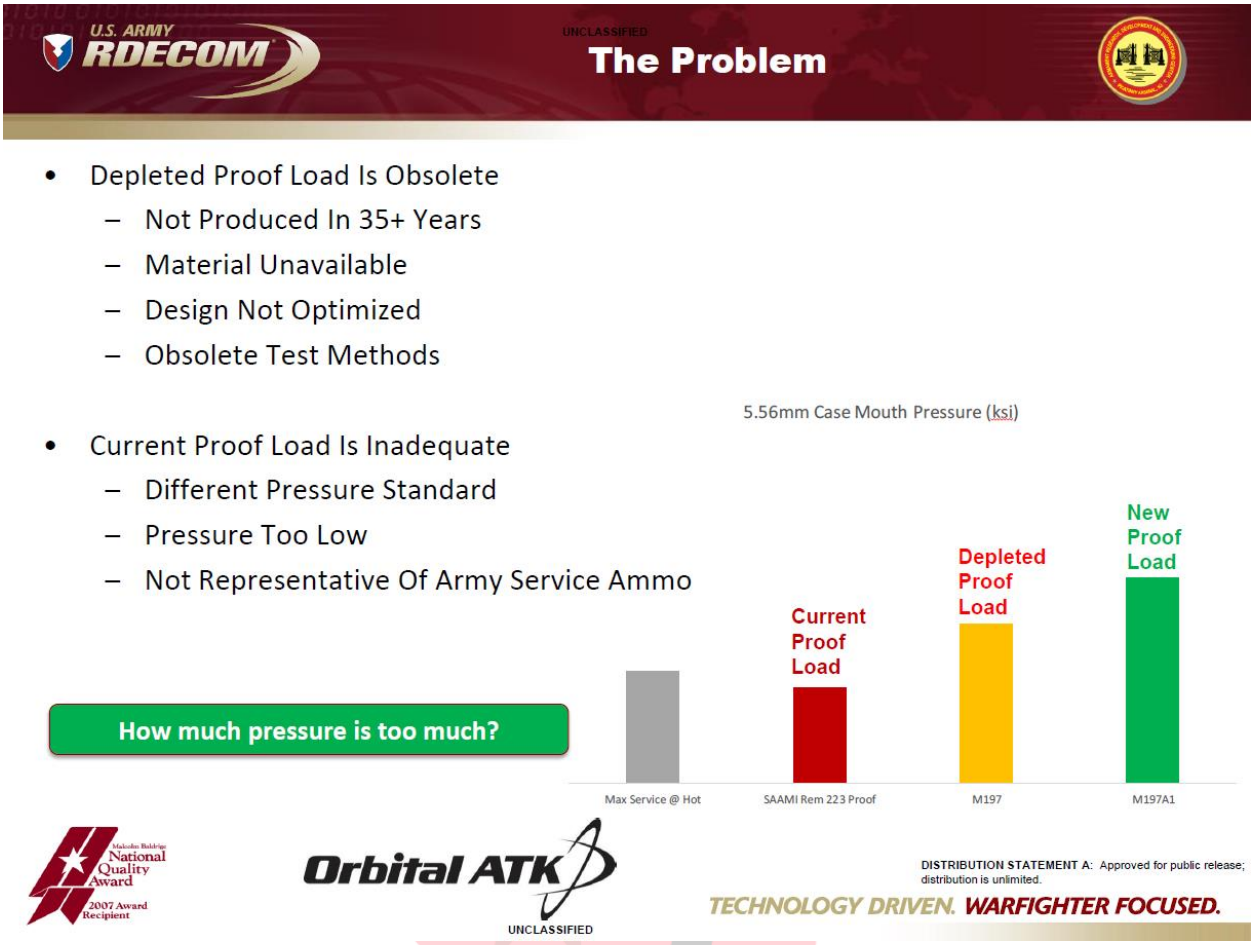


Figure 51 - RDECOM noting the need for better proof loads.

The Marines' Mk 318 SOST

With the concerns surrounding the M855A1 EPR round the US Marines elected to take an entirely different route. However, the beginnings of their round would start before the adoption of the M855A1. In 2005 the Pentagon started looking for a new bullet design after there were repeated reports of the M855 round failing to stop targets in Afghanistan and Iraq. U.S. Special Forces in particular were concerned that the M855 was not working when used with the M4A1 rifles. In response to the Pentagon's request there was only one company that responded. Federal Cartridge.

Working with the military the goals for this new cartridge were drawn up. First, it needed to be accurate even when used in high and low temperature environments. Second, it needed to deliver sub 2 MOA accuracy from an M4A1. Comparatively the M855A1 is held to a standard of 5 MOA, or five inch groups at 100 yards. Third, it needed to deal with intermediate barriers better than the M855 such as walls and windshields. Fourth, less muzzle flash was required. Fifth, the cost needed to be roughly the same as the M855.

Federal went to work and in August of 2007 the first test rounds were delivered. The design they came up with was called "Open Tip Match Rear Penetrator" or OTMRP. While the front of the bullet jacket was open with a lead core, the rear half of the bullet was a solid brass penetrator. Unlike the forward penetrator design of the M855A1, this design would allow the penetrator to continue in a straighter line after the front of the bullet had impacted the barrier. Conversely the M855A1 used a copper slug as well, however the steel penetrator would sheer off when striking a barrier like a windshield. This design allowed the new Mk 318 to be "barrier blind" in testing. Beyond this the jacket of the bullet used the same reverse dawn jacket technique as the M855A1 ERP.

The Mk318 Mod 0 SOST or Special Operations Science and Technology would be adopted as "Mk318 Mod 0 SOST Cartridge, Caliber 5.56mm Ball, Carbine, Barrier". In February of 2010 the U.S. Marine Corps formally adopted the round, with millions of the rounds being purchased by the USMC. However, there was still a problem with the round in the eyes of the government, it was using lead.

So to once again make the military's ammunition "green", the Mk318 underwent additional testing to see if the lead in the round could be replaced by another, environmentally friendly material. Testing concluded that replacing the lead potion with copper would retain the positive aspects of the round without and ill effects. So the Mk318 Mod 1 was created. The jacket was slightly stretched and crimped more than the original design to increase the ballistic coefficient of the round.

