Exhibit 71

To Defendants' Memorandum in Support of Motion for Summary Judgment

SMALL ARMS of the WORLD

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with research assistance of
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A completely new and revised version of the classic work by W. H. B. Smith

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a basic manual of small arms

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1 Rifle and Carbine Development

When the Second World War began in 1939, only the Soviet Union and United States—a nonbelligerent—had made firm commitments to the production of self-loading rifles. At the end of the war, the M1 (Garand) Rifle was the only semiautomatic weapon to have successfully withstood the tests of the battlefield. As of September 1945, Springfield Armory and Winchester had delivered 4,024,034 M1 Rifles. Although the Soviets appear to have made greater use of the SVT-38 (Tokarev) Rifle than previously thought, they relied more heavily on the bolt action M1891 rifle and submachine gun than on their semiautomatic rifles. (Soviet weapons factories made 4,450,000 STV-38s, 1,322,085 SVT-40s, and 51,710 SVT-40 sniper versions during World War II.) After World War II, bolt action rifles were relegated to secondary status as most of the world's major armies began to search about for their own solution to the self-loading rifle problem.

***Top*, US Rifle, Caliber .30, M1—eight-shot clip; *bottom*, USSR *Samozariadnyia Vintovka Tokareva Obrazets 1938G* (SVT-38) 7.62 × 54Rmm—ten-shot magazine. The M1 Rifle was produced from 1936 to 1945 and again during the Korean conflict of the 1950s. The SVT-38 was modified in 1940, and both semiautomatic (SVT-40) and selective fire (AVT-40) versions were produced during World War II.**

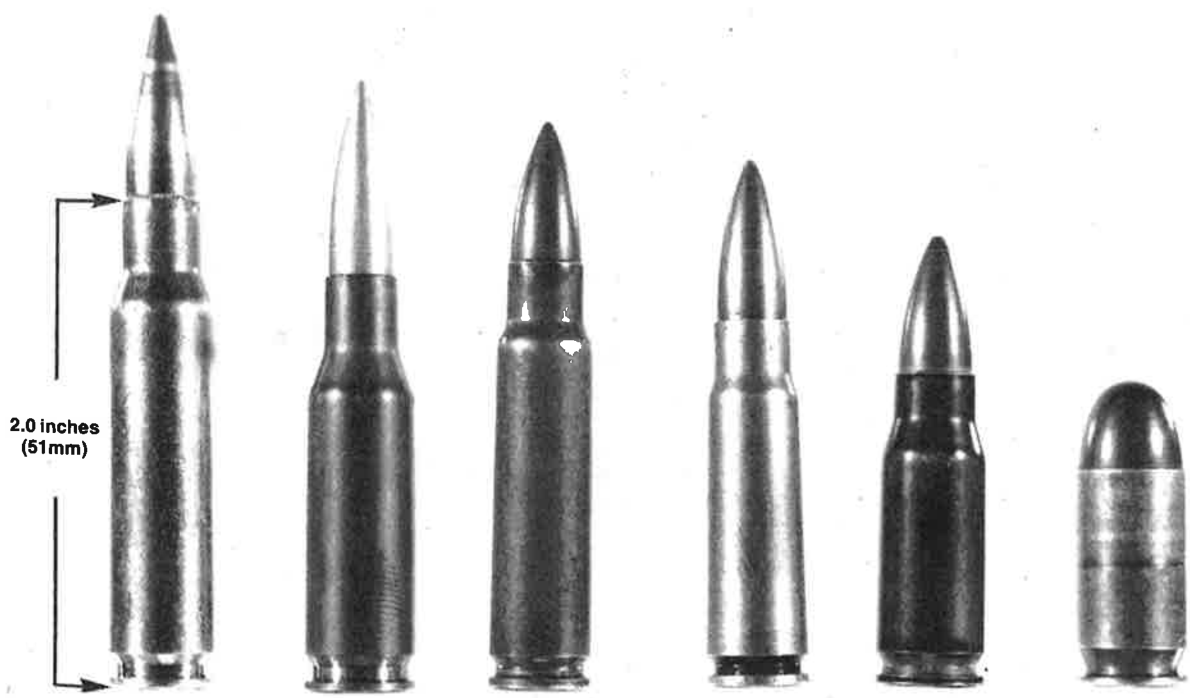
In spite of more than thirty years of rapid scientific and technological development in the field of military armaments, the standard weapon of the world's infantrymen is still the rifle. Immediately following the Second World War, many military commentators argued that the foot soldier was obsolete. They expected him to be replaced by tactical nuclear weapons and automated battlefields. A succession of military encounters in Korea, Vietnam and the Middle East, not to mention insurgencies and counterinsurgencies fought around the globe in the same period, have proven the infantrymen to be the match of their colleagues who use more sophisticated arms.

At the end of 1939–1945 war, several important trends were obvious in the small arms of the world. First, the rapid movement of the battlefield, generally typified by the advance of infantry supported by tanks and other armored fighting vehicles, stood in direct contrast to the stalemated battle front of the 1914–1918 conflict. Portability and rapidity of fire were required in all classes of weapons—rifles, submachine guns and machine guns. The German *Wehrmacht* and the Soviet Red Army were notable in their efforts to produce large quantities of pistol caliber submachine guns to provide the desired massed firepower to accompany the offensive thrust of their armored forces, but the striking power of such weapons was limited to close ranges—usually 50–100 meters. Beyond those ranges, all armies during the Second World War relied upon rifles and machine guns firing "full power" cartridges dating from either the last decades of the 19th century or the first decades of this century. World War I had confirmed the desire to have cartridges that were reliably accurate and lethal to 1200 meters and beyond. In both the European and Asian theaters of the 1939–1945 war, the ranges at which effective small arms fire was delivered were usually under 350 meters. Thus, one pressure on weapons designers was the desire of infantry tacticians to acquire small arms that combined the rapid, massed and shocking power of the submachine gun with the lethality of the standard infantry rifle cartridge.

A second fact of life brought home to military planners by World War II was the logistical nightmare created when one's forces had small arms of various types and calibers. The *Wehrmacht* was the worst example. While the German Ordnance Corps struggled mightily to issue only caliber 7.92 × 57mm rifles and machine guns to their front line troops, the variety of weapons chambered for that cartridge was staggering. Each weapon type required a separate spare parts inventory and special training. British and French troops had similar headaches. They started the war with their own national patterns of small arms, but after the evacuation of Dunkirk and the fall of France, American weapons came to play an increasingly important role in the Allied war effort.

Late in the war, the Germans introduced a new class of small arms, the *Sturmgewehr*—or assault rifle, as this class of weapons has been designated in the post-1939–1945 war era. This weapon fired a shortened 7.92mm cartridge (7.92 × 33), with an average velocity of approximately 640 meters per second (m.p.s.) (2100 feet per second [f.p.s.]) versus 840 m.p.s. (2750 f.p.s.) for the standard 7.92 mm round fired from Mauser Kar. 98k. Projectile weight was reduced from 12.8 grams (197.5 grains) to 8.1 grams (125 grains). Although not as lethal as the longer range rifle cartridge, the 7.92 mm *Kurz* was far more effective than the standard 9mm Parabellum pistol cartridge used in submachine guns by the *Wehrmacht*—muzzle velocity, 381 m.p.s. (1250 f.p.s.) for a 7.4-gram (115-grain) projectile. Experimentation with the *Kurz* cartridge led the German army in 1944/45 to plan to replace all existing bolt action and self-loading (semiautomatic) rifles with the MP43/44, *StG 44* series of selective fire assault rifles. However, this plan was thwarted by the crippling effect of the Allied land and air offensives on the German production and supply system. Nevertheless, the German experiment had a profound effect on the post-war thinking of American, Belgian, British, Soviet, Spanish and Swiss small arms designers. Captain H. B. C. Pollard, an English intelligence officer, commented on the virtues of the 7.92 × 33mm cartridge in a 1945 Allied intelligence report: "This is a wholly admirable cartridge which may well be the prototype of the rifle cartridge of the future." He continued his praise, "while as effective for military purposes as the old 8mm Mauser German Army Service Cartridge, [it] is only two-thirds the size and two-thirds the weight. In other words, a man can carry twice the amount of ammunition into action."

As a consequence of the search for rifles with greater firepower and lighter weight during the past thirty years, many new rifles have been proposed, dozens have been tested and a few have become standard weapons, replacing the Second World War generation of small arms. Three basic calibers dominate the scene today—7.62 × 51mm NATO caliber, 7.62 × 39 M43 (Soviet) caliber and 5.56 × 45mm caliber. While each can trace its origins to the assault rifle concept, each of these groups of rifles reflects a particular technical/historic trend in small arms development and as such is described by caliber in this chapter.



POST-WAR RIFLE CARTRIDGES COMPARED WITH THE 7.92MM KURZ AND M1911 .45 CALIBER CARTRIDGES

7.62 × 51mm NATO	.280/30 (7mm) UK	7.62 × 45mm M52 Czech	7.62 × 39mm M43 USSR	7.92 × 33mm PP 43 Germany	.45 (11.43mm) USA

Two World War II German self-loading rifles. Top, *Gewehr 41 (W)* and bottom, *Gewehr 43.* Both weapons fired the standard 7.92 × 57mm cartridge.

Typical *Sturmgewehr,* the German MP44, which fired the 7.92 × 33 cartridge.

NATO CALIBER RIFLES

The end of the Second World War found the Atlantic Allies armed with an incredible potpourri of small arms. At war's end, the United States, the United Kingdom, France and Canada all began to cast about for new infantry weapons. High on the list was a new rifle. Nationalism, differences in opinion about rifle and ammunition specifications and the desire to standardize weapons among the old allies created a muddled situation that lasted for the better part of a decade, popularly known as the "great rifle controversy."

During the struggle with the Axis powers, the British employed several models of the Short Magazine Lee Enfield (SMLE) Rifle. While this had been the basic pattern for their service rifle since 1902, the desire for a self-loading rifle went back to the pre-1914 period. The successful development of the No. 4 Rifle in the 1930s (an updated SMLE) set back the effort to obtain a self-loading rifle. Some experimentation toward that end was taken during World War II with the Belgian SAFN in 7.92 × 57 (called the 7.92 S.L.E.M.1), but no change was seriously contemplated as long as the war continued.

At the end of the hostilities, the Ministry of Supply created the "Small Arms Ideal Calibre Panel" and assigned it the task of developing a new infantry rifle cartridge. The British sought the lightest rifle and ammunition combination that would be consistent with firing comfort and effectiveness at the reduced maximum range of 600 meters. Commenting on this shortened range, one member of the development team said, "It was recognized that the old .303 over-killed at rifle ranges." They were seeking an "intermediate power" cartridge to be used in an assault-type rifle.

Dr. Richard Beeching, Deputy Chief of the Armaments Design Establishment, and his associates carried out the basic ballistic studies for the "Ideal Calibre Panel," which included an experimental determination of the optimum caliber, muzzle velocity and external and internal ballistics. This work, without equal at the time, led to the conclusion that the ideal caliber was .270. Preliminary talks with American Ordnance representatives led Beeching's staff to increase the caliber to .276, later designated .280, although the diameter of the projectile was not actually altered. In the summer of 1947, Beeching's panel submitted its classified findings in a formal report. The British Army team, dispatched to the United States with this document, encountered for the first time American plans for the development of a lightweight .30 caliber rifle. A difference in calibers was just the first hurdle on the path toward a common rifle cartridge.

At first, the controversy over caliber was difficult to understand, since the desire for an "intermediate power" cartridge was sparked by a common admiration for the 7.92 × 33 *Kurz* round that the Germans employed in their *Sturmgewehr* series. But the Americans displayed an ambivalence in their goals for a new rifle/ammunition system. They wanted the firepower of the *Sturmgewehr,* but they also wanted to keep the long range of their older .30-06 (7.62 × 63) cartridge. As one official statement phrased it:

> The Army is firmly opposed to the adoption of any less effective small caliber cartridge for use in either its present rifle, or in new weapons being developed. . . . Battle experience has proved beyond question the effectiveness of the present rifle ammunition, and there have been no changes in combat tactics which would justify a reduction of rifle caliber and power.

In the spring of 1951, the British Labour Party announced the adoption of the .280 E.M.2 Rifle, and the rifle controversy in the UK divided along party lines. The Labour Party stood for national integrity at the risk of disunity in the NATO alliance (formed in 1949). The Conservatives urged international cooperation based upon the relative power position of the UK in NATO.

Top: Rifle, .280 E.M.2. Bottom: Rifle No. 4 Mark 1. The No. 4 Rifle fired an 11.3-gram (174-grain) projectile at 751 m/s (2465 f.p.s.) from a 592mm (23.3-inch) barrel; while the E.M.2 fired an 8.4-gram (140-grain) projectile at 736 m/s (2415 f.p.s.) from a 622mm (24.5-inch) barrel. Overall length of the E.M.2 was kept short by its bull pup design. The magazine and receiver group are to the rear of the pistol grip, thus permitting the use of a full length barrel in a shorter weapon: E.M.2 914mm (36 inches) vs No. 4 1079mm (42.5 inches).

Stefan K. Janson demonstrating the E.M.2 Rifle he designed at the Royal Small Arms Factory, Enfield.

The latter party asked if Britain were being realistic in expecting the United States with its proportionally larger commitments and greater population to bend to the whims of the British on the caliber of the next American rifle.

By August 1951, the rifle controversy had embroiled the major members of the alliance. The Canadians, in particular, who had been stoically awaiting a solution of the disagreement, began to grow more and more concerned about producing a third cartridge. They were already manufacturing cartridges for both British and American rifles. They did not want to increase the logistical difficulties made evident by the Korean conflict. As a consequence of the Canadian desire for a resolution to the NATO ammunition question, Brooke Claxton, Canada's Defense Minister called for a four-power conference between representatives of Canada, the US, the UK and France. The meeting resolved nothing. A standard cartridge, the American Cal. .30 T65E3 emerged subsequently as the standard round in 1956. A standard rifle was never to be.

FABRIQUE NATIONALE FUSIL AUTOMATIQUE LÉGÈR (FAL)

FN's *Fusil Automatique Légèr* was one of the basic NATO caliber weapons to emerge from the "rifle controversy" of the 1950s. Designers at FN began work on a self-loading rifle before World War II; Dieudonne J. Saive was the principal engineer when the German army invaded Belgium. In 1940, he and several of his associates went to the UK where they continued their work on the rifle at the Royal Small Arms Factory, Enfield. After the war, the rifle was manufactured at FN. Designated the ABL *(Arme Belgique Légèr)* and SAFN *(Saive Automatique, FN),* it was produced in 7mm, .30-06 and 7.92 calibers.

Building upon his experience with the SAFN, Saive designed a prototype assault rifle that fired the 7.92 × 33mm *Kurz* cartridge. Demonstrated early in 1948, these early FALs were very close to being in concept ideal assault rifles. The short cartridge with its moderate recoil permitted the construction of a compact and relatively light weapon. These initial models were subsequently replaced by prototypes chambered for the British .280 (7mm) cartridge. Two variants of the .280 FAL were developed—a bull pup design and one conventionally stocked. When the US Army rejected the UK cartridge, Saive and Ernest Vervier redesigned the FAL to fire the American experimental 7.62 × 51mm cartridge. During this evolution in design, the rifle gained weight and grew in length. The American, British and Canadian armies dropped the full automatic fire requirement because the weapon was no longer controllable when fired automatically. As ultimately adopted by more than 50 nations, the basic rifle is essentially an advanced semiautomatic rifle with a 20-shot magazine. The heavy barrelled version adopted by several countries as a light squad automatic weapon, replacing older weapons such as the BREN, is neither an assault rifle nor a good light machine gun. Australia's L2A1 heavy barrel FAL, used by several Commonwealth nations, has a "bang, bang, jam" phenomena. Instead of automatic fire, it fires two rounds, and then experiences a failure to feed.

Despite its shortcomings (length, weight and recoil), the FAL has been an exceedingly popular weapon. Once the British discovered that the US Army did not like the E.M.2 Rifle but that there were some American officers who thought the FAL was a good weapon, the British became strong proponents of the FAL. The Belgian weapon was tested extensively by the NATO armies between 1951 and 1956. Two experimental lots of the FAL were manufactured in the United States—Harrington & Richardson (500) and High Standard (13). While the US Army ultimately adopted its own design, the 7.62 × 51mm M14 Rifle, instead of the foreign FAL, the Belgian rifle has seen wide use throughout the world and has been produced in larger quantities than any other NATO caliber rifle since 1945.

Early FAL prototype chambered for the 7.92 × 33mm *Kurz* cartridge.

T44

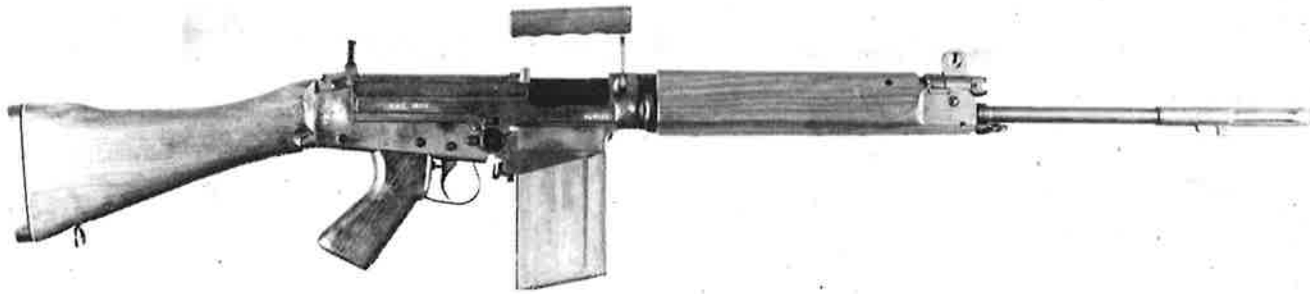
T48

Springfield Armory photograph comparing the American T44 (Prototype M14 Rifle) and the FN FAL (T48) as built for tests in the United States.

SPRINGFIELD ARMORY-ORDNANCE CORPS
CHARACTERISTICS
RIFLE CAL . . 30, T44 & T48(FN) (LIGHT BARREL)

Characteristics	M1	T44	T48(FN)
Weight - Basic Rifle (w/Empty Mag.-Less Sling)	9.6#	8.7#	9.7#
Weight - Rifle Ready To Fire (Fully Loaded-w/Sling)	10.3# (8 Rds)	10.0# (20 Rds)	11.0# (20 Rds)
Length - w/Flash Hider	43.6″ (w/o F.H.)	44.25″	44.5″
Muzzle Velocity	2800	2800	2800
Weight - Ammunition (20 Rds)	1.18#	1.04#	1.04#
Weight - Bayonet	.88#	.70#	0.63#
Weight - Grenade Launcher	.81#	.31#	0.34#

REPRESENTATIVE FALs



Canadian C1A1 Rifle manufactured by Canadian Arsenals, Limited, 1958.

Canadian-made C2 heavy barrel version of the FN FAL.

FN-made FAL for the government of The Netherlands. Note the sheet metal handguard and the combination flash suppressor/ grenade launcher. This rifle also has a unique tunnel-type front sight, and the Dutch were the first to adopt a nonadjustable rear sight.

An Indian-made FN FAL marked R.F.I. 1965 (Rifle Factory, Ishapore). This weapon is designated the 1A SL Rifle.

Early FN-made version of the heavy barrel FAL. Note flash suppressor and length of the front handguard.

Standard FN heavy barrel FAL, designated the FALO by the FN factory. (FALO is an acronym meaning FAL *lourd,* FAL heavy.)

Israeli FAL. All parts except the receivers were manufactured by Israeli Military Industries. FN manufactured the receivers. Note the strengthened front sight and gas cylinder assembly and the modified handguard. In this model the cocking handle can be used as a forward bolt assist.

Standard FAL (model 50-00) as manufactured by FN for the government of Peru. This rifle has serial number 4469.

The FN FAL is also called: the SLR, for self-loading rifle; L1A1, by the UK and some Commonwealth nations; the *Gewehr 1,* by the *Bundeswehr* (West Germany); the *Sturmgewehr 58,* by the Austrians; the C1A1, by the Canadians; and the 1A SL, by the Indian Army.

COUNTRIES USING THE FN FAL IN THEIR ARMED FORCES (WITH DATE OF ADOPTION)

Abu Dhabi, 1965
Argentina* (Fabrica Militar, Rosario), 1955
Australia* (Commonwealth, Small Arms Factory, Lithgow)
Austria* (Steyr-Daimler-Puch), 1958 (obsolete 1980)
Bahrein, 1968
Bangladesh
Barbados
Belgium* (Fabrique Nationale Liege), 1954
Bolivia, 1978
Botswana, 1978
Brazil* (Fabrica de Itajubã), 1964
Burundi, 1963
Cambodia, Khmer Republic (obsolete)
Cameroon, 1968
Canada* (Canadian Arsenals Ltd.), 1953
Chile*, 1960
Congo, Republic of, 1956
Cuba, 1959
Dominican Republic, 1959
Dubai, 1969
Ecuador, 1960
Gambia
Germany-Federal Republic, 1956 (obsolete 1959)
Greece, 1965 (obsolete)
Guyana
Haiti, 1968
Honduras, 1969
India* (Ishapore), 1963
Indonesia, 1958
Ireland (Eire), 1961
Israel* (Israeli Military Industries)
Jamaica
Jordan
Kenya, 1966
Kuwait, 1957
Lebanon, 1956
Lesotho, 1971
Liberia, 1963
Libyan Arab Republic, 1955
Luxembourg, 1956
Madagascar
Malawi, 1974
Malaysia
Mauritania, 1980
Mexico, 1968 (obsolete 1980)
Morocco, 1963
Mozambique, 1959
Muscat and Oman, 1960
Nepal
Netherlands, 1961
New Zealand
Niger, 1964
Nigeria, 1967
Pakistan, 1977
Panama, 1961
Paraguay, 1956
Peru, 1958
Portugal, 1961
Qatar, 1956
Ras Al Kahimah
Rhodesia, 1961
Rwanda, 1963
St. Kitts, 1969
St. Lucia, 1963
St. Vincent, 1968
Saudi Arabia, 1960 (obsolete)
Sharjah, 1975
Sierra Leone, 1968
Singapore, Republic of
South Africa, Republic of* (Pretoria), 1960
Sultanate de Raas, 1968
Syria, 1956
Tanzania, 1966
Thailand, 1961
Tunisia, 1967
Ummal Qiwain, 1975
United Kingdom* (BAS and RSAF Enfield), 1954
Upper Volta, 1975
Venezuela, 1954

*Denotes countries that have manufactured their own FALs. See Chapter 9 for the variations in the Fabrique Nationale–produced FALs.

US RIFLE, 7.62mm M14

The American M14 (T44E4 in prototype form) was the major competitor against the FAL in the NATO trials of the 1950s. Designer John Garand had begun work on an automatic version of the M1 Rifle before the Second World War ended. This series, called T20, was constructed in a limited number of protoypes at Springfield Armory, Springfield, Massachusetts. A different fire control mechanism was developed for the Garand by the Remington Arms Company, and that experimental series was called the T22 and T27. Plans for the production of 100,000 T20E2 Rifles in caliber .30-06 (7.62 × 63) were terminated with the August 1945 end of the war in the Pacific.

After the war, the "Army Ground Forces Equipment Review Board Preliminary Board Study" called for a 3.2-kilogram (7-lb.) .30 caliber selective fire (automatic and semiautomatic) rifle that could replace the M1 Rifle, the Browning Automatic Rifle (M1918A2) and all the existing sniper weapons. Subsequently, the US Army altered this requirement so that the new rifle could

John Garand in his tool room at Springfield Armory holding an M1 Rifle (ca 1943).

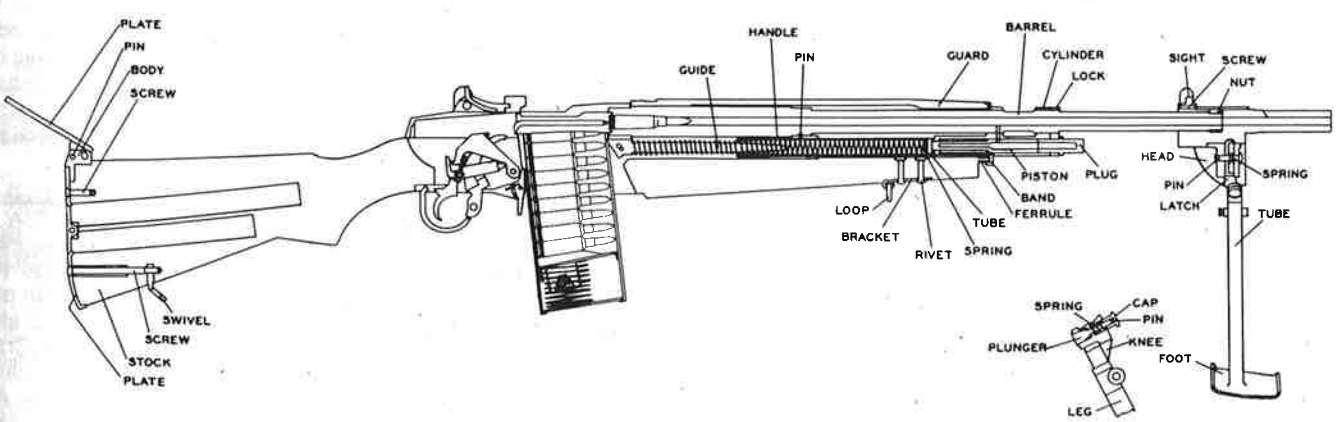
Earle M. Harvey, Chief of Small Arms Development at Springfield Armory in the late 1950s and early 1960s, shown here receiving an award from the Commanding Officer of the Armory, Col. O. E. Hurlbut in 1958.

also be used in place of versions of the carbine and all the submachine guns then in use. Three basic weapons came from all this effort: the T25, designed by Earle M. Harvey; the T28, developed by Cyril A. Moore from the unfinished Mauser *Sturmgewehr 45;* and the unconventional T31, designed by John Garand. Only the T25 (later redesignated the T47) got beyond the very limited prototype stage. Building upon design studies conducted during 1942–1944, Earle Harvey had started work on his rifle before the official specifications were laid down in 1946. The first T25s were test fired in 1948. Despite promise, this design fell victim to politics within the US Army. After a series of trials and at least one proposal that it be adopted as the replacement for the M1 Rifle, the T25 was dropped from contention following tests by the infantry at Fort Benning, Georgia, in 1952. Of four candidate rifles, the FN FAL finished first; the new Springfield entry (T44) came in a poor second; and the T25 and British E.M.2 were eliminated from consideration.

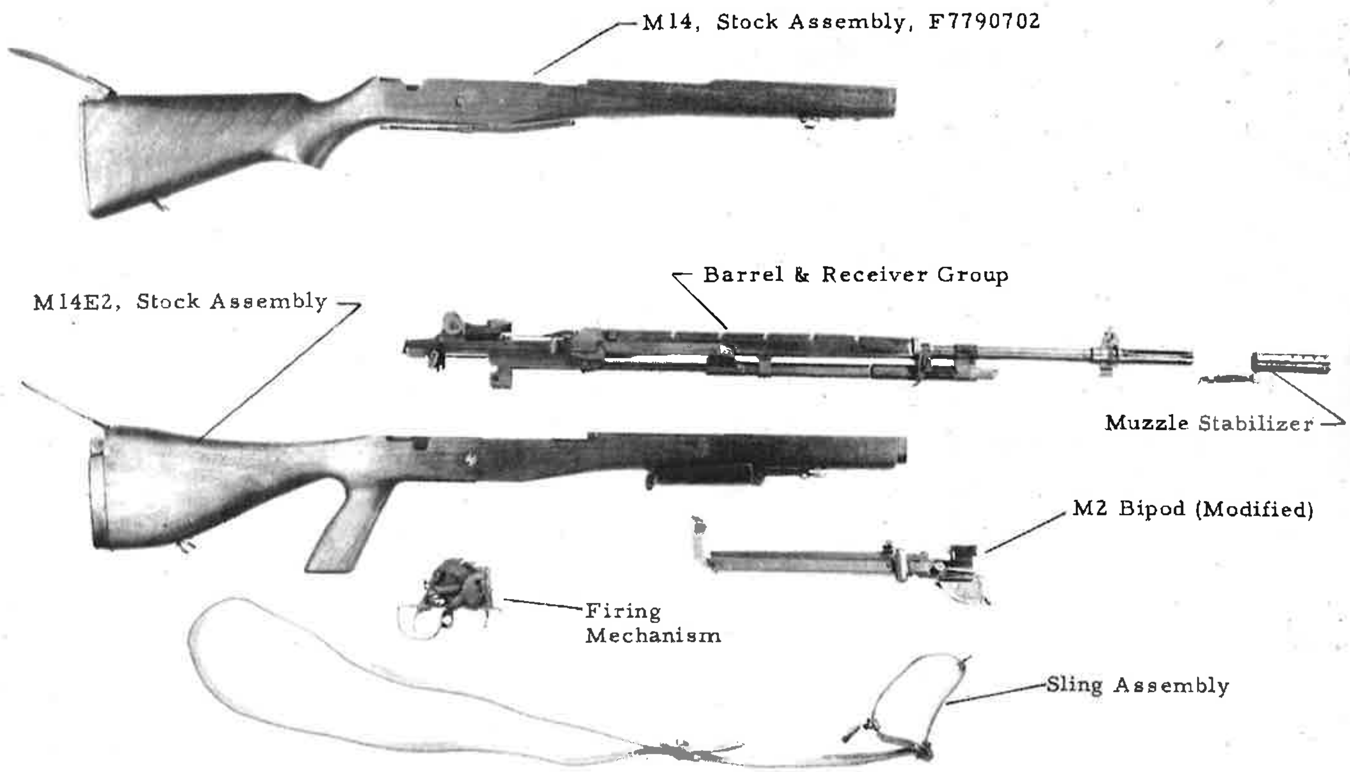
Springfield's T44 was essentially a lightened T20E2, or "product improved" M1 Rifle. Lloyd Corbett at the Armory modified the T20E2 by adding a lightweight barrel (T36, November 1949) and adapting the receiver of the weapon so that it would function properly with the shorter T65E3 (7.62 × 51mm) cartridge. As tested in 1951–1952, this weapon (now called the T44) was really a makeshift item that should not have been expected to compete successfully with the more fully developed FAL and T25. When it did perform satisfactorily for a weapon with such a limited development history, the Army decided to press for its improvement. This was only after a Board of Infantry Officers had in August 1952 recommended the limited procurement of the FAL for extensive field trials. During the next five years, the FN FAL and a series of constantly improved T44s were tested, retested and tested again in a wide variety of field conditions—tropical to arctic. After the gunsmoke and political flack finally cleared, the United States Army adopted the T44E4 on 1 May 1957 as the US Rifle, 7.62mm, M14, and the T44E5 (heavy barrel version) as the M15. The latter was never produced in quantity, and on 17 December 1959 was declared obsolete. Subsequently, Captain Durward Gosney of the US Army Infantry

M14A1 Muzzle compensator.