To differentiate the Mod 0 from the Mod 1, the Mod 1 was colored with a nickel plating to prevent the two rounds from being mixed up. At the time of this writing the Marines have continued to field the Mk318, however which version, the Mod 0 or the Mod 1 seems to be unconfirmed. Yet, with the decision to break from the rest of the military, in standardizing one branch around a different loading, would lead to difficulties and questions from the government.

Why Are You Not with Us?

After years of fielding and purchasing the Mk318 for the Marine Corps exclusively the US Government started asking why logistics were being unnecessarily complicated by using two distinct loadings of the same caliber. Since the start of the 20th century the entire US Military had standardized around a single loading for each caliber. This kept things simple, yet when the Marines broke ranks over the issues with the M855A1 the divide started.

As recently as March 19th, 2015 the House Armed Services Committee started asking questions as to why the Marines were splitting off from the rest of the military. The Marines responded by promising to test the M855A1 EPR and consider making the switch, however as of this writing data on the results of this testing seem to be unavailable.

With the Marines, by their own admission, in no hurry to adopt the M855A1 EPR, a small conceit was made with the Gen 3 PMAG from Magpul being authorized for use by the Marines. Magpul's magazine had already seen years of use and has proven itself with civilians and law enforcement and is touted as being able to deal with "difficult" ammunition types. However, it seems this move was made more to make sure that Marines who might end up having to use the M855A1 round would still have it be able to reliably feed in their rifles than a move towards settling the debate over what loading to use for the 5.56mm NATO.

This brings us to where we stand today, with the Marine Corps and the rest of the military divided over the use of the M855A1. Only time will tell if the Marine Corps adopts the M855A1 or continue to use the Mk318 despite law makers looking to force them to make the switch.

Now that we have looked over the history of the .223 Remington and the development of the 5.56mm NATO for the US Military we will now look at a number of other aspects of this round, including major loadings around the world, twist rates, and the real differences between the 5.56mm NATO and the .223 Remington.

A Brief Overview of Major 5.56mm Loads

With decades of development in both the military and civilian sectors, as well as its massive popularity in both, the 5.56mm or .223 Remington has numerous loadings developed for it. Here I will give you a brief overview of some of the major ones used by both military and civilian shooters.

US Made Cartridges: Military

Many of these cartridges are available to civilians though one or more manufacturers or brands. Federal, Black Hills, PMC, Winchester, and others make equivalent loads to one or more of these rounds available to civilian shooters and they are often not difficult to find. However, the most popular military rounds of the civilian market are the M193, M855, and the MK318 MOD 0.

Cartridge, Caliber 5.56 mm, Ball, M193

The M193 Ball round was the first to be developed for military use of the 5.56mm. Seeing service in Vietnam it was a 55 grain, lead core, copper jacketed bullet that featured a cannelure around the middle of the bullet for the case to be crimped on.

Cartridge, Caliber 5.56 mm, Tracer, M196

The M196 tracer round was developed in conjunction with the M193 ball round to allow for rounds to be tracked in fight as sustained fire was being aimed at a target. Normally when linked the M196 tracer, as with all tracer rounds would be put in linked belts of ammunition with M193 ball rounds as well. The tracer rounds would be included once every fifth round. As with all other tracer designs the rear of the bullet had a hollowed out section that held the tracer compound, this reduced the weight of the round to 54 grains. The tracer round can be identified by its bright red or orange tip.

Cartridge, Caliber 5.56 mm, Grenade, M195

The M195 grenade round was essentially a higher powered blank round used to launch rifle grenades from the end of a rifle. This design was predominantly used from WWI though WWII and was dropped with the advent of underslung grenade launchers. The crimped end of it was sealed with a read lacquer.

Cartridge, Caliber 5.56 mm, High Pressure Test (HPT), M197

A high pressure round used to proof test barrels for acceptance testing during the rifle manufacturing process. Note, if you do run across them treat them as collectors' items and do not attempt to shoot them as they have pressures in excess of what your rifle was designed to handle on a regular basis.

Figure 52 - XM197 High Pressure Test Cartridges.

Cartridge, Caliber 5.56 mm, Dummy, M199

The M199 Dummy round was used in training and function checking of firearms. The primer pocket is left open and the body of the case is fluted to prevent it from being mixed up with live ammo.

Cartridge, Caliber 5.56 mm, Dummy, M232

Yet another dummy round, again with an empty primer pocket, however the M232 is black anodized, again to keep it from being mixed up with live ammo.

Figure 53 - M232 and M199 dummy round.

Cartridge, Caliber 5.56 mm, Blank, M200

The M200 blank round is another training round used to simulate live fire. It requires a specialized bolt on most rifles and a blank firing adaptor for the gun to cycle properly. Older M200 blanks will have a white lacquer crimp, which was replaced due to excessive fouling by a violet colored lacquer.

Cartridge, Caliber 5.56 mm, Ball, M202

The M202 ball round or SSX822 is a 58 grain "tri-metal" penetrator round originally developed by FN.

Cartridge, Caliber 5.56 mm, Ball, XM287

This was a 68 grain ball round produced by Industries Valcartier, Inc. Later revisions to the round to improve it would be referred to as XM779.

Cartridge, Caliber 5.56 mm, Tracer, XM288

Another Industries Valcartier, Inc. bullet design that was also 68 grains and received its own revisions called the XM780.

Cartridge, Caliber 5.56 mm, Grenade, M755

A later variant of the M195 grenade cartridge, the M775 was designed for use with the M234, 64mm, launcher. While early versions also used a white lacquer seal, this was replaced by a yellow one for the same reasons as the M195.

Cartridge, Caliber 5.56 mm, Ball, XM777

This was an attempt to replicate the performance of the SS109 cartridge with a 55 grain bullet. It was an "semi-armor piercing" round that used 1:12" rifling along with the M193 round. The XM777 would eventually replace the 6x45mm SAW as the control cartridge for the Squad Automatic Weapon trials from the late 1970's to the early 1980's.

Figure 54 - The XM777 and the other cartridges considered in the NATO trials.

Cartridge, Caliber 5.56 mm, Tracer, XM778

The XM778 was a tracer round that was to be used along with the XM777. Given that it was a tracer round it was likely a 54 grain projectile to allow for the tracer cup in the rear of the bullet.

Cartridge, Caliber 5.56 mm, Ball, M855

The M855 ball round was the 5.56mm round of the cold war and well into today. It is easily identified by its green tip and used a 62 grain projectile over a lead core with a mild steel penetrator. This was created to be the equivalent to the FN SS109 that was used by other NATO forces when the 5.56mm was standardized as a NATO round.