US Rifle, 7.62mm M14.



US Rifle, 7.62mm M15 (obsolete).



Comparison of M14 and M14A1 (M14E2 in prototype) Rifle stocks.

Board designed a version of the M14 to overcome three specific problems associated with automatic fire—(1) excessive dispersion of bullets, even when fired by an expert rifleman; (2) excessive recoil; and (3) muzzle climb. Gosney's alterations included an "in-line" stock, front and rear pistol grips and a recoil brake that fastened over the standard flash-hider. Combined, these elements made the rifle more manageable during automatic fire. Although subsequently adopted as the M14A1, this weapon was still too light (5.8 kg [12.75 lb.]) to be used as a suitable replacement for the M1918A2 Browning Automatic Rifle (8.8 kg [19.4 lb.]).

After a tortuous five years of production, Robert S. McNamara, US Secretary of Defense, terminated manufacture of the M14 in 1963. The production version of the M14 was fabricated at: Springfield Armory (167,100), Winchester Division Olin Corporation (356,501), Harrington & Richardson (537,582) and Thompson-Ramo-Woolridge, Inc. (319,691). In 1967, surplus M14 production tooling was sold to the Republic of China (Taiwan). Since 1968, the Taiwanese have been producing that rifle as the Type 57 Rifle (i.e., 57th year since the establishment of the Republic of China in 1911).

NATO CALIBER VERSIONS OF THE US M1 RIFLE

The American experimental rifle program that led to the development of the M14 Rifle also demonstrated the feasibility of converting the standard M1 Garand to fire the NATO cartridge. The first tests of altered M1s were conducted in 1948, and they indicated that the slightly different case taper of the T65E3 cartridge case caused the new experimental case to stick in the standard eightshot M1 clip. To solve this problem, Springfield Armory engineers increased the gas port diameter from 2.15mm (.085 in) to 2.22mm (.0875 in). While this increased the power to overcome the sluggishness of the altered rifle, it also increased the strain on the other components. A new barrel was required for the shorter 7.62 × 51mm cartridge, as was a 6.3-gram (.224-oz) steel filler·block at the front of the receiver. Experiments with the T35, as this converted M1 was designated, continued through the early 1950s. For various reasons, notably the manufacture of the M14 Rifle, no large alteration of M1 Rifles was undertaken by the US prior to 1963, when the Navy embarked upon such a program.

When Defense Secretary McNamara terminated production of the M14, the Navy did not have enough NATO caliber rifles to equip its shore units. The Bureau of Naval Weapons settled upon a special chamber bushing conceived and patented by Commander Richard F. Haley and a civilian Navy employee, James O'Conner. A steel sleeve just under 25 mm (1 in) long, this bushing provided for the difference between the .30-06 (7.62 × 63mm) and 7.62 × 51mm cartridges. The external dimensions equalled the former cartridge, whereas the internal measurements matched the shoulder and neck of the NATO cartridge. The bushing was seated in the barrel and secured by firing two eight-shot clips. In the process of developing this conversion, the H. P. White Laboratories rediscovered the necessity of having a filler block to assure proper feeding of the shorter cartridges into the barrel. This time molded plastic was substituted for steel.

Tests during the summer of 1964 by the US Army Test and Evaluation Command of 10 M1E14 Rifles, converted by the American Machine and Foundry Company (AMF), York, Pennsylvania, indicated that under prolonged firing bushings were ejected randomly. Marine Corps tests indicated the same problem. While a new bushing was subsequently developed at the Weapons Production Engineering Center, Naval Depot, Crane, Indiana, the Navy also decided to purchase new NATO caliber barrels from Harrington & Richardson for 8,750 M1 Rifles. AMF altered 17,050 with the first model bushing and 5,000 with the new bushing. Harrington & Richardson used the new bushing in modifying 12,250 M1s. The grand total was 30,050 weapons. Congressional critics later questioned the economic wisdom of the Navy program, but it was carried out at a time when there were too few M14s and M16s to go around. All rifles converted in the Navy effort were marked "7.62 NATO" on the left side of the receiver.

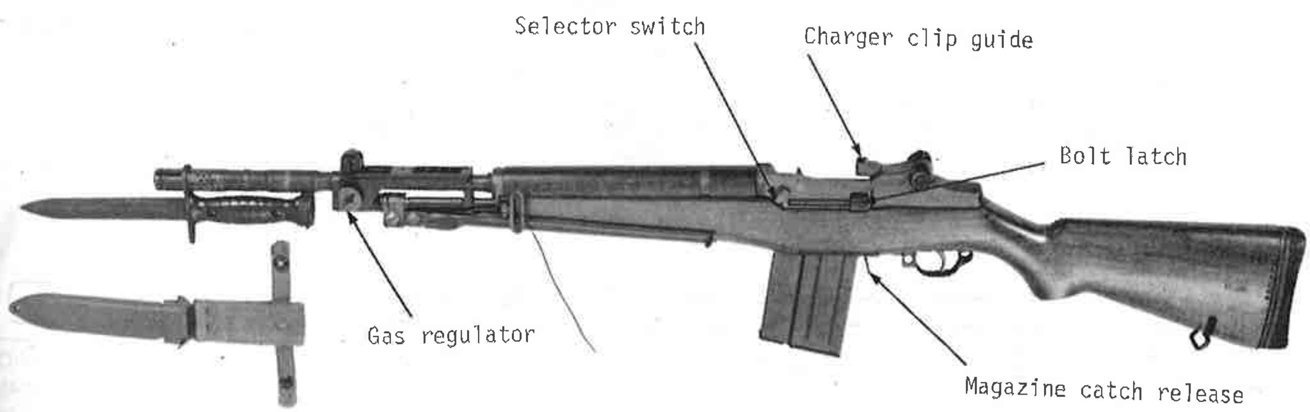
While Fabrique Nationale also devised a conversion process for the M1 Rifle, Beretta of Italy went even further and developed an updated NATO caliber M1, the BM59. Early in the 1950s, Beretta began production of the M1 Rifle with technical support from the US. The first rifles went to the Italian Army in 1952. Later, Denmark and Indonesia purchased M1s from the Italian company. More than 100,000 Garands had been produced when Beretta decided to develop a modernized version of that rifle in the NATO caliber. Studies in this direction began in 1958–1959. Domenico Salza and Vittorio Valle were the two key figures responsible for carrying out this project. Many variants were developed—most in prototype form only—with the "BM59 Mark Ital" being adopted by the Italian Army in 1962. That weapon had a Beretta-designed selective fire mechanism—full and semi-automatic—and used detachable 20-shot magazines instead of the Garand eight-shot clip. Further details on variants can be found in Chapter 29. Indonesia and Morocco have produced the BM59 with technical assistance from Beretta. Nigerian plans to produce the rifle appear to have been thwarted by the late civil war.

Total US production of the M1 Rifle between 1936 and 1957 was 6,034,228.

ARMIES USING THE M1 IN .30-06 (7.62 × 63mm)

Austria*	Iran
Bolivia*	Italy (Beretta)
Brazil*	Japan*
Chile*	Korea, Republic of
Republic of China (Taiwan)	Liberia
Costa Rica	Mexico
Cyprus	Norway
Denmark (Beretta)	Pakistan
Ethiopia	Panama
Greece	Philippines
Guatemala	Thailand
Haiti	Turkey
Honduras	United States*
Indonesia*	Vietnam*

* Denotes secondary or obsolete.



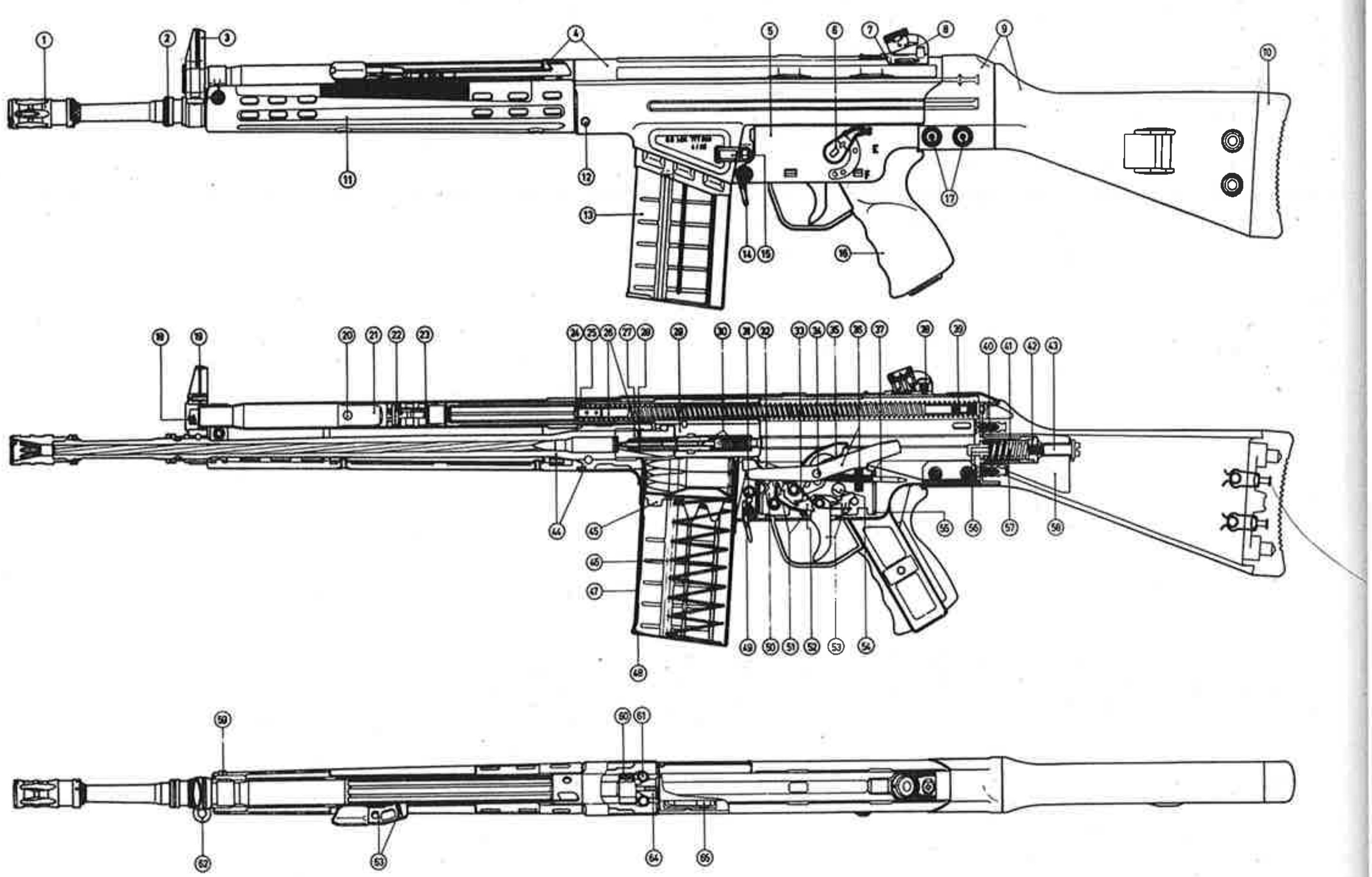
Beretta Mark 1 Ital. *BM59 Versione Normale.*

***BM59 Versione speciale per Paracadutisti* with stock folded and compensator/grenade launcher removed.**

CETME, G-3 AND RELATED ROLLER LOCK RIFLES

A whole family of rifles grew out of work done in 1944–1945 at the *Mauserwerke*. As part of the late Nazi war effort to produce an inexpensive but reliable weapon, engineers at Orberndorf am Neckar developed a delayed blow-back mechanism, using a two-piece bolt with a roller locking system, which provided the necessary delay in opening. This design was not fully developed in 1945, and incomplete weapons were captured by the Allies. The weapon had several designations: StG 45(M), Gerat 06H, MP45(M). (Operational details are presented in Chapter 21 under the G3 Rifle.) As noted above, the American designer C. A. Moore used this concept in his T28 Rifle.

Automatisches Gewehr G 3, Kal. 7,62 mm x 51



G3 Automatic Rifle, 7.62mm NATO

1. Flash suppressor/ grenade launcher
2. Snap ring
3. Front sight holder
4. Receiver and operating housing
5. Grip assembly
6. Safety
7. Sight base
8. Rotary rear sight
9. Back plate with buttstock
10. Butt plate
11. Handguard
12. Cylindrical pin
13. Magazine
14. Grip assembly locking pin
15. Magazine catch
16. Grip
17. Buttstock locking pins
18. Cap
19. Front sight
20. Stop pin
21. Stop abutment
22. Operating handle spindle
23. Operating handle support
24. Stop pin
25. Recoil spring guide ring
26. Recoil spring tube with recoil spring
27. Bolt head
28. Clamping sleeve and holder for locking roller
29. Bolt body with recoil spring tube
30. Firing pin with firing pin spring
31. Contact piece
32. Release lever
33. Elbow spring for trigger
34. Ejector spindle
35. Hammer
36. Ejector with spring
37. Pressure shank and spring
38. Fixing screw
39. Stop pin for spring guide
40. Countersunk screw
41. Buffer housing
42. Buffer closure
43. Screw for buffer
44. Barrel with barrel extension
45–48. Magazine assembly
49. Magazine release lever
50. Catch
51. Elbow spring with roller
52. Sear
53. Trigger
54. Safety pin
55. Trigger assembly
56. Buffer pin
57. Buffer spring
58. Support for buffer housing
59. Handguard locking pin
60. Extractor with spring
61. Locking roller
62. Eyebolt
63. Operating handle with elbow spring
64. Locking piece
65. Bolt head locking lever

The Mauser engineer Ludwig Vorgrimmler went to France after World War II to work on his roller lock mechanism. While at the French armament center at Mulhouse, he produced two breech mechanisms designed for the American .30 carbine cartridge (7.62 × 33).

In the early 1950s, Vorgrimmler went to Spain where he worked with other German and Spanish engineers at the government *Centro de Estudios Tecnicos de Materiales Especiales* (CETME) in Madrid. Without the immediate pressures of war, the former Mauser engineers were able to give considerable attention to weapons design and ammunition considerations. Included in their efforts was the creation of a 7.9 × 40mm cartridge that had an elongated and very light projectile—6.8 grams (105 grains)—with a muzzle velocity of 800 m.p.s. (2,625 f.p.s.). By 1952, the first prototypes of the CETME Automatic Rifle were ready for testing. After two years of experimentation, the Spanish Government began to look for a company to assist them in establishing a factory for rifle production. In March 1954, Heckler & Koch was invited by the Spanish to attend discussions concerning the advanced development and preparation for manufacture of the CETME Rifle.

Heckler & Koch GMBH, Oberndorf am Neckar, was established in 1949. The founders of the firm had been executive engineers in the *Mauserwerke* at Oberndorf. Most of the key engineers, foremen and skilled machinists had worked for the Mauser factory, which was dismantled at the end of the war. Germany ordered the first 400 rifles in 1956, and they were produced by Heckler & Koch in the NATO caliber, 7.62 × 51mm. In 1958, Spain adopted the improved CETME Rifle, which fired a reduced power version of the NATO cartridge. The following year, the *Bundeswehr* adopted the weapon as the *Automatisches Gewehr G3, Kal. 7.62mm × 51.* The G3 replaced the FAL, which had been used as the G1. A key element in the decision to adopt the G3 was the inability of the German Government to work out a satisfactory licensing agreement with Fabrique Nationale for production of the FAL.

Spanish CETME 7.92mm Assault Rifle, the prototype CETME.

COUNTRIES USING THE G-3 RIFLE

Abu Dhabi	El Salvador	Morocco	Sharjah
Bangladesh	Germany-Federal Republic*	Niger	Spain* (CETME)
Bolivia	Ghana	Nigeria	Sudan
Brazil*	Greece	Norway* (Kongsberg Vapenfabrikk)	Sweden* (FFV)
Brunei	Guyana	Pakistan*	Tanzania
Burma	Haiti	Peru	Thailand
Chad	Indonesia	Philippines	Togo
Chile	Iran*	Portugal*	Turkey
Colombia	Jordan	Qatar	Uganda
Denmark	Kenya	Saudi Arabia	Upper Volta
Dominican Republic	Malawi	Senegal	Zambia
Dubai	Mexico		

* Denotes local manufacturer of the rifle.
The French arms factory MAS, and the Royal Small Arms Factory, Enfield, are manufacturing the G-3 for Heckler & Koch as subcontractors.

Current manufacture H&K G3A3.

ARMALITE AR-10 and AR-16 RIFLES

The Armalite Division of the Fairchild Engine and Airplane Corporation was established in October 1954, for the express purpose of developing new military firearms using the latest advancements in plastics and non-ferrous metals. While the Armalite firm has gone through several reorganizations, its small development facility has always been located in Costa Mesa, California. Eugene M. Stoner was the key designer with the firm in the early years, while Robert Fremont supervised prototype manufacture and L. James Sullivan oversaw the routine drafting work. Several weapons were undertaken prior to the work on an assault rifle, including:

AR-1—7.62 NATO parasniper rifle, extremely lightweight, using a Mauser-type bolt action mechanism. Only prototypes were built in 1954.

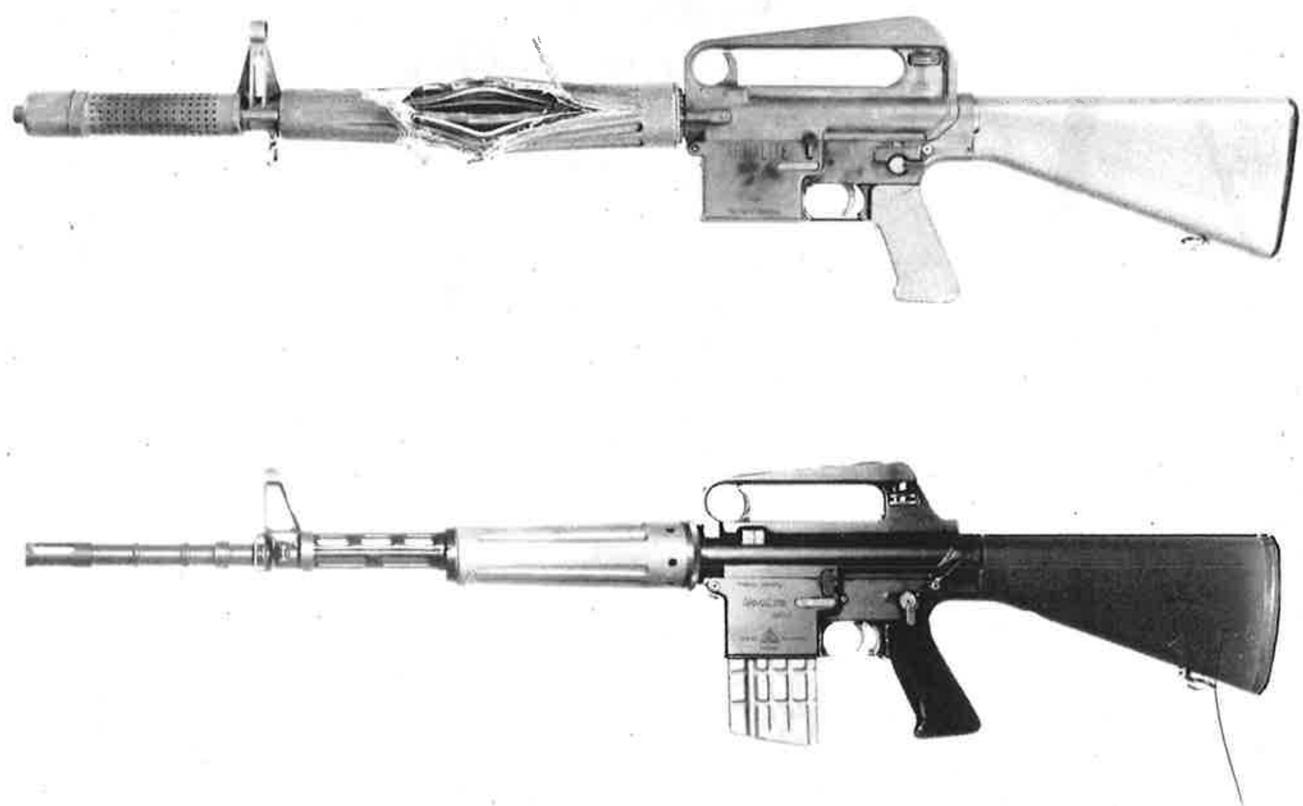
AR-3—7.62 NATO self-loader designed by Stoner into which he incorporated an aluminum receiver, fiberglass stock and a multiple lug locking system of the type later found in the AR-10.

AR-5—.22 Hornet caliber survival rifle developed for the US Air Force and officially designated the MA-1.

AR-7—.22 long rifle self-loader, which comes apart so that the barrel and receiver could be stored in the synthetic stock. Developed in 1959–1960, this rifle is still marketed under the commercial name "Explorer."

AR-9—12 gage (18.5mm) self-loading shotgun with aluminum barrel and receiver, weighing only 2.27 kg (5 lb.). Developed in 1955, it never was produced in quantities.

Work was begun on the AR-10 before Stoner joined the firm. By mid-1956, the Fairchild organization was actively promoting that rifle, despite the fact that it was still in the early stages of development. A third version of the AR-10, with a titanium barrel surrounded with an aluminum jacket, was tested by Springfield Armory in 1956 on the eve of the adoption of the M14 Rifle. When the composite barrel ruptured during the endurance test, there were severe recriminations; the Armalite people thought that their weapon had been mistreated because they were given less than favorable treatment in the report prepared on the test. Subsequently, Stoner, with the assistance of Springfield Armory, designed a new barrel for the AR-10 made of conventional barrel steel.



Top: Early Armalite AR-10 with burst barrel. Bottom: AR-10 as manufactured by Artillerie-Inrichtingen.

At about the same time, Richard H. Boutelle, president of Fairchild, was searching for a manufacturing facility that could produce the AR-10. Ultimately, as part of a Fairchild-Fokker of Holland deal, an agreement was worked out where Artillerie-Inrichtingen, a government-owned company in Zaandam, Netherlands, would manufacture the rifle. The weapon was reworked, and the newer A-I version was tested by several countries, including the Netherlands and Austria. Delayed acquisition of tooling with which to produce the AR-10 and political considerations kept the weapon from being adopted by a major military power. Small lots of the rifle were sold to Nicaragua and the Sudan by Interarms, to the Burmese Army by Cooper-Macdonald and to the Portuguese Army by Artillerie-Inrichtingen. Due to chaotic conditions at Artillerie-Inrichtingen, production was suspended sometime in 1959–1960. Twelve hundred rifles had been delivered to the Portuguese by that time. The real significance, however, of the AR-10 is that it led to the AR-15, which after several modifications was adopted by the US Army as the 5.56mm M16/M16A1 Rifle (see section on 5.56 × 45mm rifles).

The AR-16 was another 7.62 NATO caliber rifle designed at Armalite. This weapon appeared following the separation of the company from Fairchild and the departure of the Stoner design team. Whereas the AR-10 utilized aluminum forgings for the upper and lower receivers, the AR-16 was made of sheet metal stampings after the fashion of the German *Sturmgewehr.* Development work went on from 1959 to 1961 but was suspended in favor of a scaled-down version of the AR-16 in 5.56mm. That latter rifle, the AR-18, is discussed later under the 5.56 × 45mm rifles.

A final weapon deserves mention here since it is related in design concept to the other Armalite rifles. The Stoner 62 weapons system, built at the Cadillac Gage Division of Excello Corporation in Warren, Michigan, was another Stoner product. After he left Armalite, Stoner decided that a multipurpose family of weapons could be developed around a common set of basic parts. The Stoner 62 system was an attempt to create a rifle and machine gun family in the NATO caliber. He terminated work on that system when the popularity of the 5.56mm cartridge became apparent. His 5.56 × 45mm Stoner 63 system is also discussed below.

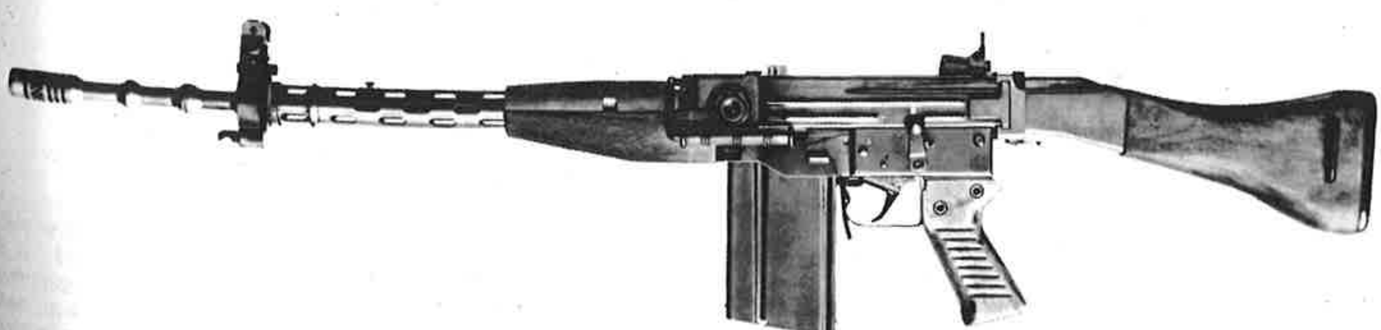
Armalite AR-16 Rifle with folding stock.

SWISS SIG RIFLES 510 AND 542

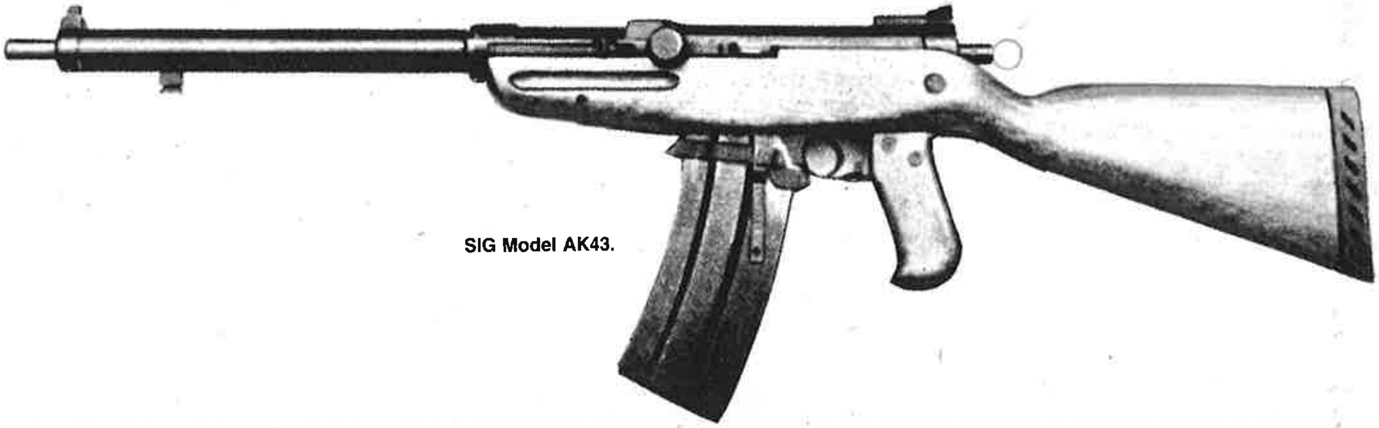
The Schweizerische Industrie-Gesellschaft at Neuhausen am Rheinfall has been one of the primary sources of sophisticated, precision, self-loading rifles. If anything, their products have tended to be of too high a quality and too expensive to manufacture until recent years. A commercial firm in competition with the government-owned Waffenfabrik, Bern, SIG has been very successful in designing weapons but less so in selling them outside Switzerland. Their sales problems have been due in part to the restrictive export policies of the Swiss Government.