Cartridge, Caliber 5.56 mm, Ball, M855 Lead Free

Retaining all aspects of the M855 however this was a change to a bismuth-tin alloy core over the lead core of the standard M855. This round was dropped after it became apparent that it was adversely affected by high ambient temperatures.

Cartridge, Caliber 5.56 mm, Ball, M855A1 Enhanced Performance Round

The M855A1, or M855A1 EPR round moved to a solid copper core bullet with a 19 grain steel penetrator tip that was exposed. The round can easily be identified by the exposed penetrator which will often be able to spin freely in the jacket.

Figure 55 - The M855A1 EPR round and the subject of debate over its use today.

Cartridge, Caliber 5.56 mm, Tracer, M856

The M856 tracer round is a 63.7 grain version of the FN L110 tracer round, the tracing compound burns red in flight and it does not have a steel penetrator like the M855 line of cartridges. Like other tracer rounds it has an orange tip to easily identify it.

Cartridge, Caliber 5.56 mm, Tracer, M856A1

The M856A1 tracer round uses a 56 grain lead free slug and can be identified by its red tip. The M856A1 is intended to be used alongside of the M855A1 and is often placed every fifth round in linked belts of 5.56mm NATO. It boasts similar ballistics as the M855A1 and has better performance over other, older, tracer rounds.

Cartridge, Caliber 5.56 mm, Plastic, Practice, M862

One of a number of "Short Range Training Ammo" loadings or SRTA's. These have not only a small powder charge than standard rounds but also fire a specially designed plastic bullet. Despite firing "live" ammo of sorts, they require an M2 training bolt to cycle properly in all M16 and M4 carbines. With the limited range SRTA ammo is often used when the training range is in or near populated areas to avoid stray rounds injuring passersby. Identifying the M862 round is easy with its aluminum case, blue, plastic bullet, and brass primer.

Figure 56 - M193, M196, M199, M200 (violet lacquer), M855, M856, and M862 loadings of the 5.56mm NATO.

Cartridge, Caliber 5.56 mm, Armor Piercing, M995

The M995 5.56mm round is an armor piercing, 52 grain projectile with a tungsten core. The M995 loading can be easily identified by the black tip of the bullet.

Cartridge, Caliber 5.56 mm, Tracer, XM996

The XM996 tracer round can be identified by its red colored tip. However, the XM996 is different from other tracer rounds because it is a "dim tracer" intended to be used by forces using night vison scopes, goggles, and other devices. Standard tracers are too "bright" for night vision so to prevent the sensors from being "overloaded", so called, "dim tracers", like the XM996 were developed to address this issue.

Cartridge, Caliber 5.64 mm, Ball, MLU-26/P

The very first .223 Remington loading for the US Military to be mass produced. These rounds were given the national stock number *1305-968-5892: Munition, Live, Unit # 26 / Personnel use.* While the commercial designation for this round was .223 Remington, the Air Force designated these rounds as "5.64mm", instead of the later, 5.56mm that would become the standard metric name used by the military. These rounds were 55 grains and were called "Metallic-Cased", or "M.C." This term indicating that they were full metal jacketed rounds. In total 8.5 million of these rounds were purchased by the military for use with the XM16. Today any brass and unfired cartridges can be identified by their headstamp of "RA 63" or "REM-UMC 63". They were packaged in 20 round commercial boxes and were not placed in stripper clips.

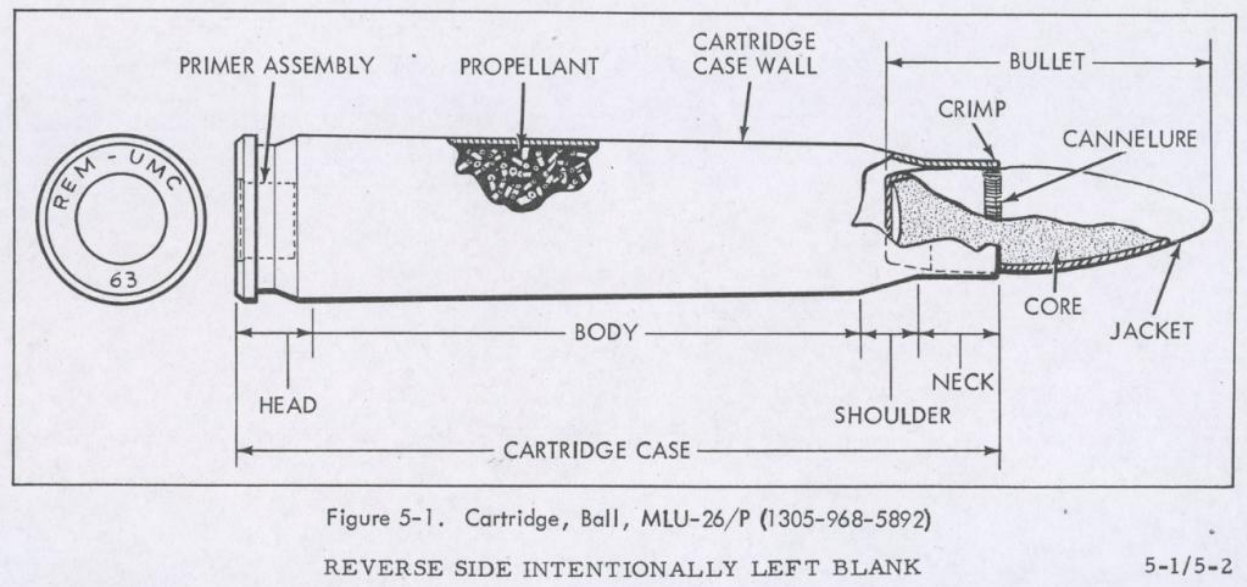


Figure 57 - The MLU-26/P was the first .223 military loading.

Cartridge, Caliber 5.56 mm, Frangible, MK 255 Mod 0

The MK 255 Mod 0 is a Reduced Ricochet, Limited Penetration or RRLP loading for the 5.56mm. Using a 62 grain copper and polymer composite core these rounds are generally used in both live fire training and in operations where limited penetration of rounds though barriers is needed such as in dense, urban environments where bystanders might be in the next room. These rounds can be easily identified by the white tips on the end of the bullets.