SIG and the Waffenfabrik, Bern, experimented with many designs in the 1940s. The government arsenal designed rifles similar to the German FG-42 to fire intermediate size cartridges in 7.65 and 7.5mm. Shortly after World War II, SIG introduced the SK-46, a gas-operated self-loader designed for such full power cartridges as the 7.5 × 55.5mm Swiss or 7.92 × 57mm German. In this design the operating gases were tapped close to the chamber, and the gas cylinder and piston were positioned to the side of the receiver. The bolt was of the tipping variety with the locking surface located in the upper portion of the receiver. Externally it resembled the straight-pull Schmidt-Rubin Rifle.

SIG subsequently introduced the AK53, a gas-operated selective fire assault rifle. The *Automat Karabin 1953* employed an unusual action in which the barrel moved forward and the fired cartridge case was ejected at the end of the forward cycle.



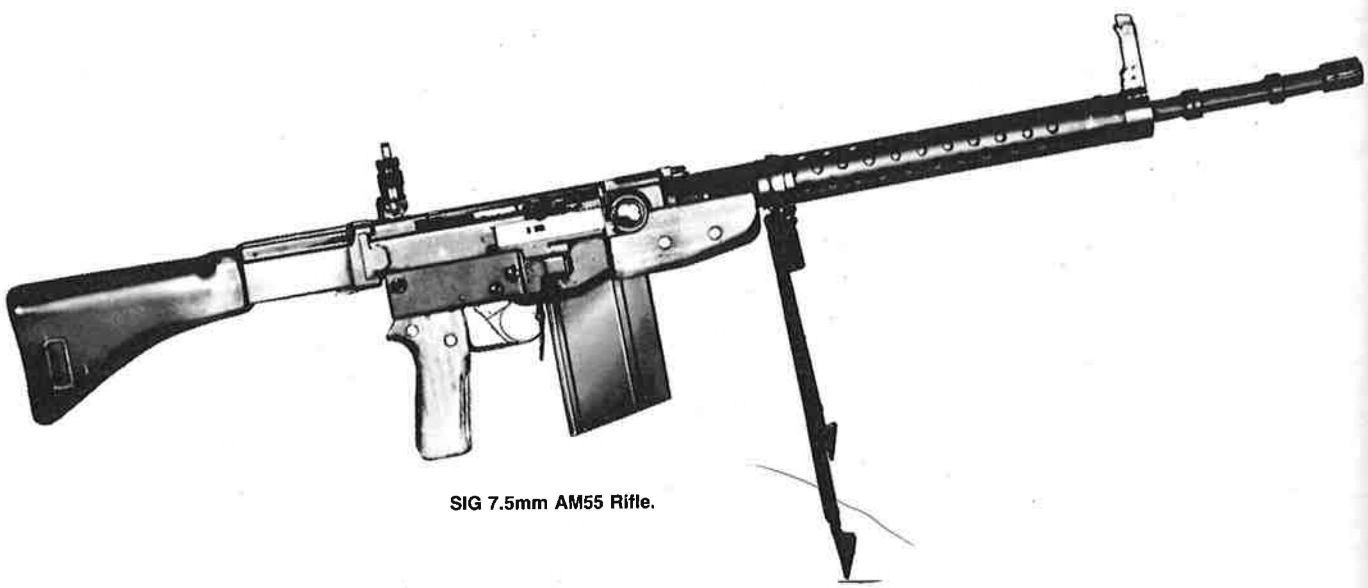
7.62mm NATO SIG Type SG510-4.



SIG Model AK43.

Prototype Waffenfabrik Bern 7.5mm Assault Rifle. Fired standard 7.5 × 55.5mm cartridge.

Prototype Waffenfabrik Bern 7.5mm Short Rifle. Fired experimental short cartridge.



SIG 7.5mm AM55 Rifle.

With this system, a low cyclic rate of about 300 shots per minute was obtained, making the weapon manageable even though it fired the standard 7.5mm Swiss cartridge. This weapon was never put into large scale production.

In the mid-1950s, SIG introduced a new rifle, the AM 55. Subsequently known as the *Sturmgewehr 57* (StG 57) in Swiss Army terminology and SIG 510 in commercial form, it is one additional permutation of the Mauser *Sturmgewehr 45* retarded roller lock breech mechanism. SIG's version was worked out by Rudolf Amsler, the company's technical director. Several 510 series rifles exist:

- 510-0 Swiss Army version in 7.5 × 55.5mm.
- 510-1 Commercial in any standard caliber.
- 510-2 Commercial lightweight.
- 510-3 Commercial in any intermediate caliber; e.g., 7.62 × 39 Soviet.
- 510-4 Commercial in 7.62 × 51 NATO. This weapon has in effect superseded the 510-1.

Although there have been alterations in stock design since 1955, the basic rifle mechanism remains essentially the same. There is no 520 series, but SIG later introduced a 530 series chambered to fire the 5.56 × 45mm cartridge. This weapon incorporated improvements in sheet metal stamping and substituted plastics for wood and metal, but the operating mechanism is still essentially the same as in the 510 Rifles.

Since the early 1970s, SIG has introduced the 540 family of rifles. The 540 and 543 are chambered for the 5.56 × 45mm cartridge; only limited production runs have been made for the 542 Rifle in 7.62 NATO. Outwardly, these rifles bear a strong resemblance to the 530 series, but internally they are quite different. Whereas the 530-1 has a roller locked bolt, the 540 Rifles have a rotating bolt, which is cammed into and out of the locked position by a cam machined into the bolt carrier. The bolt carrier arrangement is quite similar in concept to the Soviet Kalashnikov family of weapons. Unlike the AK, where the rear part of the piston assembly is machined as an integral element of the bolt carrier, on the SIG 540 Rifles the rear end of the piston fits a hole in the bolt carrier, and the operating handle holds it in place by sliding through a slot into the side of the carrier.

Following the current trend in European small arms design, these rifles have a combined flash suppressor/grenade launcher assembly attached to the barrel; they fire three-shot bursts in addition to full and semiautomatic, and they can be supplied with bipod and fixed or folding buttstock.

SIG 530-1 5.56mm Rifle with bayonet.

5.56mm SIG, Assault Rifle SG 543 short version with folding butt and 20 rounds magazine.

JAPANESE TYPE 64 RIFLE

While the Japanese Ground Self Defense Forces still use the US M1 Rifle, re-equipment is underway with the Type 64 Rifle, developed by the Howa Machinery Company, Ltd., Nagoya. This weapon, known as the R6E in prototype form, was designed to be used with a reduced charge NATO cartridge. The goal of the designers was to create a standard caliber weapon that could be fired comfortably by their smaller-in-stature troops. A lavender bullet tip coloration indicates the reduced power rifle loading. When full power NATO cartridges are used, the gas regulator can be set to a smaller orifice to prevent overpowering the weapon.

As with the U.S. M14 Rifle, the gas system can be closed off completely for launching grenades from the combination muzzle brake/grenade launcher. The Type 64 has a folding shoulder rest fitted to the top of the butt stock, and all rifles are fitted with bipods.

The 7.62mm Japanese Type 64 rifle as manufactured by Howa. This rifle was designed to fire a reduced charge version of the 7.62 × 51mm NATO cartridge.

FRENCH 7.5 × 54mm M1949/56 RIFLES

France was a major Western nation that did not adopt the 7.62 NATO cartridge. After participating in the NATO trials of the early 1950s and their subsequent withdrawal from the North Atlantic Alliance, the French decided to keep their older standard cartridge. Both their 1949/56 series of rifles and the FR-F1 Sniper Rifle fire the 7.5mm M1929 cartridge. These weapons are described in Chapter 19.

PROTOTYPE NONPRODUCTION NATO CALIBER RIFLES

Several NATO caliber rifles never got beyond the prototype stage. Among these, the 4.81-kg (10.6-lb.) Madsen Light Auto Rifle of Danish design is the most notable. Similar in operating mechanism to the Kalashnikov, it was not produced due to the success of the G3 and to the fact that the Dansk Industri Syndicat (Madsen) went out of the small arms business since it could not compete successfully with other European manufacturers.

The Luigi Franchi LF-59 Rifle is a 4.3-kg (9.5-lb.) selective fire weapon quite similar in design to the FN FAL. It has a tipping bolt like the FAL, and the magazines are interchangeable. The piston is attached to the bolt carrier, and the recoil spring is mounted in a tube that telescopes from the rear of the carrier. Steel stampings constitute the receiver, and plastics are used for the stocks of later prototypes. To make the rifle manageable during full automatic fire, the design embodies a rate reducer, producing a cyclic rate of 610-630 shots per minute. This weapon was intended to be a companion piece to the 9mm LF-57 submachine gun and .30 caliber carbine LF-58.

The Dominican Republic produced in prototype form only the Model 1962 Rifle.

Tactically speaking, none of the 7.62 × 51mm NATO caliber rifles can be called true assault rifles. All of the major weapons in this caliber tend to be too heavy and cumbersome for easy maneuvering in the field. More significant, the recoil produced by the cartridge makes weapons such as the FAL and the M14 all but uncontrollable during bursts of automatic fire. As a consequence, most M14s were issued without the selector switch

Madsen 7.62mm NATO Light Automatic Rifle.

for automatic fire, and many FALs were produced as semiautomatics only. Whereas the next American rifle, the M16, would come closer to the assault rifle ideal, the Soviets, utilizing an intermediate power cartridge, had already introduced a true assault rifle.

7.62 × 39mm M43 (SOVIET) CALIBER RIFLES

Assault rifles as a concept were not a new idea in the Soviet Union. Vladimir Gregoryevich Federov (also spelled Fyodorov) after considerable experimentation introduced his *Avtomaticheskaya Vintovka Federova, 1916g* (Federov 1916 Automatic Rifle) during World War I. He utilized the 6.5 × 50.5SR Japanese cartridge instead of the larger and more powerful rimmed 7.62 × 54R cartridge used in the 1891 Mosin Nagant Rifle, since the Japanese round was better suited for use in a rapid firing rifle. Approximately 3200 M1916 *Avtomats* were fabricated at the Sestroretsk Weapons Factory before the 1917 revolution intervened. These rifles were used toward the end of the 1914–1918 war and during the Russo-Finnish war of 1939–1940.

During the interwar years, the Soviets experimented extensively with self-loading rifles, but for some reason they returned to the 7.62 × 54R cartridge, defeating the lessons learned during World War I. Just as the Americans dropped the .276 cartridge in the 1920s to pacify the twin gods of "standard issue caliber" and "markmanship tradition," the Soviets returned to their old cartridge. Both S. G. Simonov and F. W. Tokarev produced self-loaders to fire the 7.62mm rimmed cartridge. The *Avtomaticheskaya Vintovka Simonova Obrazets 1936g* (AVS36, Automatic Rifle Simonov) recoiled badly, had poor parts durability and demonstrated feeding and extraction difficulties. In 1938, the Red Army adopted a new model of Tokarev's design, the *Samozariadnya Vintovka Tokareva Obrazets 1938g,* SVT38. Tokarev, known for his automatic pistol and his modifications to the Soviet Maxim machine guns, had evolved a rifle bolt mechanism that was quite similar to that which was later used in the FAL. Federov, Simonov and Tokarev weapons were all used during the winter war with Finland. As some of the parts of the SVT38 proved fragile, Tokarev modified his design and produced the SVT40. The most obvious differences between the two models were the use of a one-piece stock and the placement of the cleaning rod beneath the barrel. In the SVT38, a two-piece stock was used, and the cleaning rod fit a groove along the right side of the stock.

SKS45—SAMOZARIDNYA KARABINA SIMONOVA OBRAZETS 1945g

Although the Tokarev rifles were widely used throughout the 1939–1945 war, the Soviets made greater use of the submachine gun than any other country. Infantry massed with large armored units found the firepower of the PPSh41 and PPS43 submachine guns extremely effective. Out of this experience came the requirement for an *Avtomat,* an assault rifle. N. M. Elizarov and B. V. Semin developed an intermediate cartridge, the M43 7.62 × 39mm, for this purpose. Ironically, the first adopted weapon to fire this cartridge was the SKS45 self-loading carbine. Scaled down from the 14.5 × 114mm PTRS self-loading antitank rifle and the 7.62 × 54Rmm SKS41 this 10-shot Simonov weapon represented an anachronism. Despite its large-scale production, the SKS did not fit the Motorized Infantry/Armored Fighting Vehicle tactic that was evolving within the Soviet Union. First field tested in the latter days of World War II, it was adopted as a standard weapon in 1945. The SKS is a secondary weapon in most Warsaw Pact countries today.

COUNTRIES MANUFACTURING THE SKS

USSR
East Germany—*Karabiner-S*
PRC—Type 56 Carbine
North Korea—Type 63 Carbine
Yugoslavia—M59/66 Rifle

THE SOVIET 7.62mm AK ASSAULT RIFLE

A new generation of Soviet small arms emerged from the mind and later the design bureau of Mikhail Timofeyevich Kalashnikov. While on convalescent leave from the Tank Corps due to

Soviet SKS45 self-loading carbine.

serious wounds received in the battle of Brausk in the fall of 1941, Kalashnikov turned his attentions to small arms design. In 1942, he produced a submachine gun, but it could not compete with such designs as A. I. Sudayev's, which was adopted as the PPS43. Early in 1944, he began work on a turning bolt carbine firing the 7.62 × 39mm cartridge, but little came of that design either. By early 1946, Kalashnikov had completed yet another weapon. Later adopted as the *Avtomat Kalashnikova 1947g* (AK47), this weapon was a true assault rifle.

M. T. Kalashnikov 1919—; designer of the AK47, AKM, RPK, PK and SVD—the latter is a product of the design bureau he heads up at the Izhvesk Machine Factory, Urdmurt, Kazakhstan, USSR.

Even though it was in the 4.3-kg (9.5-lb.) class, unloaded, the AK47 proved to be a highly dependable, highly manageable automatic weapon. This success did not come overnight. A stamped steel receiver model built in the late 1940s and early 1950s did not prove to be durable enough. The machined steel receiver model commonly encountered is actually the third version manufactured by the Soviets. The second model can be distinguished by the angular metal fitting into which the butt stock was mounted. That attachment was in turn pinned to the rear of the receiver. Versions one and two were still in the Soviet inventory in 1952. In addition to the Soviet Union, the People's Republic of China, East Germany, Poland, Bulgaria, Romania, North Korea, Hungary and Yugoslavia have manufactured the AK47. Finland has produced the weapon in modified form, the M60 and M62, while the Israeli Galil 5.56mm Rifle is a derivative design. The initial production PRC Type 56 (with Chinese markings on the selector) is identical to the third Soviet version, but late production Type 56s have permanently attached folding spike bayonets. The PRC Type 56-1 assault rifle is similar to the Soviet folding stock model, but it has prominent rivets in the arms of the stock.

Poland has produced a special grenade launching version, the PMK-DGN-60, to which is attached the 20mm diameter LON-1 grenade launcher. This variant has a gas cutoff valve added to the gas cylinder, a special grenade sight that fastens to the standard rear sight, a recoil absorbing butt pad, a latch added to the recoil spring and a special 10-shot magazine, which will take only the grenade blanks.

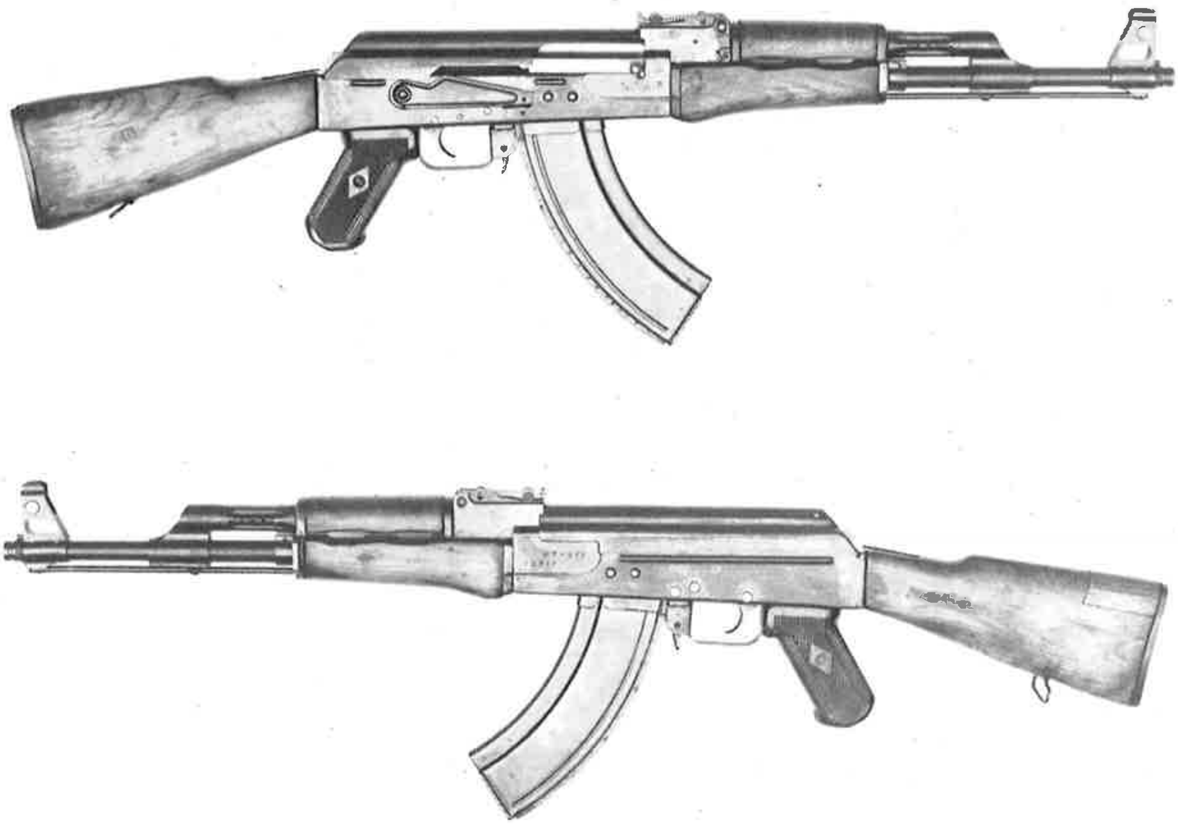
Yugoslavia has produced three variations of the AK47—M64 with a longer 508-mm (20-in) barrel and fixed wooden stock; M64A (later redesignated the M70) with a standard 414-mm (16.3-in) barrel and fixed wooden stock; and the M64B (M70A) with standard barrel and folding stock. All models are fitted with a folding grenade launching sight, a muzzle compensator and (unique among AK47s) a bolt hold-open device that catches the bolt in the recoil position after the last cartridge in the magazine has been fired. Finland's M60/M62 series has a special flash suppressor/bayonet mount, front sight mounted on the gas cylinder, aperture, plastic forearm and tubular fixed butt stock. East German AK47s do not have cleaning rods under the barrel or a recess in the butt for cleaning tools. Except for these specific differences and the selector markings, all Eurasian AK47s are similar. Operational and field stripping details are presented in Chapter 43.

Introduction of the modernized Kalashnikov assault rifle (*Modernizirovannyi Automat Kalashnikova,* AKM) in 1959 reflected a shift from the forged and machined receiver to an improved stamped sheet metal construction. The weight of the AKM, 3.15 kg (6.9 lbs.), is about two-thirds that of the AK47. Otherwise, the AK47 and the AKM are mechanically identical, except that the AKM has a cyclic rate reducer in its trigger mechanism, which slightly slows down the automatic firing cycle from the 600 shots per minute of the AK47. Recognition features of the AKM are the sheet metal receiver with a small magazine guide dimple pressed into each side, the grasping rails on the forestock, the ribbed receiver cover, the bayonet lug and the absence of vent holes in the gas tube. AKMs have been produced by the USSR, East Germany, Poland, Hungary, Romania and North Korea. The North Korean weapon does not have a rate reducer. Some late model AKMs are fitted with muzzle compensators. The Kalashnikov series has probably been produced in larger numbers than any other modern small arm; total production has been estimated to be between 30 and 50 million.

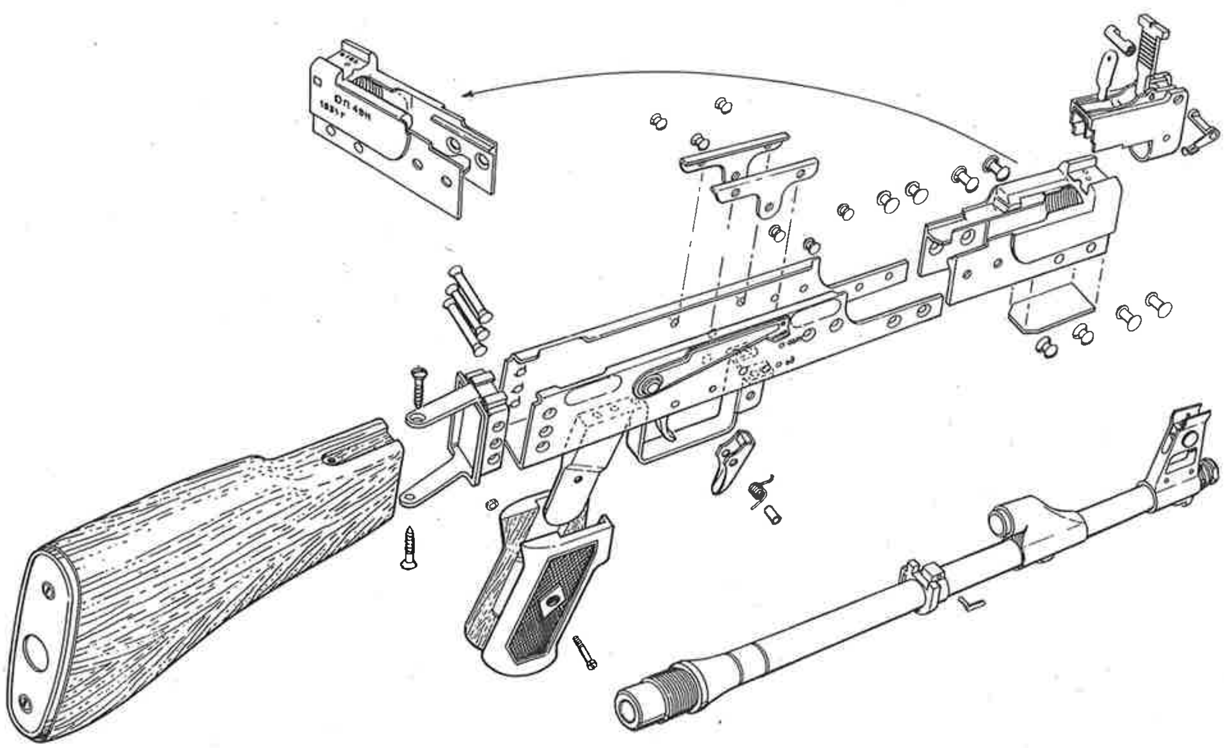
COUNTRIES USING THE SKS AND AK FAMILY BUT NOT MANUFACTURING THEM DOMESTICALLY

Afghanistan	SKS & AK
Albania	SKS & AK
Chile	AK only
Congo, People's Republic	SKS & AK
Cuba	AK only
Indonesia	SKS & AK
Iraq	SKS & AK
Laos	SKS & AK
Lebanon (para-military forces)	SKS & AK
Mongolia	SKS & AK
Morocco	SKS & AK
Pakistan	AK (PRC) only
Syria	AK only
United Arab Republic (Egypt)	SKS & AK
Vietnam, Socialist Republic of	SKS & AK
Yemen, People's Democratic Republic	SKS & AK

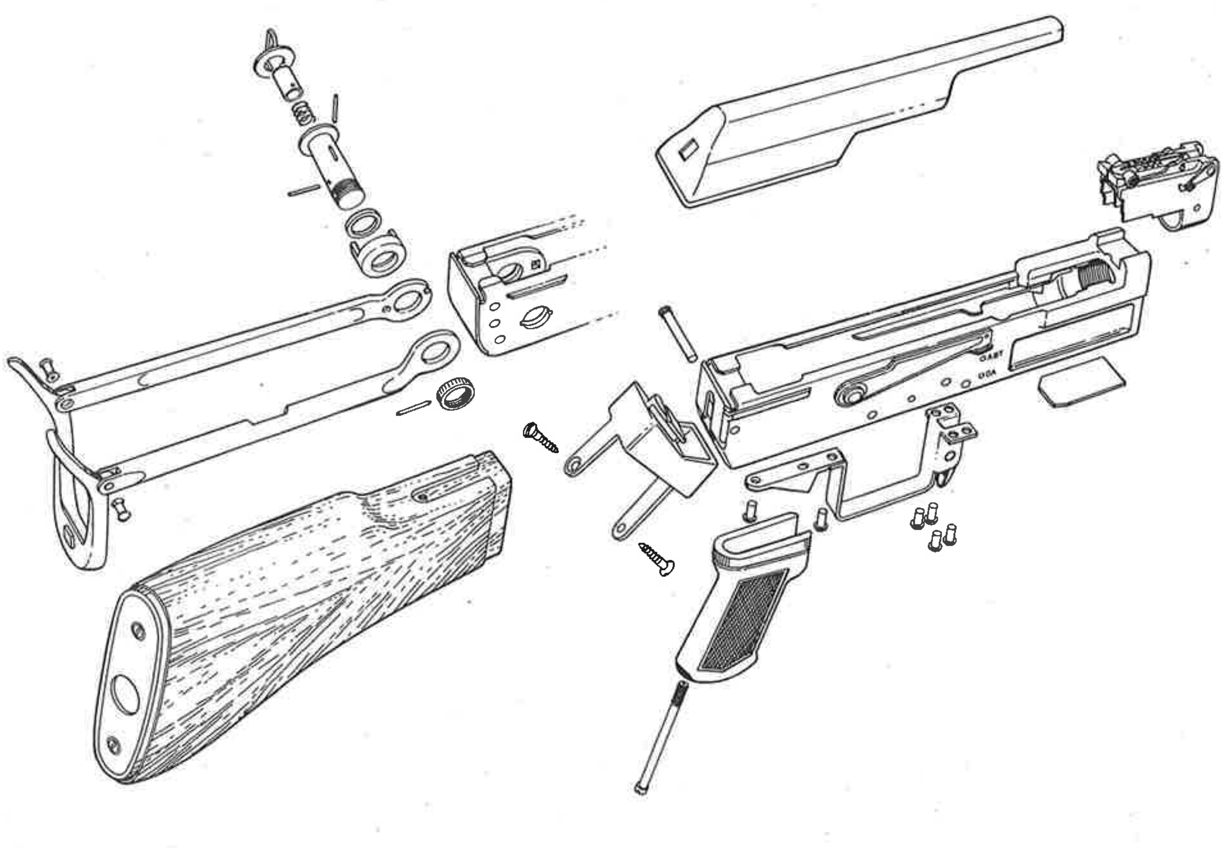
Accompanying photos and illustrations in chapters on countries producing the various Kalashnikov models give a better understanding of model variations.



First model Kalashnikov with stamped steel receiver.

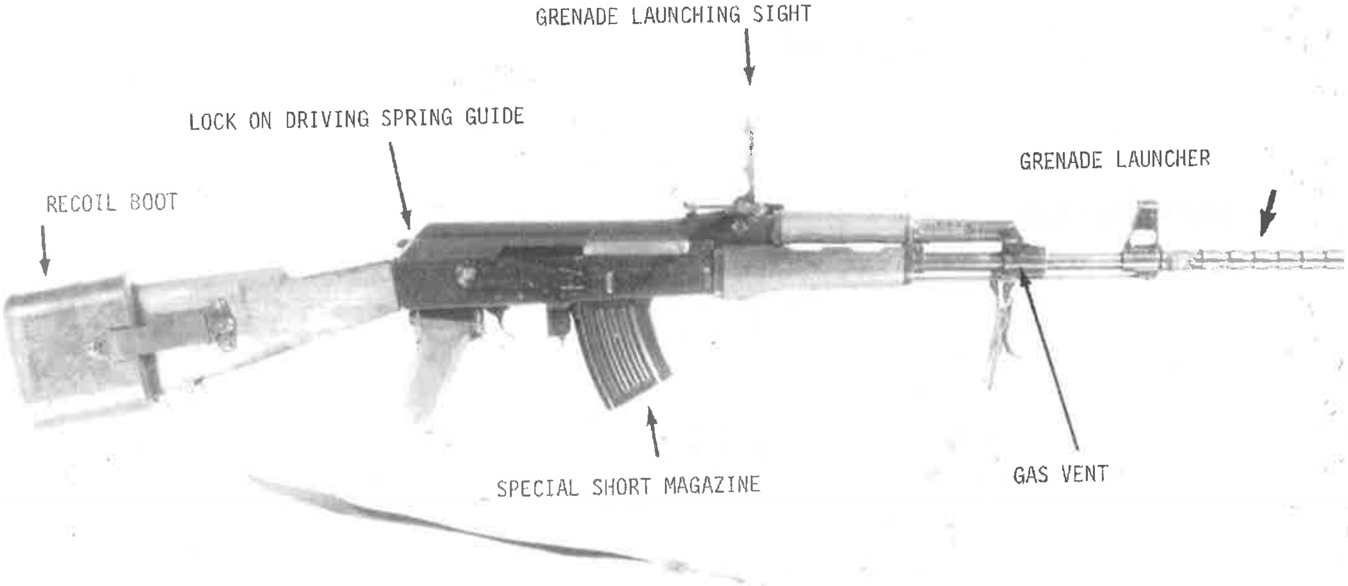


Second model Kalashnikov, which was first to have machined receiver.



Second (bottom) and third (top) versions of the AK47. Note differences indicated by numbers in the photograph.

Folding stock version of the AKM, called the AKMS by the Soviets. This rifle was manufactured in 1972.



Polish PMK-DGN60 grenade-launching rifle.

Yugoslav 7.62 × 39mm M70AB with an AKM pressed sheet metal receiver.

Finnish copy of the AKM manufactured by Valmet Oy Defense Equipment Group. Note that this M62-76 rifle has a side folding stock.

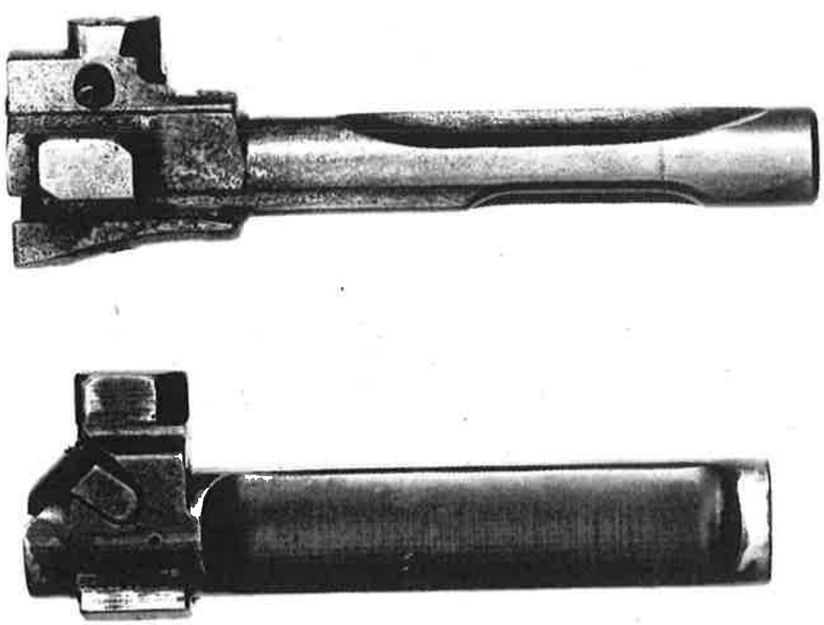
Soviet AKM.

East German MPiKM assault rifle.

Romanian AKM.

Upper or Full Auto Symbol	Lower or Semi Auto Symbol	Producer	Native Name or Remarks
AB	ОД	Soviet	AK-47, AKM and AKMS
AB	ЕД	Bulgaria	AK-47 and AKM
C	P	Poland	PMK, PMK-DGN, KbK AK
D	E	E. Germany	MPK, MPiKmS - Rifles do not have cleaning rods MPiKM and MPiKMS have cleaning rods
FA	FF	Romania	Has "S" at top for safe position
连	单	Communist China	Early Production
L	D	Communist China	Type 56 and 56-1 Assault Rifle (Late Production)
∞	1	Hungary	
...	.	Finland	RYNNAKOKIVAARI - applies to M60 and M62
련	단	North Korea	Types 58 and 68 Assault Rifle
R	J	Yugoslavia	M64 series - has U at top for safe position
30	1	Czechoslovakia	M58 Assault Rifle

Kalashnikov assault rifle selector markings.



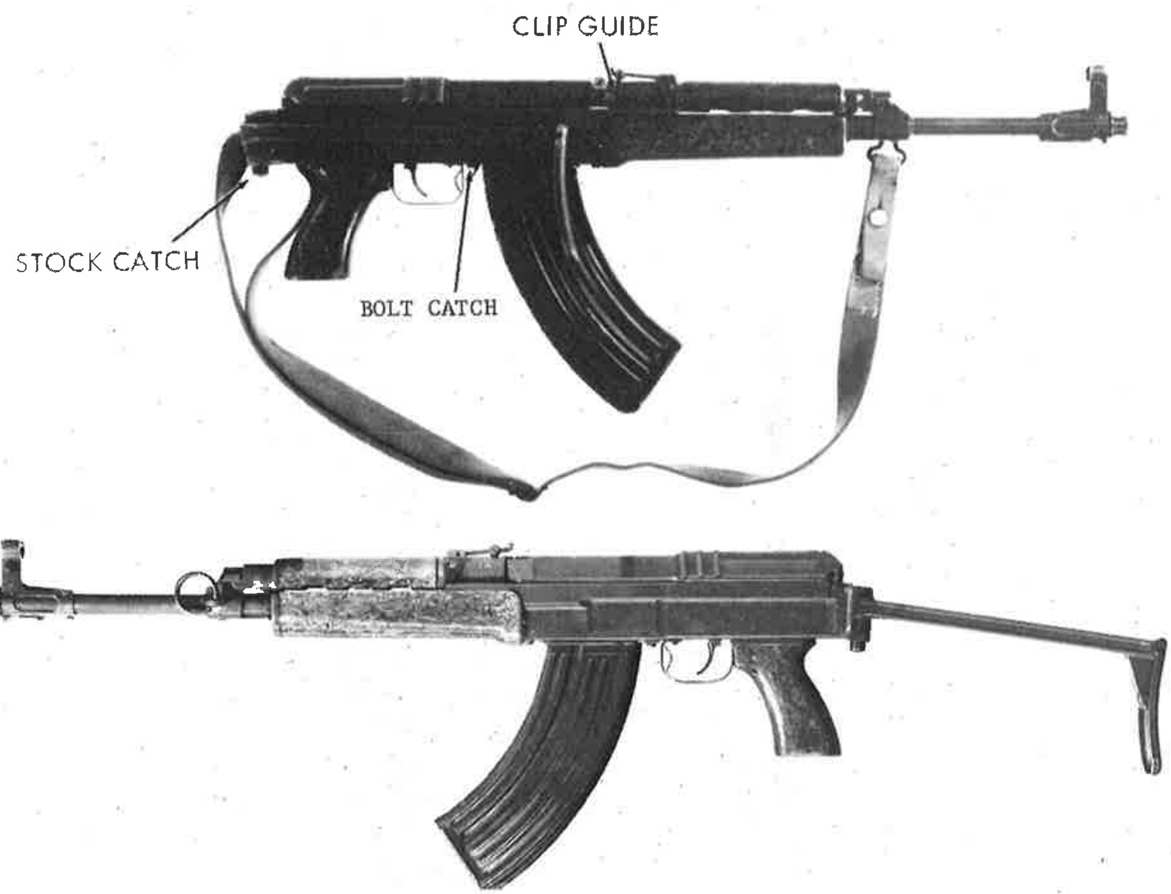
The picture illustrates the AK bolt and the U.S. M1 Carbine bolt, for size comparison.

CZECHOSLOVAK RIFLES

Czechoslovakia has always been a fertile source of small arms. After World War II, the Czech military adopted the Vzor (Model) 52 self-loading carbine chambered for their own 7.62 × 45mm cartridge. Beginning in 1957, many of these carbines were altered to fire the 7.62 × 39mm cartridge, VZ52/57 (M52/57). While obsolete in Czechoslovakia, the M52 and M52/57 carbines have been shipped and sold to third world nations. These weapons are unusual in that they employ a unique concentric gas cylinder, which surrounds the barrel, and the gas operating mechanism is composed of a bearing mounted on the barrel, a gas port in the barrel, a sliding gas cylinder sleeve positioned over the bearing, a connecting semicylinder and an actuator. Upon firing the cartridge, gases force the gas cylinder sleeve, connector and actuator to the rear, an action which in turn forces the bolt and bolt carrier to the rear. In concept, this gas system is similar to the German *MKb42(W) Sturgewehr.* The major complaint with this weapon has been its weight, 4.5 kg (9.8 lbs.), and its somewhat fragile side folding bayonet.

Czech Model 52 Rifle.

Subsequently, the Czechoslovakian Army adopted the VZ58 (M58) assault rifle, which was also a domestic design. This weapon exists in two forms—the M58P with conventional fixed stock and the M58V with folding metal stock. Early production weapons had wooden forearms, pistol grips and, in the case of the M58P, butt stocks. These components are made of a wood fiber/plastic composition material in more recently fabricated weapons. While some of these rifles have been sold abroad, the Czechs are the major user of this design.



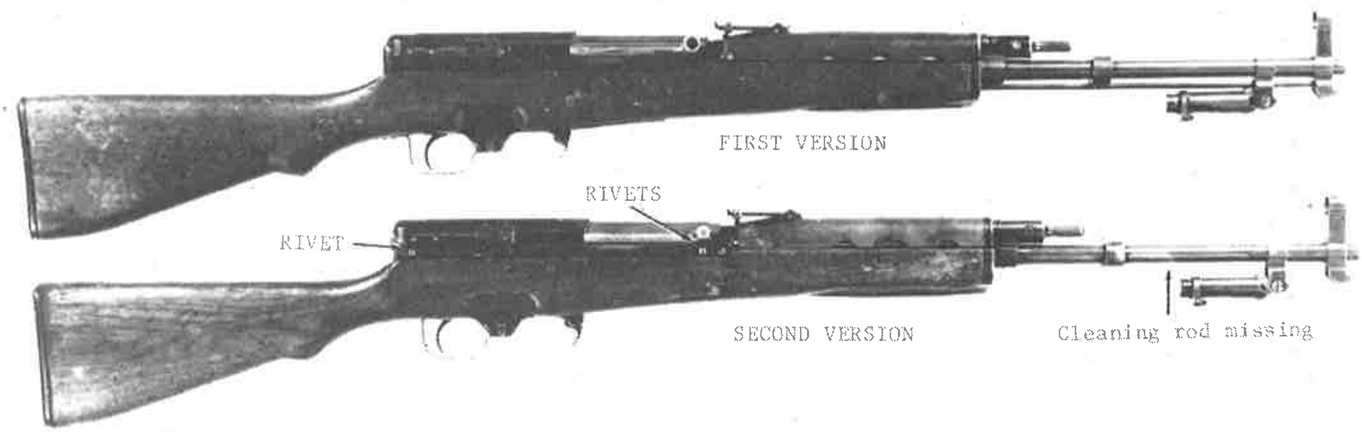
Folding stock version of Model 58.

CHINESE TYPE 68 RIFLE

The Type 68 Rifle, adopted by the People's Republic of China, is yet another basic pattern selective fire weapon adopted in the M43 7.62 × 39mm caliber. This small arm represents a divergence from the assault rifle tactical concept as it has emerged among the Warsaw Pact countries. Evidentally, the People's Liberation Army tacticians decided that its army would not be engaging in the massive armored infantry types of conflicts envisaged for potential European conflicts. Therefore, they adopted a selective fire rifle, the barrel being the same length as the SKS, with a 15-shot magazine, five shots more than the SKS but half the capacity of the AK family. Two versions of the rifle exist. The earlier model has a receiver machined from a steel forging, while the later model has a stamped steel receiver, identifiable by the large rivets at each side of the receiver. There are other minor differences apparent when the weapons are compared.

In the Type 68, the bolt and bolt carrier have evolved from the Kalashnikov design. A major difference lies in the separation of the gas piston and the bolt carrier. The piston rod acts as a tappet against the face of the bolt carrier in a fashion reminiscent of the SKS and SVT 38/40 designs. Unlike the SKS or the AK, the Type 68 has a two-piston gas regulator. A permanently attached spike bayonet similar to the Type 56 carbine and Type 56 assault rifle and an under-the-barrel cleaning rod are standard fixtures. As issued, the Type 68 Rifle has a bolt stop to hold the bolt open after the last shot has been fired. Unless the stop is altered, only the 15-shot magazine will fit; if the stop is ground down, the rifle will also accept the 30-round AK-type magazines.

In 1980, there was word of yet another Chinese 7.62 × 39mm rifle. This weapon, for which a type designation is not known,



First and second models of the PRC Type 68 selective fire rifles.

Tang Wenlie is credited by Chinese sources with improving the Type 68/73 rifle.

The improved PRC rifle developed by Tang Wenlie, a member of the People's Liberation Army.

was reportedly 0.6 kilograms (1.3 pounds) lighter than the Type 73 Rifle (second model Type 68). Designed by Tang Wenlie, this new rifle is reported to have fewer moving parts than its predecessors and to be more accurate.

MISCELLANEOUS M43 7.62 × 39mm CALIBER RIFLES

In the past two decades several 7.62 × 39 rifles have been produced in limited quantities to appeal to those nations that might have received small arms from the Soviet Bloc. These include the RH-4, made in prototype by Rheinmettal Wehrtechnik of Dusseldorf, West Germany, the HK32 by Heckler & Koch and the SIG 510-3. Only the Egyptians attempted a design for domestic consumption. That rifle, the Rashid, was made in very limited numbers and was a rework of the Ljungman Model 42 Rifle, which has been produced in Egypt (United Arab Republic) as the 7.92 × 57mm Hakim Rifle.

Members of the People's Liberation Army on night maneuvers. The soldier in front carries the Type 56 version of the AK47. Behind him is a PLA-man with a Type 56 light machine gun (RPD)

5.56 × 45mm NATO CALIBER RIFLES

The United States Army Continental Army Command made an important departure from traditional small arms development in 1957 when it sought commercial assistance in the development of a 5.56mm (.223 in.) military rifle—due to dissatisfaction among many senior military officers with the M14 Rifle and the 7.62 × 51mm cartridge. An adequate understanding of the 5.56mm rifle story is impossible without a brief look at three small arms projects—SALVO, SPIW and SAWS. SALVO studies conducted by the Operations Research Office (ORO) at Johns Hopkins University and supported by several contractors gave the impetus for the development of the M16 Rifle. Failure of the radical SPIW (Special Purpose Individual Weapon) concept assured the M16 a permanent place in the US Army's arsenal, and the Small Arms Weapons Study (SAWS), 1966–1967, judged the M16 to be the best small caliber rifle available.

ORO had been created by the US Army in 1948 to analytically study a number of problems associated with ground weapons in the nuclear era. One of ORO's early projects was ALCLAD, a search for better infantry body armor. As that study progressed, ORO and Army specialists discovered just how little was known about how individuals were wounded in combat. ORO looked into several questions regarding the manner in which soldiers were struck by rifle projectiles and shell fragments. Among them were the frequency and distribution of such hits, the types of wounds incurred in combat and the average ranges at which wounds were inflicted. Answers to these questions were obtained by evaluating over three million casualty reports for World Wars I and II, as well as data from the Korean conflict. ORO's investigations revealed that in the overall picture aimed rifle fire did not seem to have any more important role in creating casualties than randomly fired shots. Marksmanship was not as important as volume. For Army officers raised on a traditional diet of carefully aimed rifle fire, this conclusion was heretical, but analysis proved it valid.

ORO's second important conclusion was equally disturbing to the traditionalists. Whereas effective rifle fire had been occasionally delivered at 1200 meters during the 1914–1918 war in the trenches, World War II and Korean war experience indicated that the rifle was seldom effectively employed beyond 300 meters. Even when expert riflemen tried to use their weapons at greater ranges, they discovered that terrain features usually prevented accurate long distance firing. Finally, statistical data indicated that most rifle kills were made at less than 100 meters. These revelations called for some new thinking in rifle design. One fruitful approach appeared to be the development of a light recoil weapon firing a salvo of small caliber projectiles with a controlled dispersion pattern. While Project SALVO was taking form, US ordnance officers were telling their British counterparts that the UK .280 cartridge was too small, but SALVO was considering projectiles as small as 4.2mm (.17 in.).

After following the SALVO work for several years, the Continental Army Command (CONARC) decided to sponsor the development of a .22 caliber military rifle. CONARC commanding officer William G. Wyman asked Winchester and Armalite to

US lightweight rifles, 1957: Top, Winchester .224 Lightweight Military Rifle. Middle, Armalite .223 AR-15. Bottom, Springfield Armory .22 , Rifle.

develop a high velocity 5.56mm rifle. From the outset, the Armalite AR-15 was more popular than the Winchester design. Even Ralph Clarkson, the designer of the Winchester .224 Lightweight Military Rifle (patterned after the M1 Rifle and M1 Carbine), had to admit that the AR-15 had unmistakable "sex appeal." A Springfield Armory contender designed by A. J. Lizza did not get very far either. In fact, ordnance personnel opposed to the small caliber concept forbade the Armory, an Ordnance Corps facility, to participate in CONARC's heretical program.

CONARC specifications for a 5.56mm rifle called for full and semiautomatic fire, a 20-shot magazine, a loaded weight of 2.7 kg (6 lbs.) and penetration of both sides of a standard Army helmet at 500 meters. If possible, the engineers were to keep the trajectory flatter than that of the 7.62mm NATO cartridge. The desire to use the rifle at ranges up to 500 meters indicated a compromise between the SALVO studies and conventional rifle thinking current in the US Army.

M16 RIFLE

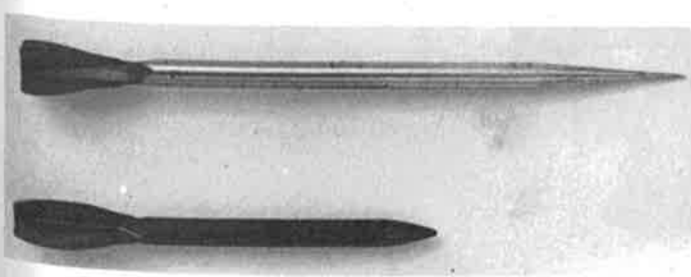
Stoner's AR-15 was designed around a slightly enlarged version of the Remington .222 cartridge case. That alteration permitted him to propel a 3.6-gram (55-grain) bullet at 1005 m.p.s. (3300 f.p.s.). The weapon itself was an eclectic design. As other designers before him, Stoner chose the best from earlier designs. For the locking system, he chose a design quite similar in concept to that of the Johnson Semiautomatic Rifle of the 1940s. He also used an "in-line" stock to aide manageability during automatic fire. That stock arrangement permitted him to place the recoil buffer in a tube that ran the length of the stock. A tube type gas system was employed to convey the gas from a port under the front sight, along the top of the barrel and into a space in the bolt carrier assembly.

There were a number of other features reminiscent of earlier weapons, such as the hinged upper and lower receiver mechanism, similar to the FN FAL; the rear sight in the carrying handle, *a la* the British E.M.2; and the ejection port dust cover, which followed the pattern established in the MP44 *Sturmgewehr.* Stoner's achievement in the AR-15 was the combination of all these ideas into an attractive, lethal package that weighed only 3 kg (6.7 lbs.).

In December 1959, Colt Firearms acquired the manufacturing and marketing rights to the AR-15 from Armalite. But selling the rifle proved to be a tough task. Although many people liked the weapon, the Army Ordnance staff was opposed to it. But in 1962, in an end run around the Army, Colt was able to get the Department of Defense's Advanced Research Project Agency (ARPA) to test 1,000 weapons in its Vietnam-oriented Project Agile. ARPA's enthusiastic report led to additional studies by the Department of Defense and the Department of the Army. Despite strong Army opposition, Defense Secretary McNamara ordered 85,000 M16 Rifles for Vietnam and 19,000 for the Air Force. From this beginning, the AR-15 became the M16, and ultimately the M16A1.

Resistance to the adoption of the AR-15/M16 led to serious problems in 1967. Congressional and Department of Defense investigations disclosed that the weapon had been issued without proper operational and maintenance training to some troops and that totally inadequate supplies of cleaning equipment had been provided to the men in the field. Combined with an ammunition/rifle mismatch and the highly corrosive nature of the humid jungle regions of Southeast Asia, this lack of training and cleaning materials led to serious problems. But after training programs were established, cleaning supplies made available and modifications made to the rifle, the M16 performed reliably. Major changes to the rifle included a new buffer mechanism to slow the rate of fire, which was greater with ball type propellants than with the IMR propellants for which the weapon had been designed. A chrome plated chamber—later followed by a chrome plated barrel—solved the rusty chamber problem, which had in turn caused failures to extract. Today (1983) the M16/M16A1 Rifle has become the basic rifle for the United States Army. It was also produced by General Motors and Harrington & Richardson during the Vietnam era; Colt continues to manufacture the rifle for the Army. In addition, with US State Department approval, Singapore, the Philippines and South Korea also produce the weapon under license from Colt.

M16A1 with 30-shot magazine and old style buttstock.



Flechettes: Top, typical rifle version. Bottom, shotgun type.

By the end of 1976, Colt had produced some 3,440,106 M16 Rifles. Harrington & Richardson and General Motors had produced 250,000 each. Total AR15 production through 1976 was 68,211. Of the Colt production, 3,135,227 M16s had gone to the US government and 304,879 had been sold overseas.

SPIW AND SAWS

Before turning to the European 5.56 × 45mm rifles, some mention needs to be made of two other US Army projects—SPIW and SAWS. The former was an attempt to "leapfrog" ahead in small arms development. The latter was a full scale field evaluation of existing small arms.

The Special Purpose Individual Weapon (SPIW) grew out of experimentation by the US Ordnance Corps and Aircraft Armaments Inc. (AAI) with high velocity steel darts called flechettes. Irwin R. Barr pioneered work on flechettes at AAI and proposed a whole range of such projectiles in a February 1951 report. In 1952, AAI produced a 12 gage shotgun shell loaded with flechettes for the Office of Naval Research. A later version was tested by the Army as part of the Project SALVO tests. Large dispersion patterns and limited range led Barr and his AAI colleagues to turn to single flechettes supported by sabots, fired sequentially from a rifle type weapon. After nearly a decade of energetic promotion of the flechette concept by AAI, the US Army decided in March 1962 to develop a Special Purpose Individual Weapon that would combine the flechette projectile with the 40mm grenade cartridge, which emerged from another project called NIBLICK. (See Chapter 45 for more on grenade launcher development.)

In February 1963, contracts for SPIW type weapons were let to AAI, Harrington & Richardson, the Winchester Division of Olin and Springfield Armory with delivery of the prototypes due in February of the next year. This incredibly short development time proved impractical, and although firing models were delivered and tested in 1964, SPIW became a long, drawn out project. After the first rounds of testing, the Harrington & Richardson and Winchester SPIWs were eliminated. Later, the Springfield weapon was dropped following the Armory's closing. Work continued on the AAI model, redesignated the XM19. In 1973, the Army announced that the XM19 could not be made to meet military requirements. A modified and simplified XM19 was tested as the XM70, but for practical purposes the single flechette concept is moribund in the US. No one disputes the lethal nature of these little steel arrows (Witness the multiple flechette artillery projectiles used with devastating effect in Vietnam.), but the SPIW concept died due to complex technical, economic and political problems.

Top to bottom: HK33, HK33K (*kurz*) and HK 53.

In 1964, General Harold K. Johnson, Army Chief of Staff, instituted a comprehensive program to review the major small arms being used and under development. This Small Arms Weapons Systems (SAWS) study was to determine which weapons were most suited for the Army's tactical missions during the years 1967–1980. After more than 18 months of investigation and the preparation of several dozen reports, the SAWS study was completed, and the Chief of Staff's office reviewed the SAWS recommendations, the requirements of the Vietnam war and the state of SPIW development. The Secretary of the Army submitted the Chief of Staff's report to the Secretary of Defense on 17 December 1966. The major suggestions were as follows. First, rifle procurement in the "forseeable" future should be limited to the M16 Rifle. Second, steps should be taken to permit "early replacement" of the M1s and BARs in the Army's inventory. Third, planning over the long term should be based upon the replacement of the M14 with the M16. Fourth, an additional production source for the M16 should be provided in the 1968 budget. And finally, "an active and broadened research and development program should be conducted to bring about further major improvements in the Army's small arms."

In his cover memorandum, the Secretary of the Army made several significant comments about the Chief of Staff's recommendations. He concluded that M16 type weapons were "generally superior for Army combat use." Second, "The current SPIW program is unlikely to result in a satisfactory competitive weapon as early as previously forecast." The Secretary's memo also suggested that some changes might be necessary in the M16, especially the propellant used in the .223 cartridge. These thoughts were passed on to the Secretary of Defense with a request for approval. After considerably more internal debate, Secretary McNamara decided that the Army would use the M16 as its primary rifle but that the M14 would also continue to be considered a standard weapon.

HK33

Heckler and Koch began work on the delayed roller-locked HK33 Rifle in 1963. After a series of modifications, this scaled-down version of the G3 was put into modest production in 1968. Major purchasers of the HK33 include the Brazilian Air Force (15,000), the Malaysian Army (5,000) and the Thai Army. In addition, the Malaysians have assembled 30,000 domestically, and the Thais are manufacturing the rifle at a factory set up for them by Heckler and Koch. There is also a short-barrelled version of this weapon called the HK53, which is designed for use as a submachine gun.

In addition to the M16 and HK33, several other 5.56 weapons have been developed and manufactured in various quantities.

STONER 63 SYSTEM

Gene Stoner, after he left Colt where he had worked as a consultant, joined forces with Cadillac Gage Corporation of suburban Detroit to develop a family of small arms built around a number of common assemblies and parts. Once again, he was assisted by Robert Fremont and James Sullivan. As noted above, Stoner built his 62 system around the 7.62mm NATO cartridge;

XM22E1 Rifle (Stoner 63) Field stripped.

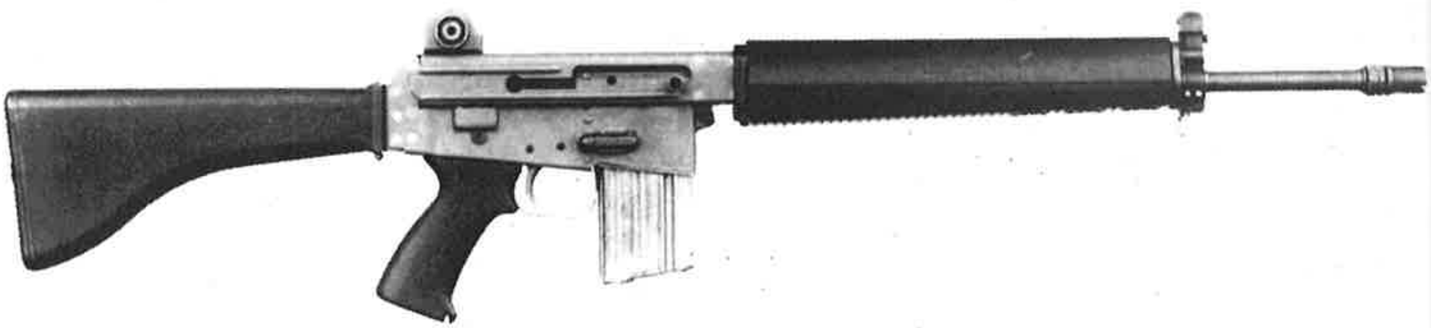
in the 63 system he turned to the 5.56 × 45mm cartridge. Fully matured, the system consisted of six weapons—a rifle, a carbine, two light machine guns (magazine or belt feed), a medium machine gun and a fixed (tank) machine gun. To adequately power the machine guns in the system and to assure reliable belt feed, Stoner used a long stroke piston system instead of the gas tube arrangement utilized in the M16. The rifle (called the XM22 by the US Army) and the carbine (XM23) fired from a closed bolt, with selective fire. The magazines were mounted below the receiver. The machine guns (The belt fed version was tested by the Army as the XM207 and by the Navy as the MK23.) all fired from an open bolt. (See Chapter 2 for more details.) During the mid-1960s, the Stoner 63 system was tested several times by the US military, after which numerous improvements were made based upon their experiments. Only the MK23 was used to any extent in combat, by Navy SEAL teams.

Although Cadillac Gage granted a manufacturing license to Mauser-IWK who later transferred their rights to NWM of the Netherlands, the Stoner system never became popular. In the US, the M16 was too deeply entrenched for the Stoner to make much headway, and in Europe there were several competing designs. The Stoner 63 system was a good concept, but the timing—an important factor—was not auspicious. It was, therefore, never successfully marketed.