Cartridge, Caliber 5.56 mm, Special Ball, Long Range, Mk 262 Mod 0 and Mod 1

A favorite of many in special forces, loaded with a 77 grain Open-Tipped Match or hollow point boat tail bullet. The Mod 0 version utilized the Sierra Matchking bullet, while the Mod 1 introduced a cannelure to the bullet and used either a Nosler or Sierra bullet. Produced by Black Hills ammunition and have been made available to the public by them as well using the same loadings.

Figure 58 - The Mk262 Mod 1 is available on the civilian market from Black Hills Ammunition.

Cartridge, 5.56×45mm, semi-jacketed Frangible, MK 311 Mod 0

Yet another RRLP loading of the 5.56mm round. These use a 50 grain, frangible projectile and are more intended for training than for use in operations like the MK 255 Mod 0. These rounds were produced by Western Cartridge Company and can be identified by their "WCC" headstamp.

Cartridge, Caliber 5.56 mm Ball, Enhanced 5.56 mm Carbine, MK318 MOD 0 and Mod 1

The USMC's favored 5.56mm loading over the M855A1 and optimized for 14" barrel firearms. The MK318 uses a 62 grain Open Tipped Match Boat Tail round. The round is "barrier blind" and the Mod 1 revision can be identified by the use of a nickel plated bullet. The Mod 0 used a lead and copper core, however the Mod 1 used a fully copper core. Recently it has been renamed to "Caliber 5.56 mm Ball, Carbine, Barrier".

Figure 59 - Mk318 Mod 0.

US Made Cartridges: Civilian

While an exhaustive list of all of the .223 Remington and 5.56mm rounds would balloon this list into a gargantuan one, that few would bother to read, many of the rounds available for the 5.56mm, specifically, on the civilian market are copies or close copies of the military loadings listed above. However, in the purely civilian rounds there are fewer political or budgetary issues to be concerned with and thus more design innovation has happened, arguably, in the civilian world of the 5.56mm. Most mid-range or premium loadings use polymer ballistic tips for varmint and small game hunting while others use more interesting designs. Below is a list of a few of the more "off the beaten path" rounds that are available on the civilian market and are geared more towards self-defense and hunting.

Winchester Defender .223 Remington

Offered in both 60 and 77 grain loadings these use nickel plated brass and split core bullets. These are offered by Winchester as self-defense rounds and appear to be a viable option for this application. However, that is not to say other loadings are not capable of being just as effective.

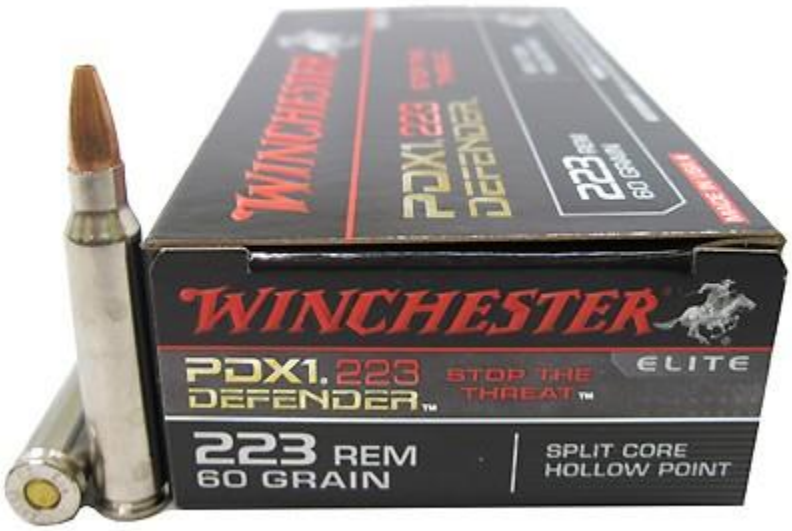


Figure 60 - The Winchester PDX1 Defender line includes an offering in .223 as well as other popular calibers.

Winchester Razor Boar XT .223 Remington

Also using nickel plated brass, low flash powder, like the Defender line from Winchester. Yet, these .223 loadings use 64 grain solid copper rounds, with "one piece" construction.

Figure 61 - The Winchester Razor Boar XT.

G2 Research .223 Trident

G2 Research offers this solid copper, 65 grain bullet that is designed to expand upon impact and create more damage than standard designs. While I personally am weary of G2's claims after the fiasco that was their over promised and under delivered G2 RIP round, I'm always willing to give newer designs a shot.

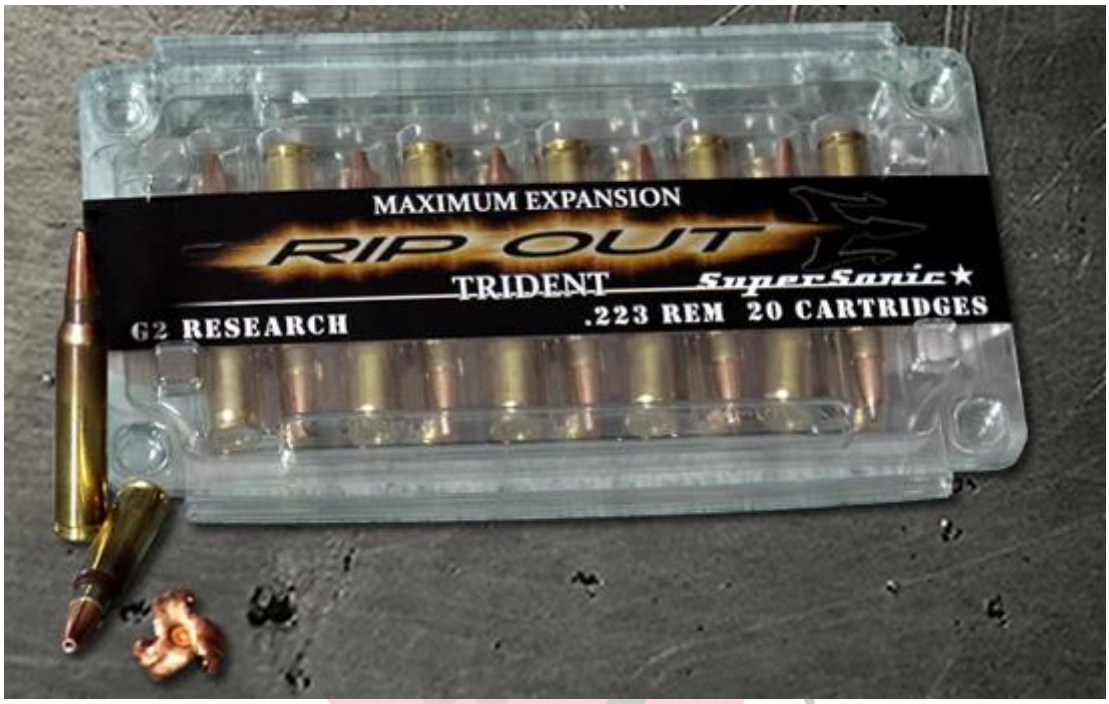


Figure 62 - The G2 Rip Out Trident design has a much more interesting design than most rounds on the market.