ARMALITE AR-18

A scaled-down version of the AR-16, the AR-18, never met military requirements successfully. Throughout its testing history, it had a bad record for parts breakage and feeding difficulties. Since Armalite never developed their own production capabilities, they gave a production license to Howa Machinery Company of Japan in 1967. Military sales to the US military were frustrated by American-Japanese treaty agreements that prohibited Japan from selling military equipment to belligerent nations. The Japanese decided that under this arrangement the rifles could not be sold to the US because this country was engaged in the Vietnam conflict.

In 1974, Armalite and Sterling Ltd. of England concluded a production agreement whereby the AR-18 and the commercial semiautomatic version (AR-180) would be manufactured in the UK. Production began in 1975.



Early Armalite AR-18 Rifle.

STERLING LIGHT AUTOMATIC RIFLE

Before starting production of the AR-18, Sterling's chief designer, Frank Waters, designed a rotating bolt, gas operated rifle to fire the 5.56mm cartridge. Building on the work with this rifle and the AR-18, Sterling engineers evolved a rifle, the SAR 80, which the Singapore government has developed more fully.

BERETTA AR70/.223.

Beretta and SIG began a study of 5.56mm rifles in 1963. After a number of years, the two companies terminated their joint development effort. In 1968, Vittorio Valle at Beretta began work anew, and the Italian firm introduced the AR70/.223 in 1970. At one point in the early 1970s, Beretta negotiated with Colt to produce the M16 in Italy. When these discussions proved fruitless, they began to market the AR70/.223 more aggressively. In this weapon, the designers decided in favor of a conventional gas piston and recoil spring system located above the barrel. After looking at existing locking systems, they adapted the twin lug used in the M1 Carbine and Kalashnikov weapons. Following the pattern of the Soviet AKM rifles, Beretta engineers welded a sleeve into the forward portion of the stamped steel receiver. That sleeve contained locking recesses for the lugs on the bolt.

The only major sale of the Beretta rifle has been to Malaysia (5,000 in 1972; Malaysia also purchased the same number of M16s and HK33s). It would appear that Beretta has abandoned the effort to produce and sell this weapon.

SIG 530 AND 540 RIFLES

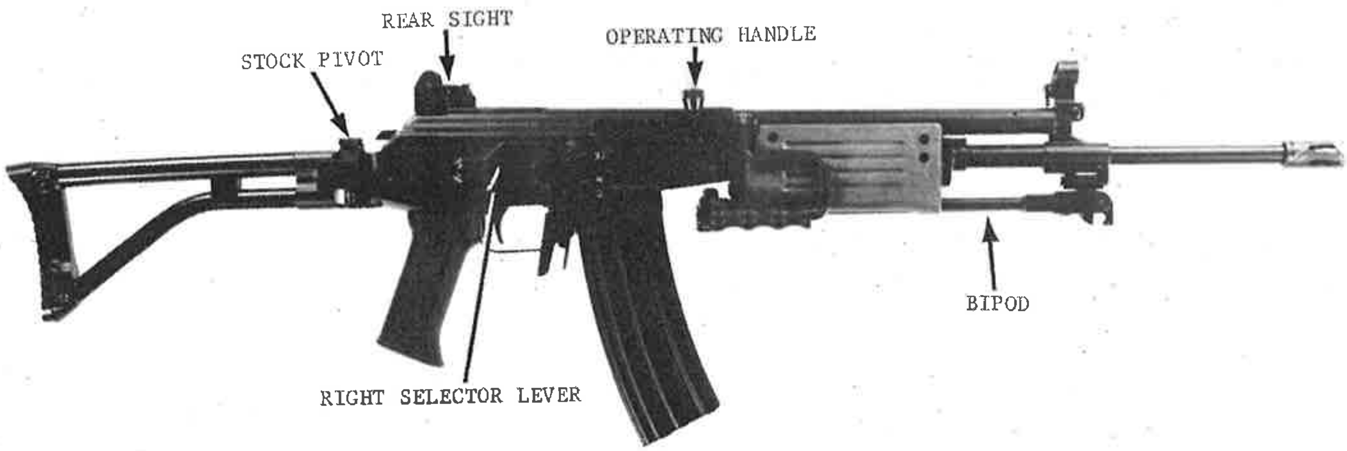
As an outgrowth of their joint effort with Beretta in the early 1960s, SIG introduced the 530 series. Unlike their Italian counterparts, the Swiss used a roller lock mechanism evolved from the 510 series. In the 5.56mm rifle, the rollers are actually a locking system instead of a delay system as in the 510 series and the Heckler and Koch weapons. Only limited numbers have been fabricated with few sales.

The latest SIG series, the 540 and 543, represent a departure from the roller lock breech mechanism and a turn to the rotating bolt mechanism. While strikingly similar to the Beretta AR70/.223, the breech mechanism of the 540 series is actually closer to the Kalashnikov family. (See discussion above.)

Beretta AR70/.223.

SIG 530-1.

FN CAL.



Israeli Galil.

The French firm Manurhin, SA is currently manufacturing the SIG 540, 542, and 543 rifles. This arrangement allows SIG to sell their design outside of Switzerland. Swiss export laws regarding military small arms are very stringent. To date at least sixteen countries have purchased rifles in this series.

FN CAL

Fabrique Nationale introduced the *Carbine Automatique Leger* in 1966. While this rifle looks like a smaller version of the FAL, it uses a different bolt than its predecessor. (For more details, see Chapter 9.) Made in very limited quantities, the CAL design embodied a three-shot burst feature in addition to automatic and single fire. FN has terminated active attempts to sell the CAL and are concentrating instead on their newer FNC.

GALIL ASSAULT RIFLE

During the past decade, the FN FAL produced by Israeli Military Industries (IMI) has been the basic rifle in the Israel Defense Force's (IDF's) inventory. The performance of the FAL did not satisfy Israeli military officers during the Six-Day War of 1967, due to malfunctions caused by desert sands and the "bang, bang, jam" malfunction of the heavy barrelled automatic version. Following the war, the IDF tested the M16, the Stoner 63, the HK33 and a native rifle designed by Lt. Col. Uziel Gal, the designer of the UZI submachine gun. All these weapons fired the US 5.56 × 45mm cartridge.

The standard weapon against which the 5.56mm weapons were judged was the AK47. That weapon had performed almost flawlessly in the hands of Israel's adversaries, and it was that performance that the IDF wished to equal or surpass. Tests that ensued were among the most stringent ever conducted for small arms. Indeed, in the effort to simulate the rigors of desert warfare, the battle-hardened Golani Brigade did everything they could to destroy the weapons given them. In nearly every case, they succeeded. IDF authorities decided that the best weapon for their purposes was the AK47.

Israeli Galili (Blashnikov before he changed his name) worked up a 5.56mm version of the Kalashnikov rifle, using a barrel, bolt face parts and magazines from the Stoner system. The resulting weapon showed excellent promise. Meanwhile, IMI

AC-556K version of the Ruger Mini-14.

MAS 5.56mm Rifle.

personnel learned from an executive officer of Interarms in the US that Valmet in Finland was producing a copy of the AK47 called the M62. After modifying samples of the M62 purchased from Interarms, IMI, at the direction of Yaacov Lior, head of the small arms branch, purchased unmarked Valmet M62 receivers and mated them to barrel blanks procured from Colt. A modified Stoner magazine was also developed. IMI has produced a hybrid weapon of promise. A folding stock version borrowed the butt assembly from the FAL. The extent of Israeli production of this rifle is unknown, but IMI has offered it for overseas sales. Guatemala has purchased the Galil in unspecified numbers.

The Netherlands submitted the Galil (MN1) for testing in the NATO trials, Sweden developed a version of the Galil as the FFV 890C, and South Africa has adopted the R4, which bears striking resemblance to the Galil.

RUGER MINI-14

Sturm, Ruger and Company introduced the Mini-14 in 1972. As its name suggests, it borrows many characteristics from the NATO caliber M14 Rifle, but there are several differences. It is not simply a scaled-down version of the US military rifle. While Ruger kept the wooden stock, the pattern of which has become a company trademark, the M14 type receiver is fabricated from an investment casting, instead of being machined from a forging. A short barrel, selective fire, folding stock variant—the AC-556K—was introduced in late 1976. Although the resulting product has considerable eye appeal, tests in the Philippines, France and elsewhere indicate that it presently is best suited for use as a police weapon.

MAS 5.56 RIFLE

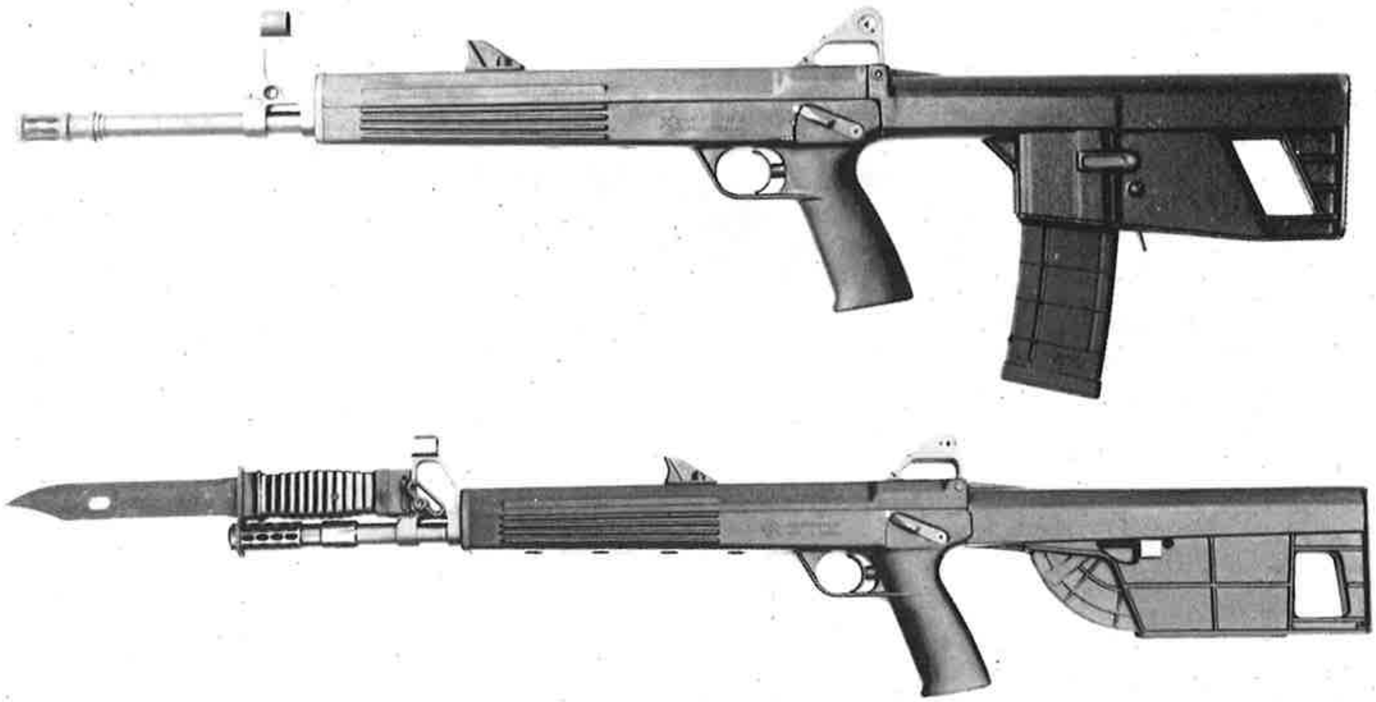
The French arms factory at St. Etienne—part of the state armament group (*Groupement Industriel des Armaments Terrestres*)—has introduced its own rifle with a bullpup configuration, the MAS, making it one of the shortest weapons in the current crop of 5.56mm assault rifles. The delayed blowback mechanism is also unique among current 5.56mm rifles. (Additional details are given in Chapter 19.) For several years, the French possessed a license to manufacture the HK33. In July 1977 the French General Staff announced the standardization of the MAS rifle and placed an initial order for 236,000 with GIAT. The first weapons were issued to the French armed forces in 1979.

INTERDYNAMIC MKS AND MKR

Made only in a limited number of prototypes, the MKS was the first publicly announced design of Interdynamic AB of Stockholm. The MKS incorporated a rotary bolt mechanism and was gas operated. The designers of the MKS sought to create an extremely short and lightweight weapon in caliber 5.56 × 45mm.

After experimentation with the MKS, the Interdynamic design team introduced a 4.7mm rimfire (but high velocity) caliber rifle and carbine series called the MKR. This weapon was also a

MKS Rifle.



Two versions of the Interdynamic MKR. *Top*, a 5.56 × 45mm model with a 30-shot GAPCO nylon magazine; *bottom*, a 4.5 × 26mm rimfire caliber model with a 50-shot plastic semicircular magazine.

bullpup style and embodied a 50-shot crescent-shaped magazine located to the rear of the pistol grip. Development of this series has been limited to date to the creation of test models.

VALMET M76

Valmet Oy of Finland has been more aggressively marketing its family of automatic rifles since the late 1970s. This state-owned engineering and ship building organization has developed a series of model variations around the basic operating mechanism of its M76 assault rifle, which is derived from the Soviet AKM sheet metal receiver avtomat. In addition to the 7.62 × 39mm M76, the Valmet Defense Equipment Group offers the M76 in 5.56 × 45mm (M193) versions. These models (described in more detail in Chapter 18) include tubular fixed and folding stock versions, and plastic and wood stock variants. In 1980, a bullpup model—the Model 255 470—was introduced for armored and airborne personnel. A squad automatic weapon version, the M78 LMG, is available in 5.56 × 45mm, 7.62 × 39mm, and 7.62 × 51mm NATO (see Chapter 2).

Valmet M82 Short (Model 255 470). This 5.56 × 45mm bullpup rifle was designed for use by airborne and armored personnel.

Valmet M76W 7.62 × 39mm assault rifle with wood stock (Model 255 460).

Valmet M76F 5.56 × 45mm assault rifle with side folding stock (Model 254 100).

Valmet M76T 5.56 × 45mm assault rifle with tubular stock (Model 254 060).

Valmet M76P 5.56 × 45mm assault rifle with plastic stock (Model 254 080).

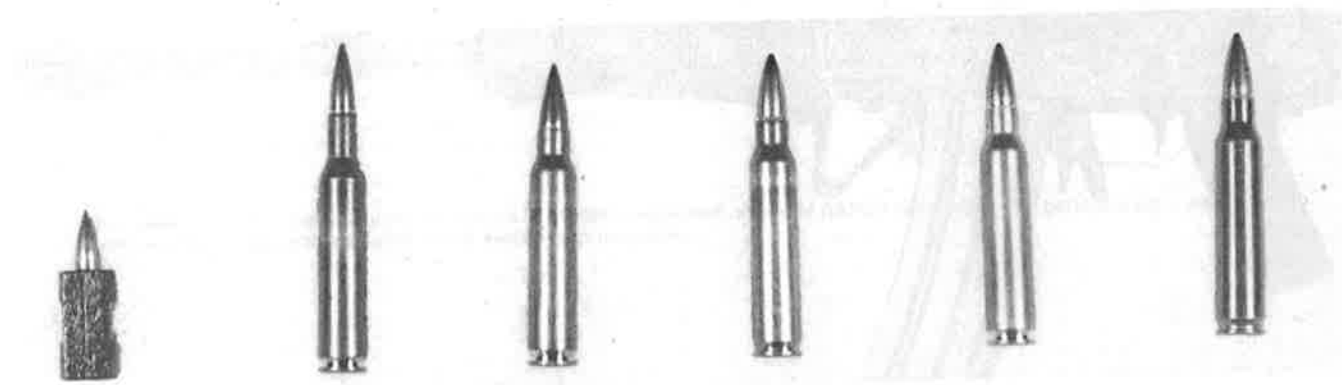
RIFLES—A 1983 STATUS REPORT

The most important development of the past five years has been the switch from 7.62mm caliber rifles to ones firing 5.56mm in NATO and 5.45mm in the Warsaw Pact. In addition to this shift to smaller caliber ammunition, several countries have been added to the list of states designing and manufacturing rifles for their own armed forces, most notably Argentina, Brazil, Singapore, and South Africa.

NATO STANDARDIZES A SECOND CALIBER—5.56 × 45mm

In June 1976, eleven NATO countries* signed a Memorandum of Understanding for the testing, evaluation, and selection of a second NATO standard caliber for small arms ammunition. At the Conference of National Armaments Directors, an agreement was reached whereby only two calibers would be used in the post-1980 family of NATO small caliber weapons. One cartridge was to be the existing 7.62 × 51mm NATO round. A second cartridge was to be chosen from candidates submitted by those nations that had signed the Memorandum of Understanding. The new NATO family of small arms would consist of an individual weapon (rifle), a light support weapon (light machine gun), and a medium support weapon (medium machine gun).

*Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Luxembourg, Netherlands, Norway, the United Kingdom, and the United States.



NATO trial cartridges (1977–1979). ***Left to right:*** **4.7 × 21mm German caseless; 4.85 × 49mm UK; 5.56 × 45mm Belgian SS109; 5.56 × 45mm US (brasscase); 5.56 × 45mm French (steel case).**

To define a second cartridge caliber for standardization (and if possible to make recommendations for a standard rifle and light machine gun), a joint NATO test program was created. Test personnel began by evaluating ammunition and weapon candidates submitted by the member countries in early 1977. To supervise the overall management of the small arms trials, a Coordination Panel for the Testing and Evaluation of Small Arms, Ammunition and Weapons was created. This panel's members were part of Subpanel 4, the Subpanel of Experts to Study Infantry Small Arms Weapons Systems for the Post-1980 Period, which is part of the Infantry Weapons Panel (Panel III) of the NATO Army Armaments Group (AC/225). Membership was limited to only the Subpanel 4 representatives whose countries had signed the Memorandum of Understanding. To carry out the actual testing, NATO established a NATO Small Arms Test Control Commission (NSMATCC). Each participating country provided personnel for the test group. The primary representative, called the principal member, had the military rank of colonel or lieutenant colonel or a corresponding civilian equivalent, and staff officers were majors or captains or civilians of equal grades. Test Control Commission personnel were assigned to this project for the period July 1976 to mid-1980 to ensure continuity during the entire operation.

Data generated by the NATO Small Caliber Test Control Commission provided a sound objective basis for making subjective (political) decisions. The tests were divided into two parts. The first consisted of technical tests that provided data relating to the need for further developments of ammunition and weapons and that determined the technical suitability of the ammunition and/or weapon military testing. The technical tests were characterized by the controlled conditions under which they were conducted in the laboratory and on the test field; chances for human error were eliminated where possible. These tests ran from April 1977 to spring 1979, and the data was then statistically analyzed. The second part of the test program included trials conducted under field conditions to determine if the ammunition and/or weapon met the stated requirements and if they were suitable for army use. These tests involved both qualitative observations and the judgment of selected military personnel with suitable field experience. They were conducted by soldiers representative of the troops that would use the materiel in combat. The military tests provided the primary basis for recommending a weapon or ammunition type as suitable for standardization.

The military trials were designed to determine the following:

Hitting performance: number of targets presented, number of targets hit, rounds fired per target, target hits, time to fire from carrying position, and time to first hit.

Training.

Reliability, availability, and maintainability (RAM): rounds between malfunction or stoppage and time to repair.

Human factors: time to negotiate obstacles and troop opinions (questionnaires used).

Safety.

Most of the military testing was conducted at the German Infantry School at Hammelburg, with testing of individual weapons extending from June to November 1978. Tests of light support weapons ran from January to June 1979. The international character of the NATO Small Caliber Tests was unique, and it may set a precedent for the international testing of materiel within the alliance. A comparison of this program with the activities that led to the standardization of the 7.62mm NATO cartridge reveals major differences.

As noted previously, small arms standardization was a goal of the Western Allies even before the creation of NATO in 1949. Talks about the feasibility of standardizing weapons, tactics, and troop training began in the fall of 1946 when Americans, British, and Canadians were trying to overcome the logistical nightmares caused by the multiplicity of weapons and ammunition types in use by the Allies during World War II. Standardization appeared to be a reasonable goal, and by the fall of 1947 some agreements had been reached, particularly in the crucial area of standardizing the thread patterns for nuts and bolts. Weapons, especially small arms, posed a more complicated problem.

At the end of a decade of trials and tests, NATO did have a single standard rifle cartridge—the 7.62 × 51mm NATO cartridge—but a standard rifle was not adopted. The Americans refused to accept the FN *Fusil Automatique Leger* (FAL), which the British had agreed to adopt over the American-designed M14 Rifle. The Bundeswehr adopted the Gewehr 3, an outgrowth of the World War II Mauser Sturmgewehr 45. The Germans had used the FAL as the G1 for the *Bundesgrenzschutz* (border police), but they were unable to obtain a production license from Fabrique Nationale, whose management was hesitant to rearm a former enemy. It was clear to the political and military leaders of the NATO countries that a better approach was necessary to solve the small arms standardization problem.

From the very beginning, there was unhappiness about the NATO small arms cartridge. The British were the least satisfied. They had conducted an extensive series of theoretical studies and practical tests, and their Ideal Calibre Study Panel recommended a 7mm (.276-inch) projectile fired at lower velocities than 7.62mm ammunition. But the United States had sponsored the 7.62mm round, and being numerically the largest partner in the alliance, the United States got its way. However, a decade later (1963), the United States Department of Defense selected the 5.56 × 45mm M16 Rifle for use by American and Allied ground forces in Vietnam. This small caliber rifle was easier to control during rapid bursts of automatic fire, and it was supposedly more lethal. Selection of the M16 began a new period of controversy within United States and foreign military circles. Basic questions about the infantryman and his rifle were raised. Many are still unresolved:

(1) Should the rifleman engage enemy positions with consciously aimed fire against specific individual targets, or should he fire bursts of fire in the general direction of the enemy, thus inflicting casualties with random hits and at the same time keeping the enemy pinned down through the suppressive effects of his fire?
(2) What are acceptable definitions of lethality and incapacitation? Can incapacitation of enemy forces with a rifle be predicted?
(3) At what ranges should rifle projectiles produce lethal and incapacitating effects? How are these effects measured?

These questions likely would have remained a matter of academic concern for NATO had the United States not made the decision in fall 1969 to equip most of the 190,000 American armed forces in Europe with the M16 Rifle. By the fall of 1971, the process of switching from the 7.62mm NATO caliber M14 Rifle to the 5.56mm M16 was complete. There was considerable grumbling in Europe about this change. The British were especially unhappy as they had adopted the 7.62mm cartridge because United States Army ordnance personnel had argued that the smaller British 7mm cartridge was not effective (lethal) enough. The Americans then introduced a nonstandard caliber into the alliance that was still smaller than the British projectile. Older British officers and Ministry of Defense officials were especially outraged when they remembered the acrimonious arguments that had led to their begrudging acceptance of the 7.62mm NATO cartridge.

When the member nations of NATO decided to select a second smaller caliber cartridge, it was apparent to all of the participants that some basic ground rules would have to be established to ensure an efficient and less politicized evaluation process. Despite more than a decade of combat experience with the M16 Rifle and the 5.56mm cartridge in Southeast Asia, basic questions about its suitability—particularly in the European environment—for all military forces remained. While most experts would agree that the recoil produced by the 7.62mm NATO cartridge was too great for use in a rapid firing assault rifle, its long-range effectiveness was a desirable feature. Rifles firing the American 5.56mm cartridge were easy to control, but were they suitably effective at long ranges? NATO had to choose a cartridge that would produce the most lethality at the desired ranges with the least recoil. Of course, before such a selection could be made, a test program would have to be conducted after agreements had been reached about the types of tests that would be run and the performance requirements the candidate cartridges would have to fulfill.

To eliminate personal and national biases, the NATO member states that signed the Memorandum of Understanding agreed that the testing should be under the control of the NATO Army Armaments Group. The tests would be international in nature, and the participants would have to agree on test procedures and performance requirements. Earlier trials had been conducted under the control of national organizations, but these new examinations would be carried out by a NATO body composed of military personnel from the participating nations.

As Colonel Maurice Briot (Belgian Army), the director of the NATO Small Arms Test Control Commission, stated in a June 1979 interview at NATO headquarters, the goal was to approach the tests in a scientific manner so that the results could be verified and reproduced—today, tomorrow, or a decade from now. The conduct of the tests, the collection of the data, and the analysis of the data would be carried out objectively within previously agreed to guidelines. Colonel Briot carefully distinguished between data analysis—the statistical process of compiling the information resulting from months of laboratory tests and field trials—and data evaluation. The analysis would be objective, but the evaluation would be subjective and political in nature. The data base of technical information from which the evaluators worked, however, would be factual, honest, and reproducible.

To ensure the integrity of the trials, the NATO Army Armaments Group agreed to several performance requirements and evaluation procedures documents. The requirements documents outlined desired characteristics for smaller caliber weapons, such as reliability, maintainability, suitability to tactical mission, hit probability, and probability of incapacitation. NATO's requirements were not necessarily the same as those adopted by individual national armed forces. For example, the NATO requirement for the maximum range to be achieved by an individual weapon, a light support weapon, and a medium support weapon is shorter than the United States requirement. The differences are especially noticeable when comparing the desired range requirements for the light and medium machine guns.

NATO's testing procedures were clearly defined in *Evaluation Procedures for Future NATO Weapons Systems* (D14), a document that Colonel Briot indicated was a very important accomplishment in itself. Document 14 was the result of work done by the Group of Experts on a Post-1970 Family of Small Arms, which reported to the Infantry Panel (Panel III). This subpanel was created in 1964 to reach an agreement on common methods of evaluating the various types of small arms and ammunition that might be used in the post-1970 period. It was also given the task of outlining programs for technical and military tests of various weapon and ammunition combinations. Document 14, which outlines the technical and military evaluation procedures, was an evolving document, which has been revised several times since the late 1960s.

In 1970, the Infantry Weapons Panel created Subpanel 4 to consider candidates for a family of small arms for NATO standardization and use in the 1980s. This subpanel subsequently organized its own group of international experts who, under the direction of Mr. Thinat of France, revised the manual (D14) and made it suitable for conducting the 1977–1979 comparative small arms trials. Document 14 was a very wide-ranging test manual, covering the entire spectrum of small arms weapons systems that NATO might seek to evaluate.

(1) Ammunition: both point target and area target ammunition.
(2) Individual weapons: assault rifles with effective ranges of 300–400 meters.
(3) Light support weapons: section/squad automatic weapons firing the same ammunition as the individual weapon, but capable of delivering a high volume of fire to about 800 meters.
(4) Medium support weapons: automatic weapons capable of engaging ground and air targets to a range of about 1,000 meters; should be capable of being mounted on ground vehicles and aircraft.
(5) Heavy support weapons: automatic weapons of heavier caliber than medium support weapons and usable on ground mounts or mounted on ground vehicles or aircraft.
(6) Grenade launching rifles and grenade launchers: part of area target ammunition evaluation.

Test personnel from the several member nations of Subpanel 4 often had difficulty in explaining their country's philosophy of testing materiel and in defining the various tests. For example, a "mud test" might have a different precise meaning for each organization that conducts one. Each test had to be discussed, and acceptable procedures developed. Common agreement as to the translated meanings of technical words and phrases had to be established, too. By creating these test procedures, the members of the evaluation group also created an environment in which they could work together with a minimum of confusion and friction. Although there were lessons waiting to be learned, the evaluations procedures document proved to be a very important milestone for the men conducting the trials.

Candidate Ammunition and Weapons

As each generation of military men has had to learn, ammunition and weapons cannot be considered separately. The two elements must be evaluated together as a system. Three different bore diameters (calibers) were represented in the cartridges submitted to NATO for evaluation: the British 4.85mm, the German 4.7mm, and three 5.56mm projectiles.

The British cartridge had a case 49 millimeters long, compared to the 45-millimeter case of the M16A1 Rifle cartridge. This cartridge case is otherwise based on the American cartridge, which would permit existing 5.56 × 45mm weapons to be converted for use with British ammunition. The British projectile weighs 3.11 grams (48 grains) compared to the 3.56-gram (55-grain) M193 round. Velocity of the British projectile from the 518.5mm (20.4-inch) barrel of the XL64E5 Individual Weapon has been cited as 900 meters per second (2743 f/s) while the M193 projectile velocity at the muzzle is listed as 975 meters per second (2970 f/s) from the 508mm barrel of the M16A1 Rifle.

The German 4.7mm projectile was part of a caseless cartridge and weapon system concept designed jointly by Heckler & Koch of Oberndorf and Dynamit Nobel of Cologne. The Heckler & Koch rifle has been designated the Gewehr 11 and is chambered for the caliber OH 4.7 × 21mm. This length dimension (21mm) refers to the length of the caseless propellant charge. This weapon and ammunition system is discussed in detail later in this chapter.

Although these small caliber cartridges (below 5.56mm) were submitted for the trials, it was not likely that either would be standardized by NATO. The G11 rifle was evaluated only during the technical tests; it was withdrawn afterwards, because the ammunition-weapon combination suffered a cook-off problem. Just as the G11 rifle and OH 4.7 × 21mm ammunition were withdrawn from the trials, the British dropped the development of the 4.85mm cartridge. They converted XL64 weapons series to 5.56 × 45mm. This decision merits an observation. The British once again appear to have pursued an ideal course of development with their 4.85mm cartridge rather than a practical one. Whatever the merits of the 4.85mm, the British were acting in what one must call an unrealistic fashion, considering that the United States Army had 1.3 million M16A1 Rifles in its inventory that it might have to replace if NATO adopted a caliber other than 5.56mm. The replacement cost in 1979 dollars would have been about $360 million. Clearly, interoperability of a new cartridge with existing weapons—either 7.62mm NATO or 5.56 × 45mm—was a tangible piece of practical data that could not be dismissed lightly by the NATO authorities.

Interoperability was one of the major thoughts behind the American development of the XM777 and XM778 projectiles and the Belgian development of the SS109, P112, and L110 projectiles. The United States Army officials started out with the goal of improving the effective range of the 5.56mm cartridge so that it would be suited for use in a Squad Automatic Weapon (light machine gun) as a base-of-fire weapon (see Chapter 2). At the same time, the improved cartridge could be used in the M16A1 Rifle without changes to the weapon or loss of the projectile's basic lethality. The key requirements for the XM777 ball projectile were improved penetration of hard targets at ranges up to 800 meters (penetration of at least one side of the standard United States steel helmet at 800 meters) and the same probability for incapacitation given a hit such as that of the standard M193 ball projectile. For the XM778 tracer projectile, the requirement was a clear daytime trace to 800 meters, a considerable improvement over the standard M196 tracer projectile.

FN Herstal developed its own improved 5.56mm cartridges for use in the FNC Rifle and the Minimi Light Machine Gun. The design team at FN sought an alternative to the American M193 (SS92 in FN terminology) because they saw room for improvement in the long-range effectiveness of the round and because of growing complaints that the M193 projectile can cause unnecessary suffering among those people struck by it. Realizing that there was an increasing possibility that high velocity projectiles of the M193-type might be restrained by international agreements (such as a proposed modernization of the 1949 Geneva agreements), the designers at Fabrique Nationale sought 5.56mm projectiles that would have improved range without the "inhumane" aspects—such as tumbling and breakup—of the M193. The new FN ball bullet, the SS109, has a more sharply tapered form—ogive—and greater weight—4 grams (the M193 weighs 3.56 grams and the XM777 3.53 grams). Like the XM777

The Enfield Weapon System (EWS). ***Top,*** **the 4.85 × 49mm XL64E5 individual weapon as tested in the NATO small caliber trials;** ***middle,*** **the 4.85 × 49mm XL64E5 light support weapon;** ***bottom,*** **after the NATO trials the XL64 series was redesigned and rechambered. This is the 5.56 × 45mm (SS109) XL70E3 individual weapon.**

projectile, the FN SS109 has a combination steel and lead core. In both, the steel insert at the tip of the projectile acts as an armor penetrator, and both the American and Belgian projectiles should be considered semiarmor piercing bullets. To help keep the projectile from tumbling when it hits a human target, the FN engineers changed the rifling twist of the barrel of the FNC rifle. Instead of the bullet making one rotation on its axis in every 12 inches (304.8 millimeters) of travel down the rifle barrel, the SS109 bullet makes one rotation on its axis for every 7 inches (177.8 millimeters). The so-called 1-in-7 twist spins the bullet to a greater extent than the 1-in-12 twist, thus theoretically imparting greater ballistic stability. It should be noted that in small-caliber, high-velocity projectiles improvement in ballistic stability generally is accompanied by a decrease in lethality.*

The SS109 projectile loses some of its effectiveness when fired from the M16A1 Rifle or the FNC with a 1-in-12 twist barrel. If the SS109 projectile was adopted by NATO, the United States Army would have to consider rebarrelling its stock of M16A1 Rifles. As noted, this would be expensive, but it was an issue worthy of consideration.

How do the XM777 and SS109 projectiles compare? This is a difficult question to answer and one of the primary reasons that the NATO small caliber trials were so important. When various organizations compare ammunition or weapons, they often do so to their own advantage. All unilateral data, therefore, had to be considered suspect by NATO, whose analysts examined how different weapons firing a particular cartridge performed under identical environmental circumstances. However, this approach did leave something to be desired in this case. For example, the M16A1 fired M193 control ammunition to establish a performance benchmark. The M16A1 also fired the XM777 round. The M193 and XM777 cartridges could also be fired from the French FAMAS rifle and the Netherlands MN1 (Galil) rifle. But the FNC and the British XL64 cannot fire the XM777 series ammunition, and the M16A1, FAMAS, and the MN1 cannot use the SS109 or the British 4.85 × 49mm cartridge. For control and comparison purposes, it would be useful to have M16A1 Rifles with 1-in-7 twist barrels to fire the SS109 and M16A1 Rifles with 1-in-5 twist barrels to fire the British cartridge.

Accepting the caveat that all nonofficial NATO comparative data is suspect but knowing that the NATO information will not be available until the late 1980s, are there some rough indications of performance that we can examine? Yes, keeping in mind the limitations we have stated. The FN SS109 cartridge appears superior for armor penetration when compared to the other contenders. It acts like a drill on the three NATO penetration targets—NATO plate (a piece of mild steel 3.5 millimeters thick), the Federal Republic of Germany steel helmet, and the United States steel helmet. If penetration of lightly armored targets had been the major criteria, then the SS109 would have been superior, but its reduced lethality also had to be considered. On the other hand, the XM777 was supposedly superior to the SS109 in terms of incapacitation and lethality, but was clearly less effective in defeating armored targets. FN engineers claimed that the design of their steel penetrator keeps production costs equivalent to the M193 (SS92) projectile, while the steel penetrator of the XM777 projectile poses production problems since it could become lodged sideways when inserted into the bullet jacket.

Clearly, the decision about which cartridge should be standardized was affected by a number of complex considerations. For example, what kind of balance need be struck between armor penetration and human incapacitation? Other issues such as the economics of manufacturing the projectile were beyond the scope of the analytical phase of the tests, but they did influence the evaluation phase.

Standardization of a second NATO cartridge, as complicated as it seems, may seem simple when compared to selecting new individual and light support weapons. Three control weapons were selected to provide a basic reference for evaluating contender weapons and ammunition: the Federal Republic of Germany G3 representing standard 7.62 × 51mm NATO class rifles (1-in-12), the United States M16A1 representing 5.56 × 45mm class rifles firing M193-type ammunition (1-in-12), and the Belgian Mitrailleuse a gaz 58 (MAG 58) representing standard 7.62 × 51mm NATO class light machine guns (1-in-12).

Technically, the main point that was not considered by the Test Control Commission was the differences between production and prototype weapons. Whereas the M16A1 Rifle was a battle-proven veteran, the G11 represented an advanced technical concept in prototype form. Only a small number of United Kingdom XL64 weapons had been fabricated; it was thus an advanced prototype. The French FAMAS, the Belgian FNC, and the Dutch MN1 were production models but had been produced in only limited numbers when compared to the M16A1. The FN Minimi machine gun had been under development since the early 1970s, and while it was not in serial production, it was much further along the development path than the British XL64E4 light support weapon. Still, the Minimi was a comparative newcomer when viewed alongside the German MG3E. This weapon is a lightweight version of the World War II German MG42. Colonel Briot noted that the technical tests and military trials were created to provide information about the weapons only as they existed when the evaluation began. This type of analysis would be scientific; weighting the tests to compensate for the different levels of development would have been subjective and speculative.

CANDIDATE WEAPONS

	Individual Weapons (Rifles)	
Belgium:		
5.56 × 45mm	FNC (1-in-7)	SS109 Series
France:		
5.56 × 45mm	FAMAS (1-in-12)	French steel case w/M193-type
Federal Republic of Germany:		
4.7 × 21mm	G11 (1-in-12)	Caseless
Netherlands:		
5.56 × 45mm	MN1 (1-in-12)	M193-type
United Kingdom:		
4.85 × 49mm	Individual weapon XL64E5 (1-in-5)	
United States:		
5.56 × 45mm	M16A1 (1-in-12)	XM777/XM778
	Light Support Weapons (LMG)	
Belgium:		
5.56 × 45mm	Minimi (1-in-7)	SS109 Series
Federal Republic of Germany:		
7.62 × 51mm	MG3E (Shortened and lightened MG3) (1-in-12)	7.62 × 51mm NATO
United Kingdom:		
4.85 × 49mm	Light support weapon, XL64E4 (1-in-5)	

On 28 October 1980, NATO approved the standardization of a second small caliber cartridge for use within the alliance (STANAG 4172):

To increase the total effectiveness of the family of infantry small arms, several allied governments intend to

*The Swedish government was experimenting with 5.56 × 45mm weapons with 1-in-9 twist barrels for humanitarian reasons.

Top, **the French contender in the NATO individual weapon trial—the 5.56 × 45mm FAMAS firing the US M193 cartridge; *middle*, Fabrique Nationale's 5.56 × 45mm FNC barrelled to fire the SS109 projectile (1-in-7 barrel twist); *bottom*, the Israeli Military Industries 5.56 × 45mm Galil, designated the MN1—The Netherlands' entry in the individual weapon trials.**

introduce into their forces in the 1980s a new individual weapon. There is general agreement that the present 7.62mm calibre will remain a NATO standard. In order to select a second smaller and lighter weight ammunition for NATO Small Arms to be standardized, an extensive technical and military programme has been organized for the testing of weapons and ammunition presented for evaluation by interested governments. As a result of this exclusively technical and military programme, 5.56mm has been adopted as second standard NATO calibre for small arms and the Belgian SS109 ammunition has been selected as a basis for standardization of ammunition for the second NATO calibre for small arms.

In evaluating the operational effectiveness of the weapons and ammunition offered as candidates for NATO standardization, the commission came to several conclusions:

Small calibre ammunition and weapons tested were smaller and lighter than the 7.62mm control ammunition and weapons. The smaller calibre ammunition is approximately half the weight and size of 7.62mm ammunition; the small calibre individual weapons are an average 0.6kg lighter than the control weapon and the smaller calibre light support weapons were at least 5kg lighter than the control weapon. An infantryman in combat using the new calibre weapons and ammunition can carry more ammunition, especially in the case of the light support weapons, and not increase the load he would carry if he were equipped with 7.62mm ammunition and weapons. Logistic support is eased because the new ammunition is smaller and lighter.

Some NATO nations have differing national concepts of the employment of small arms weapons, particularly of light support weapons. Some countries wish to have the performance of 7.62mm weapons and are prepared to accept the increased weight and size. The tests have shown that based upon the performance of the candidate systems it appears that effective light support weapon systems using the second calibre ammunition can be produced to meet the needs of those nations who wish to employ smaller calibre light support weapons with reduced weight and size.

After studying the final report of the commission, the Coordination Panel for the Testing and Evaluation of Small Arms, Ammunition and Weapons reached the following conclusions based solely upon the technical and military tests conducted during the course of the program. Other factors, such as the economic situations in particular member nations, were not considered. The panel found:

a. **Ammunition**

(1) The reflective test results of candidate ammunitions were not consistent among the various technical and military tests. The contribution of ammunition performance to system effectiveness cannot be evaluated independently since it is more directly influenced by the weapon and fired under field conditions than by the basic quality of the ammunition itself.

(2) Each candidate ammunition has a considerable advantage in weight, size, and cost over the NATO 7.62mm rounds (the weight of each contender ammunition is approximately half that of the NATO 7.62mm). The advantage in weight and size is also true for the contender weapons designed to fire the smaller calibre ammunition. Thus, the second standard NATO calibre ammunition will provide for increased system effectiveness when constrained by weight factors.

(3) There are no significant discriminators in the various candidate rounds for the individual weapon; however, the heavier bullets with a higher spin rate have significantly better terminal ballistics (i.e., penetration, incapacitation) than the lighter bullets at ranges beyond 500 metres.

(4) Each candidate individual weapon ammunition (4.85mm and 5.56mm [type variants of the 5.56mm include SS109, XM777, M193, and French M193]) meets the essential requirements in the operational characteristics . . . for individual weapon system.

(5) Each candidate light support weapon ammunition (4.85mm and 5.56mm [type variants of the 5.56mm include SS109 and XM777]) meets the essential requirements in the operational characteristics . . . for light support weapon systems; however, the SS109 ammunition is significantly better than the other ammunition with regard to the terminal effects at ranges beyond 500m.

(6) Based on the results of the technical and military tests, the SS109 (U.S. designation . . . XM855) ammunition is considered the best candidate as a basis for standardization of ammunition for the second NATO calibre for small arms.

b. **Weapons**

(1) It is not practical to make a proposal for standardization of weapons.

(2) The relative suitability of the individual weapons tested to meet the requirements of the operational characteristics . . . cannot be validly established because the weapons tested varied from prototype to in-service models. Weapons have been further developed since testing was conducted and certain weapons were not tested with the ammunition now proposed. The reliability of the weapon system appears directly related to their maturity. The individual weapons tested generally meet the operational characteristics.

(3) The relative suitability of the light support weapons tested to meet the requirements of the operational characteristics . . . cannot be validly established because the weapons tested varied from prototype to in-service models.

(4) The characteristics and performance demonstrated by the various candidate weapon systems could be used by nations in the selection of weapons to meet specific national requirements.

Considering these findings, the panel recommended the following actions, which were approved in October 1980: (1) that the NATO Army Armaments Group approve the adoption of the 5.56mm caliber as the second standard NATO caliber for small arms; (2) that they approve the SS109 ammunition as the best candidate for standardization for the second caliber; (3) that they direct Panel III to expedite its preparation of STANAG 4172 for an ammunition for both individual and light support weapons; and (4) that they agree that a recommendation for NATO standardization of an individual or light support should not be made.

Based upon their own firing tests, Fabrique Nationale engineers reported that their SS109 projectile will penetrate the NATO armor plate at 640 meters and one side of the American helmet

COMPARATIVE TERMINAL BALLISTICS FOR 7.62 × 51mm AND 5.56 × 45mm NATO BALL CARTRIDGES

Target \ Ammunition / Pitch	7.62 × 51-SS77 bullet 12″ (305mm)	5.56 × 45-M193 bullet 12″ (305mm)	5.56 × 45-SS109 bullet (XM855) 7″ (178mm)	5.56 × 45-SS109 bullet (XM855) 12″ (305mm)	5.56 × 45-XM777 bullet 12″ (305mm)
NATO Plate	620m	400m	640m	416m	ca. 410m
FRG Helmet	640m	485m	1150m	Unknown	ca. 600m
US Helmet	800m	515m	1300m	825m	ca. 820m

at ranges of more than 1,300 meters. To produce these results, the SS109 must be fired from a weapon having a 1-in-7-inch (1-in-178mm) twist barrel. Fired from a 1-in-12-inch barrel, the SS109 would not penetrate the NATO plate at ranges greater than 416 meters or the helmet at a distance greater than 825 meters. While this was an improvement over the M193, it did not meet the NATO requirements. And the Americans would have to change the barrel of their M16A1 before the SS109 ammunition could be qualified as interoperable. The competitive XM777 steel-core projectile developed by the United States would penetrate the armor plate at about 410 meters and the helmet at 820 meters. While this was slightly less than the performance of the SS109, some American officials still held out for their round because it could be fired from the M16A1 without requiring any barrel change; it was designed for the 1-in-12-inch twist barrel. The XM777 was also supposed to be less expensive to manufacture according to the estimates of some Americans, although it was not clear how this price comparison was made or what quantities were involved in the estimate. What was clear, however, was the unpopularity of the SS109 among certain groups in the United States and in Europe.

Fabrique Nationale was in an awkward position. Their cartridge won the NATO small arms ammunition competition, but the company was faced with opposition from several directions. Critics of the SS109–including proponents of the 7.62mm NATO cartridge and the new German 4.7mm caseless round—did not dispute the validity of the results within the context of the tests carried out by NATO, but they did question the relevance of those tests. Supporters of the 7.62mm NATO cartridge argued that comparing the 5.56mm SS109 and the 7.62mm SS77 projectiles was not meaningful because the SS109 represented late-1970s technology, while the SS77 reflected the state-of-the-art of the early 1950s. These proponents of the 7.62mm said that a 7.62mm bullet embodying the technology used in the SS109 would have produced a cartridge that would penetrate armor plate and helmets at ranges in considerable excess of 620 and 800 meters. They also pointed out that the 7.62mm projectile has greater total range and greater remaining kinetic energy at those long distances than any 5.56mm projectile. Supporters of the 7.62mm round fell into two camps: those who wanted the 7.62mm for both the rifle and the squad automatic weapon (light machine gun) and those who saw the need for 7.62mm in only the squad automatic weapon. But together they expressed the belief that NATO forces (and United States forces) deployed to such areas as the Middle East would require weapons that could deliver fire at ranges beyond the effective range of any 5.56mm cartridge.

Those experts who favored the German 4.7 × 21mm *ohne Hülse* (caseless) cartridge argued that the 4.7mm projectile would provide satisfactory performance against the type of targets generally engaged by infantry personnel. The kinetic energy produced at the muzzle by the 4.7mm when fired from the Gewehr 11 is about 1,500 joules, as compared to 1,575 joules for the SS109 and 3242 joules for the SS77. Further, German government and industry personnel argued that neither the 4.7 ×21mm OH nor the 5.56 × 45mm is suitable for use in a squad automatic weapon. Only the 7.62mm NATO round—perhaps a product-improved one—would suffice. They thus proposed a 4.7 × 21mm OH rifle and a 7.62 × 51mm squad automatic weapon. A "National Comment" document released in the summer of 1980 by the Federal Republic of Germany relates to the outcome of the NATO Small Arms Test and Evaluation Program: "The FRG welcomes the positive result of the NATO Small Arms Test and Evaluation Programme which has led to recommending the 5.56mm caliber for the new to be standardized round for NATO Small Arms. This result will certainly give those nations having an urgent demand for replacement of their rifles and/or light support weapons the opportunity to take advantage of a lighter and smaller round as compared with the present 7.62mm rounds."

But the Germans had been expecting more performance from the 5.56mm cartridge. The Germans believed that the SS109 did not represent "a very significant quantum jump in technology." They admitted to the considerable advantage in weight and size of the 5.56mm round over the 7.62mm round, but this improvement by itself could not be termed "very significant" operationally and technically. "In order to achieve this an overall new technology will be required such as the caseless ammunition technology as it was presented in this programme (the NATO evaluations) by the FRG," German officials said. They added another important point to their case: "Nations not having to replace their weapons within the very near future will have to consider whether the very high procurement costs for a new generation of infantry weapons in the 5.56mm caliber are to be justified since the conventional technology applied (to the 5.56mm rifle-ammunition system) will be superseded in a relatively short period of time."

Germany would certainly not replace its G3 rifle, since it would be serviceable for at least another ten years, and the German military was assuming that by the second half of the 1980s the caseless technology for small arms ammunition would be ready. Its plans do not call for the procurement of a new rifle system (the G11) until the early 1990s, so the Germans can afford to wait until the G11 and its 4.7 × 21mm ammunition is ready to be standardized.

Although the SS109 cartridge met the technical specifications established by NATO, it obviously did not satisfy the military needs or prejudices of some NATO members. The technical issues resolved by the NATO Small Arms Test Control Commission were only a small part of the overall problem. There remained the several divergent views concerning the tactical utilization of the rifle and the squad automatic weapon. And of paramount concern were the political and economic issues raised by ammunition and weapon standardization. Certain manufacturing concerns stood to profit handsomely if their cartridge or weapon was chosen by NATO. At stake was not just the royalty-free NATO utilization of ammunition and weapon designs, but the licensed production of such materiel in the export markets, as well. In addition, national prestige (lost or gained) and the resultant changes in the international balance of payments would also have to be considered.

Ancillary Issues

U.S. SAW Program. The United States Squad Automatic Weapon (SAW) program entered a new phase in September 1980 with the award of a "maturity phase" contract to Fabrique Nationale (FN) for further development of its 5.56mm XM249 SAW, the Minimi, which has a 1-in-7-inch (1-in-178mm) twist barrel and is designed to fire the SS109 cartridge. After fifteen months of engineering work at FN, the United States Army standardized the Minimi at the M249 (see Chapter 2 for more details).

U.S. M16 PIP. During 1978–1979, the United States Armed Forces and Colt Firearms examined the desirability of developing a product-improved M16A1 Rifle (M16 PIP). Such a project would solve two immediate problems. First the Army and the Marine Corps have an urgent requirement for new rifles to replace their aging M16A1s, and they do not wish to wait years for some future system. And second, a product-improvement program would correct many of the deficiencies in the M16A1 that have already been identified, thus extending the usefulness of the basic rifle. Many of the M16A1 Rifles in the United States inventory have been worn out from use as training weapons, and it is not unusual to find M16A1s that have been fired 40,000 to 50,000 times. Weapons that have seen this kind of wear malfunctioned during United States Marine Corps exercises in Norway in March 1980. The Corps analyzed this and other recent reports of poor performance and concluded that the M16A1 was

***Top,* standard 5.56 × 45mm (M193) M16A1 rifle; *middle,* Colt proposal for product-improved M16A1 (heavier barrel, improved handguards and butt stock); *bottom,* 1982 candidate PIP M16A1 with additional features of improved rear sight and three-shot burst control.**

essentially a good weapon, but that new rifles were needed to replace old and worn out ones. The Marines also concurred with Army conclusions that several M16A1 components could be improved to increase the field life expectancy of the rifle. Most of these improvements had already been suggested by Colt Firearms but had been rejected because of inadequate funds or perhaps because of hostility toward the manufacturer. (This unfortunate attitude toward Colt is a legacy of the manner in which the M16A1 was introduced into United States Army circles during the Vietnam War.)

Product improvements to the M16A1 Rifle include a single-shot fire and 3-shot burst fire, a stronger butt stock, improved front handguards, new tapered slip ring, a new 1-in-7-inch (1-in-178mm) twist barrel with a heavier diameter toward the muzzle end, and a new fully adjustable rear sight. The new butt stock proposed by Army and Colt officials will be made from a new material called super tough nylon. Tests conducted thus far indicate that the improved stock will be ten to twelve times stronger than the currently issued one. Both halves of the new stronger round handguards are the same, eliminating the requirement for stocking left and right handguards. The new barrel contour from the rear of the front sight to the muzzle makes that vulnerable section of the barrel twice as strong as the current M16A1 barrel. The resulting product-improved M16A1 would be much more durable, an especially desirable characteristic for weapons carried by airborne troops. An M16 PIP was tested in the summer of 1981, with special attention being given to the performance of the 5.56mm projectile against targets protected by sand bags and/or flak jackets. These critical target situations were not evaluated during the NATO small caliber trials.

Initially there were many opponents standing in the way of an M16 PIP. For instance, there were individuals within the United States Army Armament Research and Development Command (ARRADCOM) who could not agree on what deficiencies to correct or what changes to make to the rifle. Some Army, Marine, and Colt officials felt that any additional "improvements" beyond those just outlined might delay the fielding of a product-improved weapon and perhaps jeopardize the entire idea, because there are voices within the American defense establishment that call for abandoning the M16A1 altogether—that faction of Army and Marine Corps officers who prefer the 7.62mm NATO caliber, and the group that prefers to wait for some significant improvement in the technology, such as that promised by the new caseless round.

The M16 PIP and the procurement of FN's Minimi forced some serious soul searching within the United States Department of Defense. In 1981, the American defense community had determined the answers to several important questions. An especially important one concerns future technology: Are the Germans really capable of fielding the G11 weapon-ammunition system within the next four to six years, and just how many NATO members will wait for its production or at least defer their decision on a 5.56mm weapon until they see how the new rifle performs? Some American officials feared that the United States would be the odd nation out if it proceeded with the fielding of a product-improved M16 and the Minimi. Others, including an important group of Marine Corps officers, believed the M16 PIP and the SAW were already too late; they already should have been in the hands of troops. The dilemma was clear: Make a decision to adopt the improved rifle and a SAW, and the decision may prove to be the wrong one several years later. Defer the decision and wait to see what the Europeans do, and American troops might be caught without sufficient numbers of conventional ground defense weapons. Both paths were fraught with problems, but a choice had to be made about which alternative would provide American troops with the best weapon systems at the best price.

The Marine Corps was the first to make up its collective mind (although there are minority opinions within it). At a 15 July 1980 briefing to the commandant on the procurement of a squad automatic weapon, Commandant General Robert H. Barrow expressed his frustration about the conflicting and confusing information he was receiving about small caliber weapons. He directed the Marine Corps Development and Education Command to form a special task force to study the requirements for infantry weapons systems. After an intensive four-month study, several important recommendations were made to the commandant, who approved them: (1) Procure the 40mm MK-19, MOD 3, automatic grenade launcher. (2) Reprogram four million dollars in FY1981 funds to purchase equipment that will expedite the production of fuzes for the 40mm M432 HEDP round. (3) Begin fielding the following weapons: the MK-19 (FY1983), the .50 caliber M2 Heavy Barrel Browning machine gun (FY1983), a 5.56mm SAW and ammunition to be determined by analysis of data gathered during the maturity phase contract with FN (FY1984), the M16 PIP (FY1982), and a 9mm Parabellum handgun (FY1983). (4) Cancel testing of 7.62mm NATO caliber SAW candidates. (5) Continue support of the Joint Service Small Arms Program (JSSAP) project to develop improved armor-piercing small caliber projectiles.

Although many may argue with the results of the Corps' analysis, the task force directed by Lt. Col. Richard Maresco approached its study in an interesting manner. The group started with the premise that all the weapons issued by Marine infantry units had to be viewed as part of a whole. Too often in the past, single weapon types—rifles, machine guns, and grenade launchers—had been examined out of the context of the battlefield. Maresco and his associates looked at the seven major types of targets suited for engagement by infantry weapons—personnel, armored personnel carriers (APCs), infantry fighting vehicles (IFVs), general purpose vehicles, tanks, structures, and aircraft (fixed-wing and rotary)—and evaluated each class of weapon available to them as it compared to current weapon threats that the Corps might meet. Deficiencies in current American weapons were also identified, along with near-term weapon options that could help the Marines overcome these deficiencies. As Maresco phrased it, "We need to solve the deficiencies with readily available weapons, and then we need to plan for future developments that will further enhance our infantry weapon inventory." The MK-19, MOD 3, automatic grenade launcher with armor-piercing ammunition would improve the Marine Corps' ability to defeat the BTR (a current Soviet armored personnel carrier) and the BMP (a Soviet infantry fighting vehicle) at ranges greater than 2,000 meters. Adding the .50 caliber Browning Heavy Barrel machine gun at the battalion level would help the Marines counter the 14.5mm machine gun on the BTRs. Firepower in the rifle squad would be increased by the introduction of the 5.56mm squad automatic weapon, and a product-improved M16 would allow the Marines to extend the life of their rifle. The 40mm M203 grenade launcher was identified as one of the most important weapons in the rifle squad for dealing with APCs and IFVs. The primary deficiencies that could not be corrected by the adoption of these weapons were the inability of small arms to successfully engage lightly armored vehicles or to defend against attack helicopters. New weapons will have to be developed to meet these threats. The task force also recommended procuring better one-man portable assault weapons, equipping anti-tank weapons with night acquisition sights, and improving lightweight and medium mortars and mortar ammunition.

Maresco's task force realized the complexity of this study and its political sensitivity from the beginning. Their anlaysis of the SAW issue is illustrative of the analytical process used by the men and their sensitivity to the political problems involved. As Maresco said in his briefing to Commandant General Barrow, "We will discuss this at length due to the volatility of the issue and to highlight the depth, logic and rationale that went into this particular analysis." According to Maresco's team, "The squad automatic weapon (SAW) option introduces a significant new capability by providing suppressive fire against area targets, particularly exposed enemy personnel at ranges of 300 to 800 meters. The SAW has a volume of suppressive fire that surpasses the Soviet 5.45mm AK-74 rifle and is competitive with the next generation Soviet machine gun (RPK-74)." A one-man system, the SAW is lighter than the M60 7.62mm machine gun and can be employed at the squad level, but the Marines' report pointed out that it is heavier than the M16A1 and will demand large quantities of ammunition, which may cause some logistics problems. However, the Marines believed that introducing a SAW would be worth any logistics problems it might cause.

Maresco and his colleagues addressed the question of the best caliber for a squad automatic weapon: "While theoretically a unique caliber could be developed, practical considerations limit the alternatives to 5.56mm and 7.62mm." The task force concluded that a 5.56mm weapon was "roughly comparable" to a 7.62mm weapon in maximum effective range and rate of fire. A 5.56mm weapon-ammunition system would be lighter than a 7.62mm system, but on the basis of relative performance the Marines could find "no clear-cut superiority of one caliber over the other . . . each enjoys some advantages." In the final analysis, a 5.56mm SAW was chosen as the Corps' candidate for several reasons:

(1) 5.56mm permits approximately twice as many rounds as 7.62mm for a given basic load.
(2) 5.56mm selection avoids the disadvantages of unilateral acquisition.
(3) 5.56mm SAW has completed testing and requires only completion of the maturation phase prior to beginning production. The 5.56mm SAW could be fielded as early as 1983; an off-the-shelf 7.62mm SAW, not earlier than 1986.
(4) The lift requirement—combat transport (weight and cube)—for a given number of 5.56mm rounds is less than for the same number of 7.62mm rounds.