Hornady Superformance .223

Offered with both 53 grain V-Max and 55 grain GMX bullets. Hornaday's Superformance .223 rounds are typical of the hunting and varmint loadings for the .223 Remington. The V-Max bullet uses a lead core and a polymer ballistic tip while the the GMX uses a solid copper design.

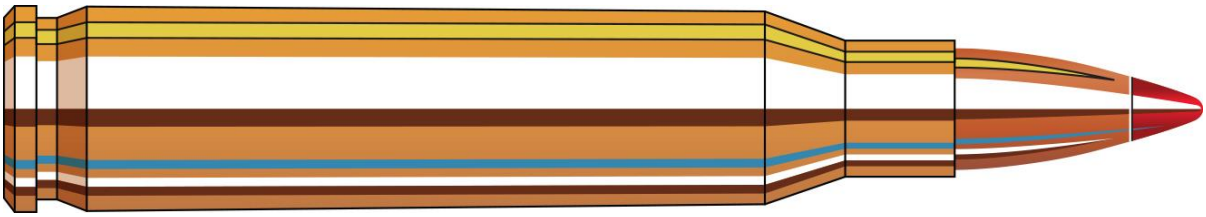


Figure 63 - Hornady Superformance is offered in a number of loadings.

Foreign Loadings of the 5.56mm

With the 5.56mm NATO being, well, a NATO standard round other NATO allies produce various loadings of the round. These countries include the UK, Germany, Canada, and many others. Below is a list of the common loadings by country. A number of these have equivalent loadings here in the US.

Australian 5.56mm Cartridges

Cartridge, Ball, F1

Australian Defense Industries (ADI), now called Thales Australia, produced round and an equivalent to the FN SS109 which is in turn the same as the M855 round used by the US.

Cartridge, Ball, F1A1

An optimized version of the F1. It features changes to the length of the boat tail, the meplat, case thickness, primer cup design, and uses the AR2210V01 powder.

Cartridge, Blank, F3

A blank round, again produced by Thales Australia. Like most blanks it can be identified by the crimp in the case mouth.

Belgium 5.56mm Cartridges

Cartridge, Ball, SS109

Again yet another SS109 variant from Belgium. It uses a 61 grain projectile with a steel penetrator. It was created by Fabrique Nationale and adopted in 1979 as the NATO standard loading for Belgium.

Canadian 5.56mm Cartridges

Cartridge, Ball, C77

Canada's SS109 variant used in their C7, C8, and C9 rifles and produced by General Dynamics Canada.

Cartridge, Blank, C79

Again another blank round with a crimped case mouth. Much like the C77 loading it is produced by General Dynamics Canada.

German 5.56mm Cartridges

Cartridge, Ball, DM11

A 63 grain round similar to the SS109 and the US' M855 round. Using a steel penetrator and easily identified by their green tip, these rounds are produced by RUAG Ammotec.

Cartridge, Tracer, DM21

A tracer variant of the DM11 round that can be identified by an orange tip. It is also produced by RUAG Ammotec.

South African 5.56mm Cartridges

Cartridge, 5.56×45mm, Ball, M1A3

This round was produced in South Africa and was based on the American M193 round. Featuring a 56 grain full metal jacket round it was used in the R4 assault rifle.

Swiss 5.56mm Cartridges

5,6mm Gw Pat 90

Short for Gewehrpatrone 90 / 5,6mm GP 90 ("5.6-mm Rifle Cartridge 90") these rounds were adopted by the Swiss military in 1987. With both French and Italian spoken by the Swiss militiamen the names *Cartouche pour Fusil* and *Cartuccia per Fucile* are both used in French as Italian respectively. While most of the time when the name 5,6mm GP 90 is being used it is equivalent to our "5.56mm NATO", however it may also refer to the .223 Remington as well. The Gw Pat 90 uses a 63 grain full metal jacket bullet that pairs well with a 1:10" twist rate.

The Swiss first used this round when they started moving to the SIG SG 510. The Swiss wanted to round to not only have an average effective range of 300 meters, they also wanted to reduce lead use as well. To this end they bullet was first designed with a nickel alloy jacket, however after this was found to decrease barrel life this was changed to a tombac jacket in 1998. A year later the round would be revised again with a copper plug at the base as part of the Swiss effort to make their own ammo "green".

As of 2009 the round was produced by RUAG Ammotec and features a FMJ, tracer, and blank version.

The FMJ version of the round uses a Copper-Zinc alloy case and a double base propellant. The bullet itself has a ballistic coefficient of 0.331 (ICAO) / 0.337 (Army Metro). While being ostensibly "green" with the addition of the copper (obvious joke) plug, the bullet is still 95% copper, while the rest is 2% antimony and 3% copper.

For the accuracy of these rounds a minim of 0.72 MOA for ten rounds at 300 meters. The cartridge dimensions are also the same as what are used by Swiss civilians and conform to the C.I.P. standards for the .223 Remington round. When you look at the way the Swiss military runs the accuracy standard becomes clearer. All military troops that use a firearm have to qualify once a year on their weapons. Combine this with many civilian shooters using the Gw Pat 90, over 1 billion of these rounds were produced as of 2005 and the number has only increased since then.

Figure 64 - The tracer version of the 5,6mm Gw Pat 90.

British 5.56mm Cartridges

All of these rounds were produced by Radway Green for the British military.

Cartridge, Ball, L2A1

A version of the US' M193 round and similar in performance and design.

Round, Ball, L2A2

The British version of the M855 round that was also derived from the FNSS109 round.

Round, Tracer, L1A1

A tracer version of the L2A1 round and it can be identified by its red tip at the end of the bullet.

Round, Tracer, L1A2

A tracer version of the L2A2 and uses the same red top as the L1A2.