(5) 5.56mm SAW affords ammunition and magazine interchangeability with the current Marine infantry rifle.
(6) Although total system life cycle costs have not been developed, 5.56mm SAW ammunition would be less expensive than 7.62mm ammunition.

The XM249 was standardized as the M249 SAW in early 1982.

Marine Corps plans (as of mid-1982) called for the procurement of the 5.56mm product-improved M16A1 (M16A2), the 5.56mm M249 squad automatic weapon, the 40mm MK-19, MOD 3 grenade launcher, and the .50 caliber (12.7mm) M2 Browning heavy barrel machine gun. The accompanying table summarizes proposed procurements:

USMC SMALL ARMS ACQUISITION PLANS

Weapon	FY82	FY83	FY89 (Cumulative Total)
M16A2	30,000	55,000	245,000
M249	2,117	2,907	9,900
MK-19 MOD 3	792	570	2,334
M2 HB MG	400	275	750

G11—WEAPON OF THE FUTURE?

Heckler & Koch engineers Tilo Möller, Günter Kästner, Dieter Ketterer, and Ernst Wössner created the new Gewehr 11, which fires the 4.7 × 21mm *ohne Hulse* (caseless) ammunition developed by Dynamit Nobel AG of Furth-Stadlen. This weapon was tailored to the new round, and it is thus necessary to think in terms of a weapon-ammunition system.

During the NATO small arms ammunition trials, the NATO Small Arms Test Control Commission noted that the Heckler & Koch G11 "was the only weapon system in the tests presenting a new technology." All of the other rifles and ammunition were linear developments from existing concepts. The HK G11 employed caseless ammunition—the metal cartridge case had been eliminated—and the rifle itself was designed around several innovative ideas not commonly encountered in small caliber weapons. Heckler & Koch withdrew the G11 from the NATO tests when they discovered that the weapon tended to fire prematurely as heat built up in the breech mechanism after several rounds had been discharged (cook-off). But this setback did not stop the weapon designers at Heckler & Koch or the ammunition developers at Dynamit Nobel. By mid-1981, they were confident that they had not only solved the cook-off problem but had also significantly improved the G11's mechanism. Their confidence led them to demonstrate the G11 publicly for the first time at the American Defense Preparedness Association's (ADPA) Second International Small Arms Symposium on 14 October 1981. During this event, Heckler & Koch invited the author to visit their factory in Oberndorf/Neckar to test-fire the G11. The following report is based upon an exclusive briefing and shooting session arranged by Heckler & Koch. To date (mid-1982) the author is the only military analyst or journalist to have fired the new weapon.

By simply shooting the G11 at the ADPA Small Arms Symposium, Dieter Rall of the Heckler & Koch factory revealed that the German rifle was a unique weapon. To the casual observer, the G11 did not appear significantly different from the other rifles being demonstrated as they fired single shots, but there was one significant difference. A photographer standing near one of the conventional rifles had his nose bloodied when a fired case flew into his face; from the G11 no cases were being ejected. Its molded-propellant cartridges do not have metal cases: they are caseless. This is the first indication that the G11 is unique.

But the true uniqueness of the G11 becomes clearer when it discharges three-shot bursts. The cyclic rate of the mechanism is 2,000 shots per minute during full-automatic. (For continuous fire, the rate is 600 shots per minute.) Despite this high rate of fire, the noticeable recoil of the G11 is very low and the muzzle movement of the weapon very limited. While one can appreciate these facts by watching someone else fire the G11 and by studying the inventors' comments on the design, only personal experience with the rifle can fully convince the potential user that it represents a major step forward in the design of small caliber rifles. Tilo Möller, director of research and development (*Leiter der Entwicklung*), and his team of designers at Heckler & Koch have re-thought the military rifle. The result is a new concept for shoulder weapons.

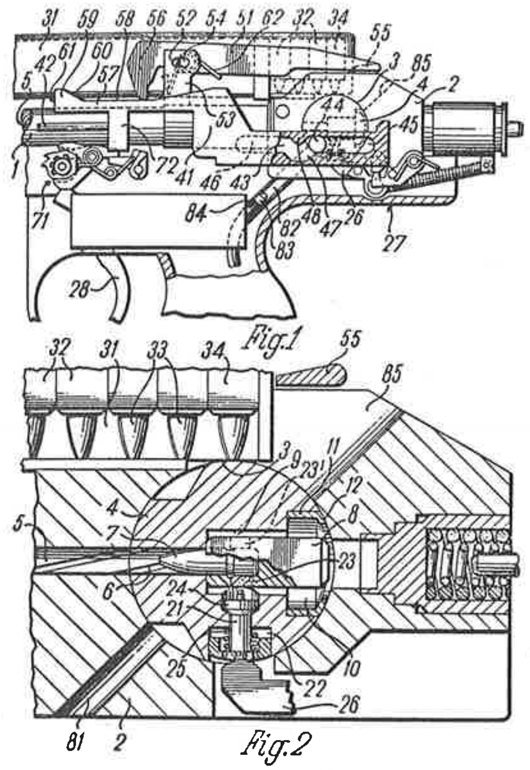
Design Assumptions

Möller and his associates began the development of the G11 by analyzing the role of the military rifle on the battlefield of the future. They assumed that future infantry actions would take place in a mobile, fluid environment, with infantrymen engaging their opponents at close range. Once they left their armored personnel carriers, they would have to carry their own supplies of ammunition. Möller and his colleagues, therefore, considered three primary objectives in the design of a new rifle: (1) it must have practical rates of fire that will produce the maximum hit probability; (2) it must be lightweight, so that the infantryman can carry a large amount of ammunition; and (3) its durability must be maximized.

Improved hit probability. Rifles, when fired in the continuous-fire mode, tend to be relatively inaccurate. This fact was clearly demonstrated in American Project SALVO studies conducted in the early 1950s. Since then, arms designers have attempted to reduce the dispersion of the projectiles leaving the muzzle of the rifle by reducing the intrinsic recoil force of the cartridge (e.g., by using smaller caliber projectiles) and by attaching devices to the muzzle of the weapon. The Heckler & Koch design team tried a new approach. In addition to single-shot fire, they incorporated a three-shot SALVO-type burst and full-automatic (continuous-fire) cycles into their design.

In the three-shot burst mode, the G11 fires at a cyclic rate of 2,000 shots per minute. The median dispersion is about 1.2 mil (i.e., 3.6cm at 300m), and the maximum dispersion is 2 mil (6cm

U.S. Patent Dec. 21, 1976 3,997,994



This patent drawing illustrates the early G11. Note the positioning of the hammer and firing pin (numbers 24 and 26) and the forward slanted exhaust port (number 81).

at 300m).* As a Heckler & Koch presentation notes, "A detailed analysis of shooting behavior by the typical infantryman under stressful combat condition shows that the normal single aimed shot misses because of aiming errors by the soldier. The hit probability of the shooter can be significantly increased by ensuring that the weapon has a built-in dispersion which takes into consideration the normal aiming error." Such a built-in dispersion pattern would not be practical in a weapon that fired only single shots or a conventional series of shots. In the G11, the controlled dispersion of the three-shot burst is independent of the shooter. Controlled dispersion is made possible by the G11's extremely high rate of fire and its reduced recoil.

The G11 can also be fired at full automatic, but the rate is only 600 shots per minute. Designers at H&K, knowing that rates above 700 shots per minute tend to waste ammunition and produce limited hits, reasoned that the G11's lower rate of fire, combined with the lower recoil of the cartridge, would provide a dispersion smaller than that generally encountered with conventional rifles. The lower rate of fire would also allow the infantryman to track his target more easily without worrying about inherent weapon accuracy. Rates of fire also affect another basic consideration—consumption of ammunition.

*A mil is the angle whose tangent is 1/1000; i.e., the angle subtended by 1 unit at a distance of 1000 units (e.g., 1 meter at 1000 meters).

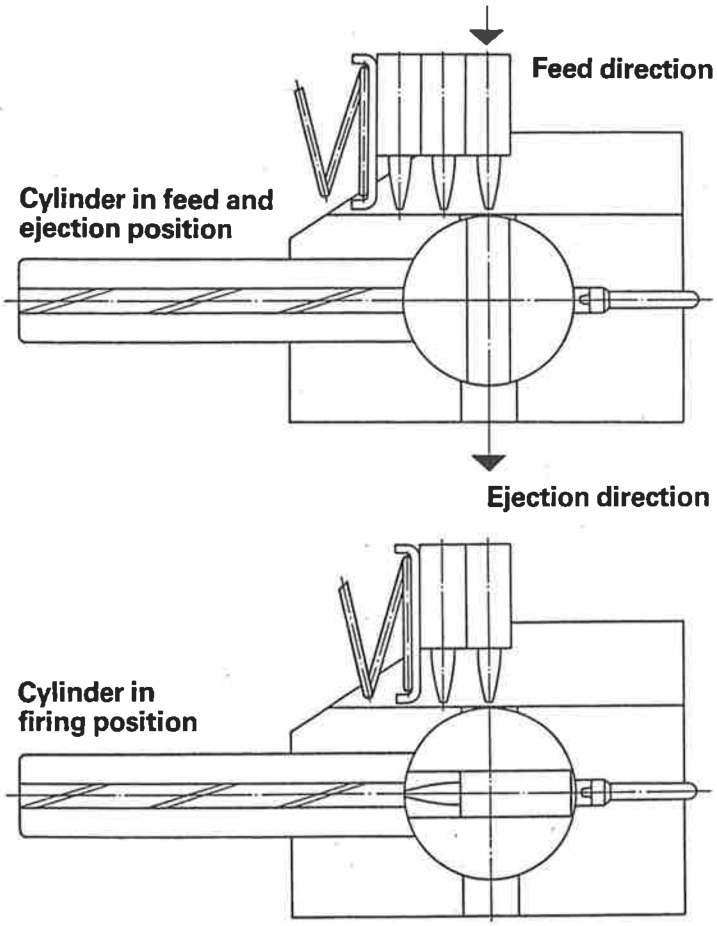
Lightweight weapon and cartridge. Over the past century, there has been a continuous reduction in caliber and an increase in velocity of shoulder-weapon projectiles. At the same time, we have seen the introduction of steadily improved small arms mechanisms that allow more ammunition to be fired through them. As a result, battlefield consumption of ammunition has increased dramatically. During the American Revolution (1776–1783), it was estimated that an infantryman had to discharge about seventeen shots from his musket to produce a single casualty among the opposing forces. During the Korean conflict and the Vietnam War (1950–1975), it has been estimated that at least 50,000 shots were discharged to produce one incapacitated enemy soldier. There are a multitude of reasons to explain the increase, but the significant point is that self-loading weapons make it easier to expend ammunition. Taking this into consideration, the Heckler & Koch design team decided it was necessary to keep the weight of the G11 as low as possible, so the user could carry the rifle and a large amount of ammunition comfortably. Since the NATO ammunition trials of 1976, Heckler & Koch engineers have reduced the weight of the G11 from 5.87 kilograms to 4.2 kilograms. Their goal, as they further simplify the weapon and reduce its number of component parts, is a weapon that weighs 3.6 kilograms empty and 4.5 kilograms with one hundred rounds of ammunition. Weight is directly related to weapon durability, another area of concern for Heckler & Koch.

Weapon durability. In combat, small arms take a beating in the hands of infantrymen. Whether the rifle is being bounced on the floor of an armored personnel carrier as it travels cross-country or is dragged along the ground as the soldier advances on his belly, it must be reasonably indestructible. With this in mind, Möller and his colleagues enclosed the G11 in a stamped sheet metal housing which gives the operating parts maximum protection. While this makes the G11 slightly heavier than some other weapons, the weight penalty is justified by the added longevity of the weapon in combat.

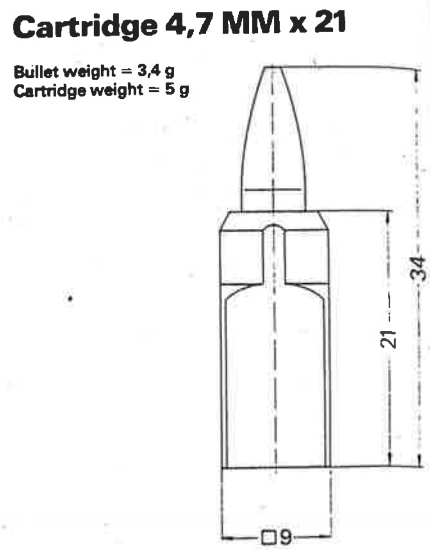
Conclusions about the Design

Looking at what was needed in a new weapon for the infantryman, Möller and the others concluded that caseless ammunition would help them reach their design goal. Caseless ammunition would have several advantages: (1) It would contribute less weight per cartridge to the weapon-ammunition system. (2) Short, compact cartridges would permit a shorter operating mechanism. (3) Elimination of extraction and ejection systems would open the way for the manufacture of a nearly sealed mechanism. The new weapon would be short enough and light enough to be an acceptable substitute for both the rifle and the submachine gun.

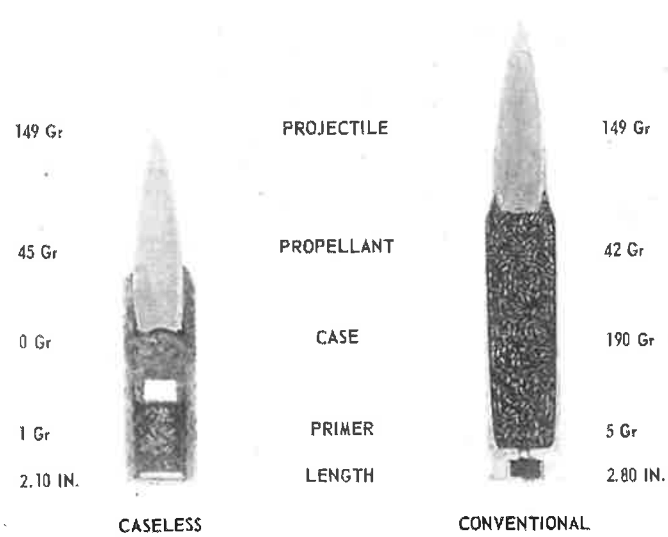
The concept of a caseless cartridge and gun system is not a new one. Nearly 150 years have passed since Johann Nikolaus von Dreyse introduced his paper-cartridge breech-loading *zundnadelgewehr.* But needle-fire rifles were replaced in the 1860s and 1870s by shoulder weapons that used cased metallic cartridges, because caseless rifles had two major faults. First, the breech seal (obturation) had been difficult to perfect and tended to erode over time, and second, the caseless cartridges, whether made of paper or cloth, could be damaged more easily than brass-cased cartridges. When American ordnance engineers began to experiment with caseless cartridges in the 1950s and 1960s, they added a new problem to the defects traditionally associated with such ammunition. After a few shots were fired from self-loading weapons, the heat that was retained in the chamber section of the barrel would ignite the uninsulated propellant of the caseless cartridges. Obturation, fragility, and cook-offs seemed to be major stumbling blocks that would prevent



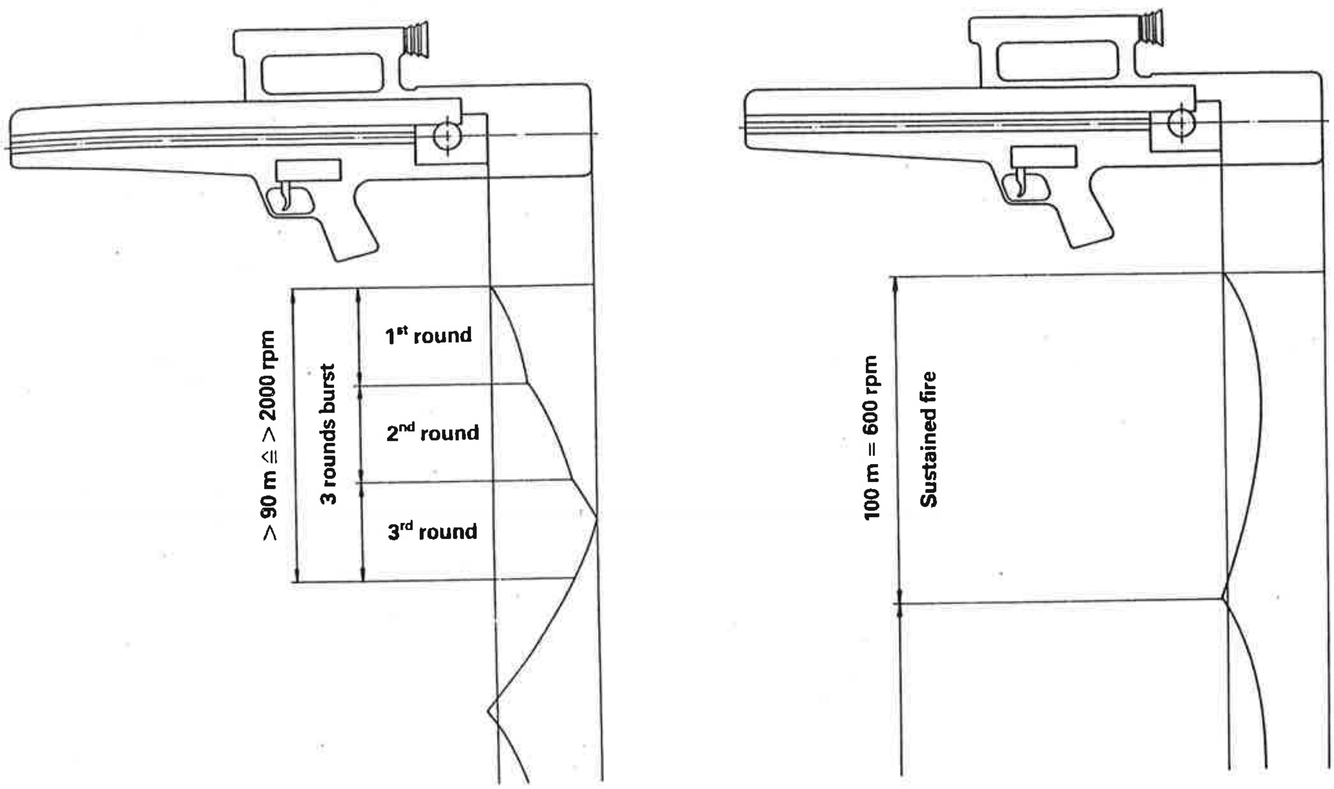
Simplified diagram of the G11 operating mechanism. Note the repositioning of the firing pin and the exhaust port.



The 1982 version of the G11 cartridge. Note the square cross section.



Experimental United States caseless 7.62mm cartridge from the late 1960s. Note the round cross section.



Simplified diagram of the recoiling parts of the G11. Note that the operating mechanism travels once to the rear during the three-shot burst and to the rear with each shot during sustained automatic fire.

the perfection of a caseless ammunition and weapon system in infantry calibers.

These problems challenged the engineers at Heckler & Koch. In 1969, they began to experiment with mechanisms that might be employed to transport, feed, contain, and seal caseless cartridges during the shooting cycle. Their first attempts were essentially the conversions of conventional self-loading mechanisms with linear bolt movements. These first steps sufficiently demonstrated the need for a new type of operating mechanism. From these experiments emerged the cylinder bolt of the G11.

The heart of the G11 is a cylindrical breech piece (*walzenverschluss*) that rotates about an axis at right angles to the bore of the barrel. A cartridge chamber was created by boring a hole across the line of the axis of the breech. When the weapon is loaded, the chamber is aligned with the axis of the barrel. The firing pin in the current models serves a dual function; it detonates the cartridge primer and acts as an obturator that seals off the breech end of the chamber. During the reloading cycle, the breech cylinder rotates ninety degrees clockwise. When it comes to a halt, a cartridge is fed into the chamber, and a cover plate opens on the underside of the rifle allowing any propellant residue or gas to be vented downward. Since it was first introduced in 1973, the cylinder breech has benefited from several refinements. In the earliest versions, the firing pin was mounted at ninety degrees to the axis of the cartridge with the primer located on the downward-facing side of the cartridge.

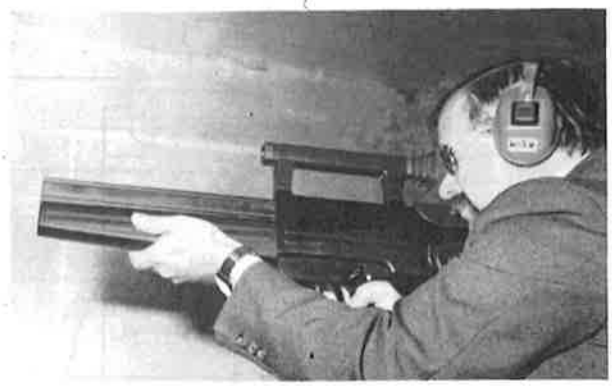
By the time of the 1977 NATO small arms trials, Heckler & Koch had reached the fifth generation of its G11 prototypes. As noted previously, in the course of those technical trials, premature discharges caused by overheating of the cartridges in the cylinder breech forced the Germans to withdraw the G11 and its ammunition. The Dynamit Nobel cartridges used in 1977 were molded from a nitrocellulose-based propellant (NC), cook-off temperature for which was about 178° C. This temperature was often reached after as few as seven or eight shots.

The 1976 vintage 4.7 × 21mm cartridge had an overall length of 32.5mm (from base of cartridge to tip of projectile), as compared to 57.4mm for the 5.56 × 45mm round. This version of the 4.7 × 21mm OH cartridge had an octagonal cross section; across the widest flat it measured 11.2mm and across the other major flat 8mm. The molded propellant was 20.9mm long; hence, the 21mm designation. The projectile had a diameter of 4.92mm, and the polygonally rifled barrel of the G11 measured 4.74mm across the lands (the high point of the rifling).

The propellant started out as loose powder of a predetermined shape and particle size. After surface treatments and moisture control but without the addition of adhesives or binders, it was compressed under very high pressure into the shape of a cartridge cut in half lengthwise. A prefabricated booster charge was inserted between two halves of the molded propellant before they were sealed together into a single unit by a solvent. The two booster charges served different functions. The one located in front of the primer unit served as an anvil against which the primer could be detonated. A larger charge located behind the bullet acted to disintegrate the propellant charge so that a large surface area was exposed to combustion. The gas pressure curve of this type of cartridge was similar to that of metallic case cartridges with like propellant weights. The entire cartridge was coated with a protective finish (a methatrylade resin) to stabilize it mechanically and environmentally. Its essentially rectangular shape allowed for more efficient packaging in the magazine.

The 3.4-gram (52.5-grain) bullet used in the 4.7 × 21mm OH cartridge was long—23mm—to provide the maximum sectional density. Its ogive offered optimum exterior and target ballistics. Coated inside and out with gilding metal, the projectile had a steel jacket and a lead core. The deep groove at the rear of the

The 1982 family of 4.7 × 21mm caseless cartridges. ***Top row,*** **ball projectiles;** ***bottom row,*** **tracers, plastic training rounds, and blanks.**



The G11 in 1982.

bullet served to anchor it to the propellant body and helped to prevent the core and jacket from separating upon impacting the target. When the cartridge was chambered in the rotating cylinder housing, the projectile was preseated in a portion of the rifle bore that was contained in that housing. It was reported that the 4.7mm projectile would penetrate one side of the FRG helmet at 600 meters. Tracer cartridges and a special exercise (maneuver) cartridge with plastic bullet were also developed. In tl blank cartridge, the bullet was replaced by a larger forward boost charge so that the weapon would function properly.

Until Heckler & Koch was forced to pull its entry from tl NATO trials, the development of the G11 ammunition-weap system was a joint venture of the German government, Heckl & Koch, and Dynamit Nobel. After the disappointing showir the government withdrew its support, leaving the two manufa turers to continue the G11 project with their own funds. Heckl & Koch engineers went on to build more prototypes, each o more refined than its predecessor. Among the externally obvio

G11 Rifle

Left side view of the G11.

changes was the shift from a complicated cocking level assembly beneath the barrel to a simpler one mounted on the left side of the rifle's housing behind the trigger guard. More significant were the internal changes in design that simplified the mechanism and improved the transfer of heat away from the cartridge chamber. Exact details of these changes are carefully guarded by Heckler & Koch because they are in large part the reason for the weapon's improved performance.

After the 1977 trials, the ammunition firm, Dynamit Nobel, set to work on a high-ignition-temperature propellant (HITP) with a cook-off point at least 100° C. higher than that of the earlier NC cartridges. By the time Dynamit Nobel had readied this new ammunition, Heckler & Koch had completed the tenth-generation G11 prototype. The performance of this rifle and the HITP ammunition was markedly improved in terms of both resistance to cook-off and dispersion control, so improved that the G11 again captured the fiscal support of the German government. It is important to note that because of their investment of private resources, Heckler & Koch and Dynamit Nobel have a proprietary control over the exploitation of the G11 technology. By the winter of 1981, Heckler & Koch had reached prototype generation 13.

Generation 13

According to Heckler & Koch, the cylinder breech of the G11 has several advantages over conventional linear bolt mechanisms. These include (1) simplified design with a minimum number of parts; (2) shortened overall weapon length with a longer barrel for the given weapon length (it is not necessary to accommodate the linear travel of a bolt); and (3) the short bolt travel and the simple feed process, which make very high rates of fire possible. There are also other features unique to the G11.

All of the mechanical parts of the weapon, with the exception of the trigger, the firing-mode selector, and the cocking handle, are enclosed in the weapon's sheet metal housing. All of these parts float within that housing. Upon the detonation of the primer and the exit of the projectile from the muzzle, the entire operating mechanism—including the magazine above the barrel—recoils to the rear. At the same time, the cylinder breech rotates 90 degrees to pick up another cartridge. In the three-shot mode, the hammer initiates firing of the second and third cartridges as soon as the reloaded breech is properly aligned. During the three locking and firing cycles, the recoiling parts move to the rear with ever-increasing velocity. The shooter experiences only a single recoil impulse, and that impulse is not as great as that experienced with existing 5.56mm rifles. Still, the recoil of the three-shot burst is greater than that of the G11's single-shot and is distinctive when compared with its continuous-fire mode. The weapon's mechanism returns to the original point of aim relatively easily after each three-shot burst.

When continuous fire is indicated on the ambidextrous selector lever, the hammer remains cocked after the first round has been fired and the weapon has completed a full recoil stroke. Therefore, the rate of fire is not determined by the movement of the breech mechanism; it is controlled by the independent recoil mechanism. The G11 is very easily controlled when fired at the continuous rate of 600 shots per minute.

Möller and his fellow engineers have taken considerable care in the packaging of their G11 operating mechanism, and they have designed the G11 with the infantry rifleman in mind. They sought to minimize the number of protuberances and the number of openings into which dirt, water, and other substances could enter and to eliminate moving parts. And the engineers wanted to produce a weapon that could be aimed instinctively from the shoulder or the hip.

The G11's sheet metal housing surrounds all of the operating parts, including the barrel, but excluding the 50-shot magazine that lies horizontally along the axis of the barrel. With the exception of the barrel's bore opening, the weapon is completely sealed from dirt and moisture; the trigger has a flexible seal, the magazine catch release button is sealed, and the exhaust port on the rifle's underside opens for only a fraction of a second after each shot is fired. The cocking handle, a circular device that rotates 360 degrees to charge the cylinder breech, cannot get in the shooter's way or snag on clothing or other things. This loading device does not rotate during the firing of the weapon. Above the barrel, the horizontal magazine reciprocates with the motion of the barrel, but it, too, is designed to keep foreign matter out of the interior of the rifle. The smooth exterior surface of the G11 offers some other advantages. The sheet metal housing has limited infrared and reflectivity (there is no exposed barrel to provide an IR signature). Additionally, it can be easily decontaminated in the event of exposure to chemical, biological, or nuclear agents. But the most important point for the user is the ease with which the G11 can be carried with one hand, possible because the weapon's center of gravity is slightly behind the pistol grip.

Heckler & Koch's engineers have included a single-power (1 × 1) optical sighting device on the G11 to assist the user with instinctive aiming. Since this sight aid does not magnify, the rifleman can keep both eyes open as he observes the field of fire. The sights currently mounted on the G11 have an illuminated reticle to help acquire targets under poor lighting conditions. To conserve battery energy, this moderately priced sight, which was designed so that it could be mass produced, has a timer in the circuitry to shut off the reticle illumination after three minutes.

4.7 × 21mm OH Ammunition

The G11 is only half the story. Without a reliable and perfected ammunition, the best mechanism would not be suitable as a military weapon. While the molding process for the newest Dynamit Nobel caseless ammunition is essentially the same as that described previously, the exterior and interior designs of the 1981 version of the caseless cartridge were significantly changed from the 1976 ammunition. Instead of having a rectangular cross section, the current ammunition is essentially 9mm square. The improved cartridges were 34mm overall, compared with 32.5mm for the 1976 round. It is impossible to improperly load the cartridge into the magazine because of the square cross section. Whereas the booster charge in the 1976 cartridge was loaded from the bullet end of the cartridge, in the 1981 type it is loaded from the rear. In comparison with the conventional metal cartridge case, the flat surfaces of the caseless cartridges allow it to be loaded into the magazine without the dead spaces. Heckler & Koch specialists also report that the caseless cartridges feed with less friction than that experienced with metal cases. A slightly flattened tip on the projectile aids its movement in the magazine.