Round, Blank, L1A1 & L1A2

Blank training rounds. Much like other blanks it also has a crimped case mouth.

Round, Drill, L1A1

A dummy round used by the British military for training much like the L1A1 and L1A2 rounds.

What's The Real Difference Between .223 Remington and 5.56mm NATO?

If there is one topic that keeps coming up over and over again it's the difference between the .223 Remington and the 5.56mm NATO.

While during the early development of the round until the SAAMI certification of the round in 1962 the difference between the two rounds was negligible. Early loadings of the military's 5.56mm were just .233 Remington commercial rounds, but when the SAMMI certification came though the chamber dimensions, cartridge dimensions, and chamber pressures were all locked in place. Meanwhile the 5.56mm, and eventually the 5.56mm NATO standard would continue to evolve.

The emergence of this differentiation for civilian shooters came about when in January of 1979 SAAMI released its warning about firing 5.56mm, military rounds, in .223 Remington firearms. SAAMI issued this warning because military specification 5.56mm ammo was beginning to appear on store shelves. By this time the chamber pressures of the military's 5.56mm rounds had increased above and beyond that of its commercial counterpart. However, there were some key changes made to account for this increase in chamber pressures.

While the exterior dimensions of both the 5.56mm and the .223 Remington are essentially identical, it is the chamber sizes that make up the bulk of the important differences between the two rounds. A chamber milled out for the 5.56mm NATO will be larger in certain key areas that are necessary to deal with the higher chamber pressures.

With this, there are a number of "compromise" chambers out there that have been created to attempt to bridge the gap between these two rounds and improve the inherent accuracy of the 5.56mm NATO round while keeping chamber pressures down.

The image below shows the various .223 Remington and 5.56mm NATO chamber dimensions.

.223 Remington Vs. 5.56mm NATO Chamber Dimensions

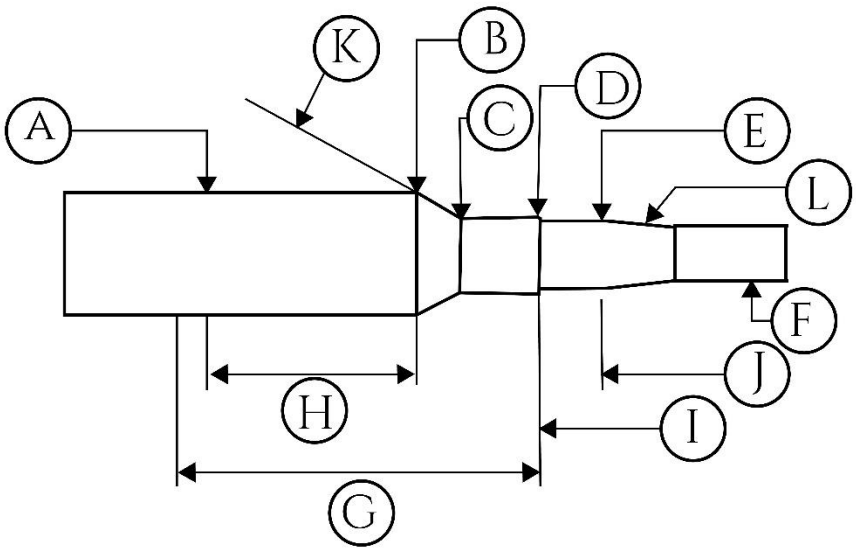


Figure 65 - Chamber dimensions compared.

Dimension	PTG 223 Rem Match	Clymer 223 Rem	PTG 223 Rem	JGS 223 Wylde	JGS 5.56 Compass Lake	JGS 5.56 NATO	PTG 5.56 NATO	Clymer 5.56 NATO
A – Base Diameter	0.3779	0.3794	0.3804	0.381	0.3803	0.3803	0.3803	0.3816
B – Shoulder Diameter	0.3568	0.3553	0.3553	0.3572	0.3553	0.3553	0.3553	0.356
C – Neck @ Shoulder	0.251	0.255	0.255	0.2568	0.2551	0.2551	0.2551	0.255
D – Neck @ Case Mouth	0.251	0.254	0.254	0.2558	0.254	0.254	0.254	0.255
E – Freebore Diameter	0.2242	0.2245	0.254	0.224	0.224	0.2265	0.2265	0.227
F – Pilot Diameter	0.219	0.218	0.219	0.219	0.219	0.219	0.2185	0.218
G – Base-to-Case Mouth	1.76	1.772	1.772	1.7726	1.772	1.772	1.772	1.775

H – Base-to-Shoulder	1.432	1.434	1.4338	1.4316	1.4338	1.4338	1.4337	1.438
I – Neck Length	0.2034	0.22	0.2201	0.2228	0.2202	0.2202	0.2203	0.218
J – Freebore Length	0.068	0.025	0.025	0.0619	0.025	0.0566	0.0566	0.05
K – Shoulder Angle (Degrees)	23	23	23	23	23	23	23	23
L – Throat Angle (Degrees	1.5	3.1	3.1	1.25	1.5	1.2	1.2	2.5

So what does this mean for the average shooter? Well we have essentially four different chamber specifications that you might encounter, .223 Remington, .223 Wylde, 5.56mm Noveske, and 5.56mm NATO as well as two different pressures from the .223 Remington and the 5.56mm NATO. With that said, there is some room for variation in both the chamber specification and the ammo pressure specification. .223 Remington might be loaded "hot" and the chamber specifications might be off, either to allow overhead with "hot" loads or because of lower quality machining.

If you have a "tight" .223 Remington chamber with 5.56mm NATO ammo you will encounter chamber pressures that are higher than what it was designed to handle, however that's not to say that you will automatically encounter a "Ka-Boom". Dangerous chamber pressures, even with a "tight" .223 Remington chamber are unlikely so long as it's not a barrel from a fly by night machining shop.

So what does this mean for the old wisdom that you should never shoot 5.56mm in a .223 Remington barrel? Well in most cases you will be dealing with higher than normal chamber pressures so you will be wearing out your barrel faster. Most of the time it will be unlikely to end up in a "Ka-Boom" however I would still caution against shooting 5.56mm NATO in a .223 Remington barrel. Even with this all said, the old wisdom still holds that you should not shoot 5.56mm NATO in a .223 Remington firearm. Even knowing what I know I'd not take the risk of running 5.56mm NATO in a .223 Remington barrel when I can find the right ammo easily.

In testing done by Lucy Gunner Labs and published at LuckyGunner.com they found that even when shooting 5.56mm NATO ammo in a .223 Remington chamber that both the velocity and pressures from the ammo were not significantly higher. However, again, you should be mindful of the fact that the .223 Remington chamber was designed for pressures 7,000 psi lower than the max chamber pressure of the 5.56mm NATO. With variations in barrel dimensions due to machine and human error, its inadvisable for someone to consistently shoot 5.56mm NATO in a .223 Remington barrel.

While "compromise" chambers like the .223 Wylde try to solve the problem of higher chamber pressures while keeping the round accurate, you should look at what you are going to be using the rifle for and match up your barrel, caliber, chamber dimensions, and loads to what you are doing. For the vast majority of shooters out there a 5.56mm NATO barrel, with a twist rate matched up to your chosen bullet weight, will do just fine. For more precision shooters there are plenty of high quality barrels out there from reputable machinists and shops that will deliver the kind of accuracy and performance that you are looking for.

But What About Twist Rate?

Since the first introduction of the M16 into Vietnam what twist rate and bullet weight to use has been a debated topic. Over the years a set of parings between the twist rate and the weight of the bullet have been developed to stabilize certain weights of bullets.

Below is a chart of barrel twist rates and the best weights to pair them with to stabilize them in flight for the highest accuracy.

Twist Rate	Bullet Weight
1:12"	40 Grains
1:9"	55 Grains
1:8" or 1:7"	62 Grains
1:7" or 1:8"	77 Grains
1:7"	80 Grains

As you can see as the heavier the bullet the faster twist rate needed to stabilize the bullet. While you can shoot any bullet weight you want in your barrel you will see the best accuracy if you shoot a bullet of the right weight to properly stabilize in your rifle. Most experts prefer either a 1:8" or a 1:9" twist rate barrel to allow for the greatest flexibility in the bullet weights useable. As you can go from 77 grains all the way down to about 62 grains with a 1:8" twist rate. For those shooting long range a faster twist rate of 1:7" may be a better option as it will stabilize heavier, wind bucking, bullets.

And Barrel Length?

In civilian, law enforcement, and military use the barrel length of the AR-15 rifle continues to be pushed shorter and shorter with AR-15 pistols using stabilizing braces becoming a popular way to have an "Short Barreled Rifle" without the hassle of dealing with the ATF. However, this leads us to a case of diminishing returns.

The shorter the barrel length the less space for the powder to burn before the bullet exits the barrel thus the velocity of the round decreases. In a 2010 study by Dr. Philip H. Dater & Jason Wong they found that,

> *"[D]ecreased velocity with barrels much shorter than 14.5 inches have a number of unwanted effects. Lowered linear velocity produces lower rotational velocity, which will result in diminished gyroscopic stability of the bullet. It will also result in significantly decreased projectile kinetic energy, decreased ability to generate a significant would channel, and will reach a point of diminishing returns where lethality of the projectile definitely comes into question."*

So the best thing to do is to forgo 5.56mm NATO barrels shorter than 14.5" and instead look to other calibers for use in these super short barreled pistols and rifles if you are looking for something to use as a real home defense rifle or pistol. However, if you are simply looking for a fun range toy, a 5.56mm NATO AR pistol is still a fun option. Simply because it's not the best does not mean that it's not still fun.

BARREL LENGTH and BORE PRESSURE

Results in table are 5 (or more) round averages.

Barrel Length (in)	Pressure (psi)	Velocity (f/s)	SPL [dB(A)]
24	4800	2964	162.5
23	5050	2951	162.7
22	5150	2873	162.7
21	5380	2849	162.7
20	5717	2979	162.9
19	5780	2921	163.1
18	6600	2889	163.1
17	7788	2835	163.6
16	7430	2786	163.3
15	7878	2729	163.4
14	8487	2686	163.6
13	8858	2649	164.0
12	9814	2626	164.6
11	10540	2643	164.2
10	12140	2575	164.3
9	13567	2446	164.7
8	15860	2357	164.7
7	17040	2204	164.8
6	20760	2034	164.5
5	25042	1823	165.1

Figure 66 - While barrels less than 14" will produce the 2,500 fps needed for the round to be reliably lethal other problems such as bullet stability in flight, flash, sound, and reliability issues start to become exponentially larger.

Load Data

For reloaders brass, bullets, primers, and powder are all easy to find. Most major reloading manuals feature load data for the ever popular round.

Below is the data from Hodgdon for the 62 grain SFT SCIR bullet, and *Cartridges of the World 13th Edition,* with various loads. More load data can be found on Hodgdon's website as well as other reloading manuals.

BULLET WEIGHT

62 GR. SFT SCIR

				Starting Loads			Maximum Loads		
Manufacturer	Powder	Bullet Diam.	C.O.L.	Grs.	Vel. (ft/s)	Pressure	Grs.	Vel. (ft/s)	Pressure
Hodgdon	CFE 223	.224"	2.260"	23.8	2,884	44,100 PSI	25.9	3,110	53,700 PSI
Hodgdon	Varget	.224"	2.260"	22.1	2,773	44,700 PSI	24.1	2,974	52,600 PSI
IMR	IMR 4320	.224"	2.260"	22.7	2,729	45,200 PSI	24.4	2,920	52,700 PSI
IMR	IMR 4064	.224"	2.260"	21.9	2,671	42,200 PSI	23.6	2,928	53,200 PSI
IMR	IMR 4166	.224"	2.260"	21.4	2,626	44,000 PSI	23.8C	2,890	53,000 PSI
Winchester	748	.224"	2.260"	22.3	2,779	44,600 PSI	24.0	2,967	52,400 PSI
Hodgdon	BL-C(2)	.224"	2.260"	22.5	2,772	45,100 PSI	24.2	2,949	52,500 PSI
IMR	IMR 4895	.224"	2.260"	22.4	2,782	46,900 PSI	24.1	2,956	53,400 PSI
Hodgdon	H335	.224"	2.260"	19.3	2,678	47,500 PSI	21.4	2,887	53,600 PSI
Hodgdon	H4895	.224"	2.260"	21.0	2,740	42,300 PSI	23.0	3,004	53,000 PSI
IMR	IMR 8208 XBR	.224"	2.260"	21.4	2,787	43,400 PSI	23.2	2,999	53,000 PSI
IMR	IMR 3031	.224"	2.260"	20.3	2,700	43,500 PSI	22.0	2,940	53,100 PSI
Hodgdon	Benchmark	.224"	2.260"	20.8	2,755	45,400 PSI	22.7	2,948	52,800 PSI
Hodgdon	H322	.224"	2.260"	19.5	2,717	45,400 PSI	21.2	2,904	52,300 PSI

Figure 67 - Image from Hodgdon.com

.223 Remington Loading Data and Factory Ballistics

Bullet (grains/type)	Powder	Grains	Velocity	Energy	Source/Comments
40 SP	IMR 3031	25	3300	1140	Sierra, Speer
40 SP	IMR 4198	22	3200	995	Sierra, Speer
40 Nos BT	Varget	28.0	3674	1195	Hodgdon
45 SP	IMR 3031	25	3300	1162	Hornady, Sierra
45 SP	IMR 4198	22	3200	965	Hornady, Sierra, Speer
50 SP	IMR 3031	25.2	3250	1250	Sierra, Nosler, Hornady, Speer
50 SP	IMR 4198	21.5	3200	1155	Nosler, Hornady, Speer, Sierra
55 SP	IMR 3031	24.5	3200	1330	Hornady, Nosler, Sierra
55 SP	W748	25	3000	1110	Hornady, Nosler, Sierra
55	Varget	27.5	3384	1395	Hodgdon
60 HP	IMR 3031	24	3100	1130	Hornady, Sierra
80	Varget	25.0	2869	1460	Hodgdon
55 SP	FL		3240	1280	Factory load
55 FMJBT	FL		3250	1290	Military load
40 HP	FL		3650	1185	Federal factory load
62 Fusion	FL		3000	1239	Fusion Factory Load
60 Nosler Partition	FL		3160	1330	Federal Factory Load
75 BTHP	FL		2930	1429	Hornady Superformance

Figure 68 - .223 Rem loads from Cartridges of the World 13th Ed.

Chambered Firearms

Much like the popular 9mm an exhaustive list of chambered firearms would take up an entire book by itself. However, the AR-15 is the most popular platform for the round, in rifle, carbine, and pistol configurations. The Ruger Mini-14 uses the .223 Remington as well as a number of bolt action and semiautomatic firearms. The SCAR, M4, SIG MCX, SIG 516, and SIG M400 all use the 5.56mm NATO round, yet this just scratches the surface of the various AR-15 variants and designs that utilize the cartridge.

Just about every major manufacturer and most of the smaller, specialty shops, produce some kind of firearm chambered in this caliber. You will be hard pressed to **not** find 5.56mm NATO, .223 Remington, and a firearm to shoot them with.

One Bullet to Rule Them All

Over the years many different loads have come along to try to dethrone the 5.56mm from its place as the top "AR-15" caliber. While the most successful has been with the .300 Blackout, its main edge is its ability to be easily suppressed. For the time being and probably for decades to come the 5.56mm and the .223 Remington will remain the top choice for civilian and military shooters alike, even as other rounds try to replace it in the AR-15.

While the 5.56mm NATO will never be the “one size fits all” cartridge that many would love for it to be, it will never be the perfect choice for every use case, however it remains a medium range round with plenty of “stopping power” and controllable recoil to allow for fast follow up shots and engaging multiple targets rapidly. For home defense as well as military and law enforcement the 5.56mm NATO serves the purpose of being an excellent choice for most use cases.

Hopefully you have found this to be an enlightening look at the history of the .223 Remington and the 5.56mm NATO. From the early concepts and ideas that gave birth to the round that date as far back as the late 1800’s to today, the 5.56mm round has a longer history than most realize.

I thank you for reading and for those of you who would like even more information about the history of the 5.56mm NATO as well as other rounds I have collected my research material in the bibliography below. For those of you who would like more information on historic and forgotten calibers as well as more modern ones be sure to visit our website, DeadCalibers.net for more articles and information as we continue to document the pursuit of ballistic perfection.

Dead CALIBERS

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Below are links to the various papers, articles, and videos that I have used to compile this research. Many of them give more in depth details about some of the topics that I have covered here. For those interested in going deeper into this topic I highly recommend looking at not only the works of Daniel Watters and his 5.56mm Timeline at LooseRounds.com but Chris Bartocci's book Black Rifle 2 and his YouTube channel as well. Finally, you should check out Daniel E. Watters continuing work on the history of the 5.56mm NATO on his Facebook page here. https://www.facebook.com/The-556mm-Timeline-A-Chronology-of-Development-259763052133/

Recommended Watching

There are many amazing firearms channels on YouTube and sites like Full30.com. However, there are a few that I have found to be amazing resources for the history of firearms. While there are other, hands down, amazing ones like C&R Arsenal the ones below were incredibly helpful in my research for this book in particular.

Chris Bartocci – Small Arms Solutions

https://www.youtube.com/channel/UC_tDPoCymsSKJ4uViL3G_zQ

Chris' work is extensive and covers a variety of topics on modern firearms. He's a former Colt employee and also wrote the book, *Black Rifle II.* When it comes to mechanical information about firearms there are few others that I have found with the breadth and depth of knowledge about small arms that Chris Bartocci possesses.

In Range and Forgotten Weapons

In Range –

https://www.youtube.com/channel/UCeUNM9NqJqZXfRNeuW4_2sg

Forgotten Weapons -

http://www.youtube.com/user/ForgottenWeapons

Created by Ian McCollum both In Range TV and Forgotten Weapons are excellent sources of information on early and obscure firearms. Ian's work is extensive and is perhaps the premier source of information on prototype firearms that many have never heard of. While most of his work is dedicated to his website and companion channels on YouTube and Full30.com he recently advised the developers of *Battlefield 1* and is listed in the credits for helping him with keeping the game *"mostly"* accurate. But realism does not always a good game make.

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About the author

Anders E. T. Herzberg is a man of many hats, with years of experience in firearms, writing, electronics, and the visual arts.

His love of firearms started at the age of 21 with a six shot revolver and a fortunate meeting with one of his now best friends, David, that would spur his interest in firearms for years to come. After years of training and research into firearms and the history of small arms he decided to start *DeadCalibers.net*. A repository of the history of various small arms calibers dating from some of the earliest designs to the most modern developments in cartridge technology. With Dead Calibers, he and his team hope to preserve the fascinating history of small arms development for future generations. When it comes to firearms he's found that there's always more to learn and often, as soon as you start calling yourself an expert is when you stop learning.