Ballistic Performance

The Dynamit Nobel cartridge meets all major NATO criteria for rifle cartridges. Its effective range is in excess of the required 300 meters, and the trajectory elevation at that range (300 meters) is only 0.17 meters (NATO technical specifications call for 0.25 meters). To obtain optimum terminal ballistic performance, the very slender ogive and the long length were retained, which produced a high cross-sectional density (i.e., weight of the projectile divided by the diameter squared).* Because of its high cross-sectional density, the 4.7mm projectile has low sensitivity to crosswinds. For example, the bullet will drift only 0.275 meters at 600 meters in a 1-meter-per-second crosswind. The side drift of the M193 5.56mm ball projectile is about 0.338 meters, and it is even greater for the 7.62mm NATO bullet.

How good is the G11 and its ammunition from a ballistic standpoint? This will certainly be a topic of much debate over the next five years. In basic considerations, such as helmet penetration, the 4.7mm exceeds that of the United States M193 projectile. At the most common combat ranges (under 300 meters), the German cartridge is comparable to the Fabrique Nationale SS109 (XM855), but the 4.7mm cartridge produces a lower kinetic energy than either the M193 or the SS109 (XM855). Since there are still many military people who are not yet convinced that the 5.56mm cartridge is an acceptable substitute for the larger, heavier 7.62mm NATO round, Heckler & Koch personnel may have a difficult time convincing potential users and buyers of the G11 weapon-ammunition system that it has sufficient incapacitating power. Assuring the doubters of the 4.7mm's suitability will surely require a long and arduous process of teaching by the Heckler & Koch–Dynamit Nobel team.

It should also be noted that Heckler & Koch ballisticians, working with their colleagues at Dynamit Nobel, have tailored the terminal ballistics of their 4.7mm projectile so that it satisfies International Red Cross requirements regarding humane wounding effects. Fabrique Nationale took similar steps when they developed the SS109 projectile. The 4.7mm bullet will not distort in human targets, being relatively stable even at short ranges. Some future judges of the G11 system may well question if complying with such guidelines does not run counter to the goal of providing a weapon-ammunition system with maximum incapacitating capabilities. It is precisely the tumbling of the American 5.56mm M193 and the Soviet 5.45mm M74 projectiles that makes them so lethal and devastating. Being marginally stable as they pass through the air, they lose their stability and tumble when they strike the denser medium of human flesh. As they tumble, they tear the flesh, but more significantly they dump their kinetic energy quickly into the target. It is that sudden energy dump that results in serious incapacitating wounds or death. Very stable projectiles pass quickly through the target and do a minimum of traumatic damage from the release of kinetic energy. Humane bullets versus effective incapacitating projectiles is an issue that continues to demand closer scrutiny by military and civilian authorities.

Shooting the G11

At best, these technical details can give the potential user only a partial understanding of the unique character of the G11. When he picks up the new rifle for the first time, however, he will notice at once that it fits the shooting hand very well and that there are some significant differences in the G11. The magazine catch release, the magazine, and the cocking device are all located in unorthodox positions. After a few minutes of handling the weapon, they still may seem strange, but they are also very logically placed. Loading the weapon begins with withdrawal of the 50-shot magazine and loading the feed device with 25-shot charger clips. It is anticipated that the G11 will be issued with one sheet steel magazine. Fifty-shot (two 25-shot chargers back-to-back) loaders will be carried on armored personnel carriers. Men afoot on the battlefield will be issued 10-shot chargers. After two quick strokes, the magazine is loaded and inserted into the rifle. With the left hand, the shooter turns the charger clockwise a full 360 degrees. This loads the chamber and cocks the G11; it is ready to fire.

In the single-shot mode, the G11 behaves much like other small caliber military rifles. The perceived recoil is mild, and the sight is easily brought back on target. It may be disconcerting at first, however, not to have cartridges flying about and getting underfoot. Shooting the G11 in the three-shot burst mode is quite unique. At two thousand shots per minute, the three shots produce what appears to be a lengthy but single report. Unlike a product-improved M16A1 or the FNC, which both have three-shot burst control, the G11 will not give the shooter the sensation of three separate shots being fired.* And, the three rounds are gone before the user has a change to worry about keeping the weapon on target; the recoil is that of a single shot. To the author, the recoil from a three-round burst felt roughly equivalent to the recoil of a single shot fired from the Colt M16A1 or the Fabrique Nationale FNC. Although quite comfortable, the recoil of the three-shot burst was appreciably greater than the recoil of a single shot from the G11 or of the individual shots of the continuous-fire mode. The moderate rate of the continuous-fire cycle (600 shots per minute) allows the shooter to control the rifle from either a sandbag rest or the offhand position.

During the shooting demonstration at Fort Benning and during the author's firing experience in Oberndorf, an improved version of the nitrocellulose-type (NC) caseless cartridge was used. The manufacturers are saving the high-ignition-temperature propellant cartridge for more serious shooting, and they are continuing to guard this HITP ammunition from possible competitors who might wish to analyze its composition. Even with the NC ammunition, there were no cook-offs. At Fort Benning, several magazines were fired from three different rifles. At Oberndorf, one G11 (serial number 64) was fired for more than 200 shots. The shooting varied from a series of single shots to a number of three-shot bursts and several long strings of continuous fire. The Heckler & Koch test shooters reported that there was no reason to worry about cook-offs, and the HITP ammunition would produce even lower probabilities of premature firings. During the Fort Benning and the Oberndorf firing sessions, there were no malfunctions. It is readily apparent that Heckler & Koch has made significant improvements in the performance and safety of the G11 since it was tested by NATO in 1977.

Marketing the G11

Heckler & Koch military sales personnel realize that selling the G11 will be a challenging task. With the recent standardization of the 5.56 × 45mm (SS109-XM855) cartridge as the second NATO infantry caliber, Heckler & Koch and Dynamit Nobel will have to convince the NATO armed forces that the 4.7 × 21mm caseless cartridge merits early consideration as a substitute for the 5.56mm NATO round. However, two steps are being taken that may assist the firms in their effort to sell the G11 and its ammunition: The German armed forces plan to test

*Sectional density (w/d^2) exercises an important influence on the projectile's ability to retain velocity as it travels toward the target. The air pressure retarding the projectile, which builds up in front of the bullet, is greater as the diameter of the projectile is increased. Likewise, the kinetic energy of heavier bullets is greater than it is for lighter bullets traveling the same velocity. The heavier a bullet is in proportion to its diameter, the higher its sectional density and the more efficient it will be in boring through the air. Density and velocity affect the projectile's performance in crosswinds.

*When set on full automatic, the M16A1 and the FNC tend to rise after six or eight rounds have been fired. For this reason, three-shot burst control units were developed for both weapons. When fired in this mode, the rifle can be held on target because the automatic cycle is interrupted before the muzzle begins to climb.

this weapon-ammunition system, and the United States Department of Defense has formalized an agreement that will allow the United States to share the Germans' new small arms technology. The US project is called the Caseless Ammunition Rifle System (CARS).

Development tests of the improved G11 began at the Meppen Proving Ground in the FRG in August 1981. Operational testing is scheduled to start at Hammelburg in early 1983. During the Hammelburg tests, about twenty-five G11s will be subjected to rigorous field trials over twelve to eighteen months. If the rifle and its ammunition are found satisfactory, standardization of the weapon for the *Bundeswehr* would take place in 1984. Limited fielding of the rifle with the *Fernspaher,* a special reconnaissance force, would begin in 1986. Because defense funds for procuring new equipment are limited, general fielding of the G11 would not begin until the late 1980s. Although the German Ministry of Defense is prepared to proceed unilaterally with the standardization and fielding of the new rifle, it hopes for cooperation on this project from its NATO allies.

In November 1981, United States Department of Defense officials began discussing the possibility of participating in the continuing development of Dynamit Nobel's caseless ammunition and Heckler & Koch's "mechanism technology". By the end of November, a draft memorandum of agreement (MOA) between the United States Department of Defense (DOD) and the German Ministry of Defense (MOD) was being circulated in Washington and Bonn. This MOA did not speak directly to the G11 because there was (and is currently) no official American "requirement" for an infantry rifle beyond the M16A1. In the absence of such a requirement, DOD officials can talk only about mechanisms and technology in the abstract. It is understood that the draft MOA involves possible American participation in technical assessments of ammunition and mechanisms (i.e., G11 prototypes), joint U.S.-FRG troop evaluations, the development of a joint U.S.-FRG requirement and specification for a caseless ammunition-weapon system, and finally, a joint project to select an advanced rifle based upon a joint U.S.-FRG requirement and specification.

American and German officials have different motives for pursuing this memorandum. The Americans want to become involved with the Germans at this point so they are not locked out of this revolutionary ammunition-weapon project. The Germans realize that an American decision to adopt a caseless ammunition-weapon would enhance their attempts to sell the system to other members of NATO. But discussions at senior DOD-MOD levels do not always reflect the prevailing opinions held by staffers at lower working levels of these two organizations. In the United States, especially, many people will have to be convinced that the caseless ammunition-weapon concept is viable. As part of an educational campaign, Heckler & Koch demonstrated the G11 weapon and ammunition at a number of American military installations during the spring of 1982. Failures to immediately sell the G11 to the Americans would not kill this development project. On the other hand, if the Americans decide to participate, the whole undertaking will receive an immeasurable boost. But then Heckler & Koch, Dynamit Nobel, and the German Ministry of Defense would have to beware of the Americans' general tendency to join a project and then try to dominate its management.

FABRIQUE NATIONALE FNC

Successor to the FN CAL, the 5.56 × 45mm FNC is major competition for both the M16A1 and the G11. The FNC has a bolt and bolt carrier assembly that is quite similar in concept to that of the Kalashnikov assault rifles. Its upper receiver is stamped sheet metal and its lower receiver is made from an aluminum casting. As with the PIP M16A1 rifle, the FNC has a 3-shot burst setting. It also has a full automatic setting. FNC designers decided to use the M16A1-type magazine to insure interoperability with the M16A1 and the M249 squad automatic weapon (Minimi). Sweden and Indonesia have adopted the FNC as their newest infantry rifle. Additional details are presented in Chapter 9.

HECKLER & KOCH G41

A redesigned version of the 5.56 × 45mm HK33 series, the Gewehr 41 incorporates a longer barrel (480mm [18.9 inches] versus 390mm [15.4 inches]); a M16A1-style handguard; redesigned trigger assembly and pistol grip (single-shot, 3-shot, and full automatic fire modes); dust cover for ejection port; bolt-hold open device, forward bolt assist; carrying handle; and new NATO standard telescopic sight mounting points. The G41 also uses the M16A1 magazine and can take the M16A1 bipod. Additional details are presented in Chapter 21.

THE SINGAPORE ASSAULT RIFLE (SAR 80)

Chartered Industries of Singapore Pte. Ltd., after nearly a decade of producing the American Colt M16A1 Rifle under license, is perfecting a 5.56mm selective-fire rifle and has under development a 5.56mm light machine gun. CIS, as this government-owned manufacturing company is known on the island republic, was created in 1967 to produce military equipment and mint coins. Experience with manufacturing the M16A1 prompted CIS and the government to embark upon a new rifle project to answer long-standing complaints that the Singaporeans had about the American rifle. Many of the raw materials for the weapon—receiver forgings and barrel blanks, as well as smaller finished components—had to be purchased directly from the licensor, Colt Firearms Division of Colt Industries. In addition, the government-to-government agreement that allows CIS to produce the M16A1 requires Singapore to obtain United States State Department approval of sales of the rifle to third parties.

Borrowing a Technology Base

In 1966, the Singapore Armed Forces decided to purchase 5.56mm M16A1 Rifles to replace their 7.62mm NATO-caliber L1A1 Rifles, which were mostly Australian-made. Their first attempt to acquire the American weapon was thwarted when the United States Congress opposed the sale of 20,000 M16A1s to Singapore on the grounds that they were needed more desperately by American and Vietnamese forces in Southeast Asia. After a lengthy negotiation, Colt and the government of Singapore signed a contract permitting the Singaporeans to manufacture up to 150,000 M16A1 Rifles in a facility they were building in the new Jurong Town industrial community on the southwestern coast of the island. Colt trained technicians from Singapore at their factory in Hartford, Connecticut, in 1969 to 1970, and supervisory personnel from Colt reported to Singapore in June 1970 to help set up the production tooling. In March 1972, CIS delivered their first production rifles (50 to 100 pieces).

For the most part, Chartered Industries' rifle factory utilized general-purpose tooling that could be adapted to other uses. By late 1972, the Singaporeans realized that the CIS factory could not be operated economically. Its large number of employees plus the limited quantities of rifles (about eighty thousand) needed by the Singapore Armed Forces combined to keep profits down. Colt was understandably not enthusiastic about allowing CIS to

The Fabrique Nationale FNC field stripped. Note similarity of the bolt and bolt carrier assembly to that of the Kalashnikov weapons.

The Heckler & Koch 5.56 × 45mm HK33 rifle.

The Heckler & Koch G41. Note the longer barrel, redesigned handguard, modified lower receiver, carrying handle, and M16-type magazine.

compete with them for sales throughout Asia, especially when the American company learned that the Ministry of Defense was willing to permit the sale of CIS-made M16A1 Rifles at cost or below to keep the Jurong factory active. When Singapore successfully negotiated the sale of sixty thousand M16A1s to Thailand, they shared the delivery evenly with Colt, but both sides were dissatisfied with the arrangement. Colt officials surmised that Singapore would not be bound by State Department limitations on the sales of Singapore-made M16A1s, giving Singapore a market to which Colt did not have access. And Ministry of Defense personnel knew that Colt could control Singapore's export activities by limiting the availability of raw materials for which they could be charged a premium price.

From their experience with manufacturing the M16A1, CIS reasoned that they had the expertise to produce some other weapon—ideally a weapon that did not require limited-access raw materials and one that could be fabricated with their existing production tooling. Working toward this goal, CIS arranged for engineer Frank Waters of Sterling Armament Ltd. of Dagenham, Essex, in the United Kingdom—holder of production rights for the AR-18, a product of the firm that had created the M16 (AR-15)—to develop a modified version of the Armalite AR-18 5.56mm Rifle. During 1978, CIS was turning out prototypes of the Armalite-Sterling-Waters weapon. These first rifles were field-tested by the School of Infantry Weapons of the Singapore Armed Forces Training Institute (SAFTI), which found that the prototypes demonstrated problems of the type that could be expected with a new rifle.

Despite moderate troop enthusiasm for the Singapore Automatic Rifle (SAR), CIS went on with its program to improve the weapon. Early in 1980, about twenty-eight SAR 80's were gunsmithed together for additional testing. Since that time, CIS personnel have continued to work out the bugs in the SAR 80's design. Plans call for an initial production lot of several thousand rifles.

Design Features

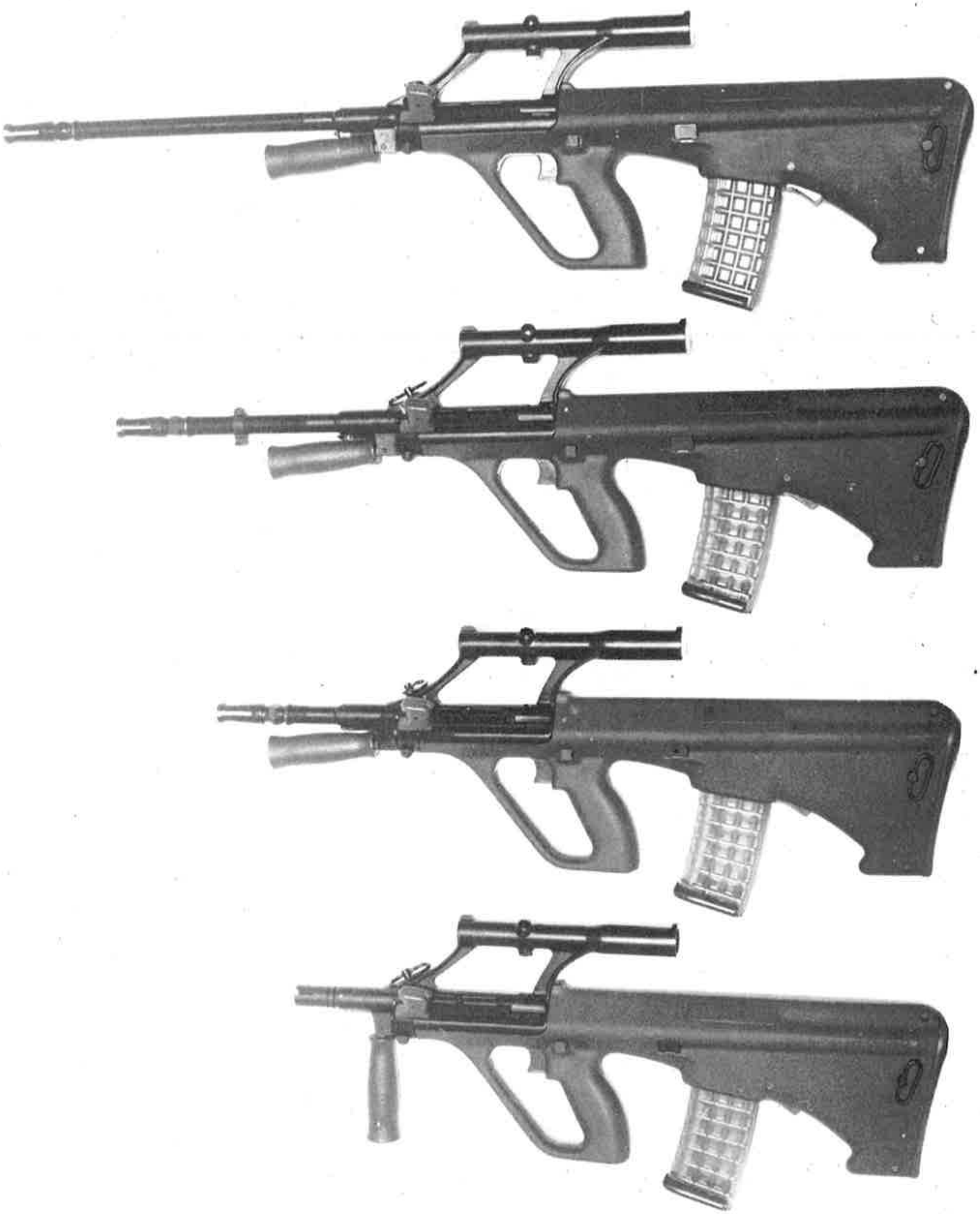
From a design standpoint, there is little new associated with the SAR 80. As with its direct ancestor, the AR-18, the Singapore rifle has a receiver made of stamped sheet metal. (The M16A1 upper and lower receiver components are machined from a special set of aluminum forgings.) A number of other components, such as the gas system regulator-front sight assembly and the flash suppressor, are produced by investment casting. At least 40 percent of the SAR 80's parts—screws, springs, and pins—can be purchased from small machine shops. The SAR 80 can use either of the M16A1 magazines; the 20-shot version is fabricated in Singapore, the 30-shot model is not. SAR 80 ammunition (M193 Ball and M196 Tracer) and the bayonet (the M7) are the same as those used with the Singapore M16A1. Additional details are discussed in Chapter 40.

STEYR AUG

Steyr-Daimler-Puch, in conjunction with the Austrian army, developed the *Armee Universal Gewehr* (AUG) in the mid-1970s as a 5.56 × 45mm replacement for the 7.62 × 51mm NATO caliber Stg. 58 (FAL). Initial serial production began in 1978 with

Sterling Armament Company's AR-18 5.56 × 45mm rifle.

Chartered Industries of Singapore 5.56 × 45mm SAR 80 assault rifle, which evolved from the AR-18.



Four versions of the Steyr Armee Universal Gewehr (AUG). ***Top to bottom:*** **light machine gun version with 610mm (24-inch) barrel; rifle variant with 508mm (20-inch) barrel; carbine with 407mm (16-inch) barrel; submachine gun with 305mm (12-inch) barrel.**

the first rifles being consigned to Austrian troops. Steyr has carried out an intensive sales campaign in an effort to sell this rifle to other unaligned nations. There are indications that Steyr has met with some success in the Middle East, especially in the United Arab Republic (Egypt). Attempts to sell to other countries (such as the People's Republic of China) have been opposed by the Soviets who argue that the Austrians must remain neutral under the post–World War II peace treaty.

The Steyr AUG is available in four different barrel lengths: submachine gun, carbine, rifle, and light machine gun. This weapon is also notable for the extensive use of synthetic (plastic) components including a see-through magazine that allows the shooter to tell how many rounds he has remaining. More details are given in Chapter 8.

LEADER DYNAMICS 5.56 × 45MM RIFLE

This 5.56 rifle was developed by Leader Dynamics, a relatively new arms firm established in Smithfield, New South Wales, Australia. Charles George of Sydney was the designer. The Leader Dynamics operating mechanism is quite similar in concept to the Armalite AR-18. There is a bolt and bolt carrier assembly like the AR-18, but the Leader Dynamics rifle bolt has three locking lugs instead of the eight lugs on the AR-18 bolt. Unlike the AR-18, the Leader Dynamics rifle has the operating rod handle mounted near the front sight. A very sturdy weapon, the Leader Dynamics rifle is expected to be a competitor in the forthcoming Australian 5.56mm rifle trials. Other serious contenders are the Colt M16A1 and the Fabrique Nationale FNC. For more details see Chapter 7.

SWISS RIFLES

The Eidgenossische Waffenfabrik, Bern (W + F) has been engaged in small arms design since the late nineteenth century. During that time, the Waffenfabrik has more or less been in competition with the commercial arms factory SIG Neuhausen for production of Swiss military arms. The W + F rifles currently being developed have an operating mechanism conceptually inspired by the Kalashnikov bolt mechanism. There are two calibers being tested, 6.45 × 48mm and 5.60 × 45mm, and two barrel lengths, 850mm (33.46-inch) and 1010mm (39.76-inch). The short barrel 6.45mm weapon is called the MP E21, and MP C41 in 5.60mm. The rifle versions are SG E22 and SG C42 respectively.

COMPARATIVE DATA FOR W + F AMMUNITION

	MP E21	SG E22	MP C41	SG C42
Caliber:	6.45 × 48	6.45 × 48	5.60 × 45	5.60 × 45
Muzzle velocity m/s:	770	990	780	900
(f.p.s.):	(2347)	(3018)	(2377)	(2743)
Energy O J:	1868	2552	1248	1660
(ft. lbs.):	(1378)	(1882)	(920)	(1224)
Weight of projectile:	6.3	6.3	4.1	4.1
(grains):	(97)	(97)	(63)	(63)

In mid-1983, the Swiss Army adopted a much modified SIG 542 rifle, the SG541 in 5.6 × 45mm, as the *Sturmgewehr* 90. Over the next twenty years, 600,000 of these rifles will be manufactured for the Swiss Army.

CETME MODELO "L"

This is a scaled-down version of the 7.62 × 51mm CETME rifle. The model "L" fires the M193 5.56 × 45mm, and it is available in a fixed butt stock version (400mm barrel) and a sliding stock version (320mm barrel). This weapon has been tested by the Spanish armed forces, but to date only small pilot quantities have been manufactured. See Chapter 42 for additional details.

FUSIL DE ASALTO ARGENTINO MODELO 81

Development of the FAA Modelo 81 began in April 1976 at the Fabrica Militar de Armes Portatiles "Domingo Matheu," at Rosario. Development was completed in March 1981 and in the spring of 1982 work began on a pilot lot of fifty rifles that will be used in comparative trials of 5.56 × 45mm rifles. Other leading contenders include the Fabrique Nationale FNC and the Colt M16A1. It is anticipated that the FAA Modelo 81 will be used to supplement the 7.62 × 51mm NATO FAL rifle. If and when this rifle goes into production (not before 1987), it will probably be issued to airborne and commando forces.

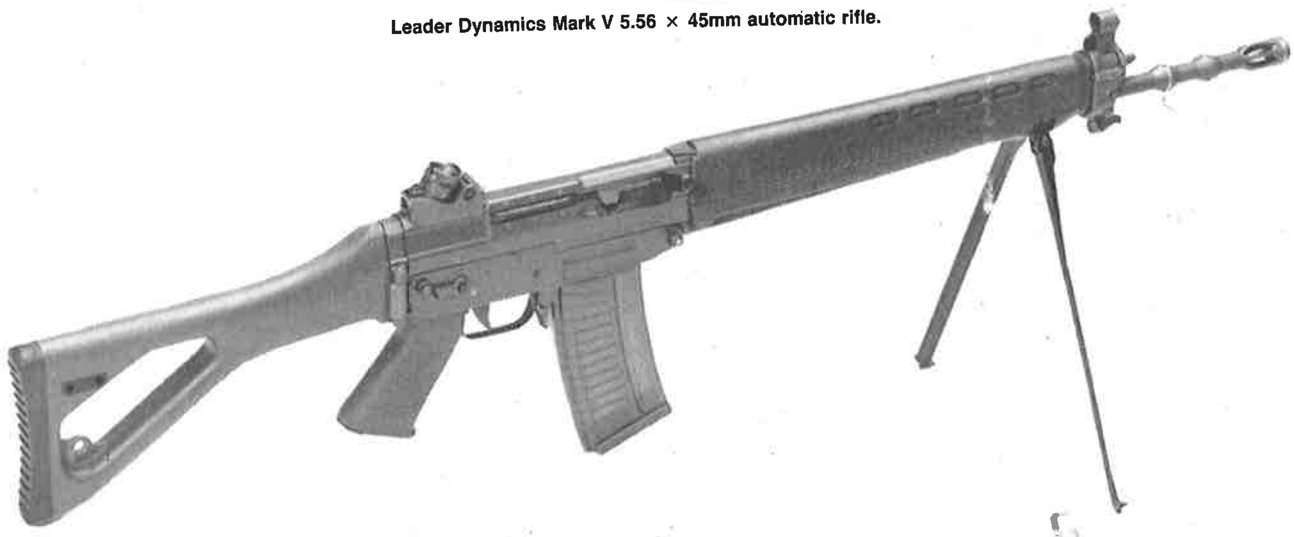
The FAA Modelo 81 incorporates a bolt, bolt carrier, and gas piston assembly similar in concept to the Kalashnikov family of rifles. Influence from the design of the Fabrique Nationale FAL, which is manufactured under license in Argentina, can be observed in the style of the upper and lower receivers and in the mechanism of the side-folding stock. The designers of the FAA Modelo 81, CETME Modelo "L", the Waffenfabrik Bern rifles, and the Leader Dynamics rifle all have made extensive use of sheet metal stampings, and synthetic materials have been used for the stocks and handguards. For more details on the FAA Modelo 81, see Chapter 6.

VARIATIONS ON A THEME: NEW VERSIONS OF THE KALASHNIKOV ASSAULT RIFLE

In recent years, American defense officials have been discussing plans for including a capability of qualitative upgrading of materiel after its initial introduction into service. Called preplanned product improvement (P^3I), this concept is intended to increase the service life of future systems and to reduce the costs involved in acquiring enhanced capabilities. If adaptability is a significant attribute of weapons systems, then the small arms of the Soviet Union should be examined as an excellent case in point. Nearly forty years have passed since Mikhail Timofeyevich Kalashnikov introduced the first prototypes for his famous assault rifle, and new variants of this basic weapon concept are still being developed within the Eastern Bloc. In this section is a pictorial roundup of some of the more recent additions to the growing family of Kalashnikov-derived weapons.

During the past thirty-five years three different approaches have been taken to the manufacture of the Kalashnikov assault rifles. From 1947 to about 1950, the Soviets tried unsuccessfully to manufacture a rifle, the receiver assembly of which combined sheet metal stampings and machined steel components. These early Kalashnikovs were not satisfactory because the rivets which held the components together were not reliable. Sometime after 1950, the Soviets introduced a Kalashnikov rifle with a receiver assembly that was machined from a steel forging. The second variant was widely copied in the Eastern Bloc and is the rifle that is usually called the AK-47. In 1959, the Soviet Army introduced the *Modernizirovannyi avtomat Kalashnikova* (AKM), which was a new design of a stamped sheet metal receiver. All of the subsequent variants on the Kalashnikov assault rifle have been built around the AKM receiver assembly.

Leader Dynamics Mark V 5.56 × 45mm automatic rifle.



SIG SG541 rifle, the new Swiss Army *Sturmgewehr 90.*

CETME 5.56 × 45mm Modelo "L" assault rifle.

Argentine FAA 81 5.56 × 45mm assault rifle.

From left to right: **A comparative view of the Soviet 5.45 × 39mm M74, the 5.6 × 39mm target and hunting round, the 7.62 × 39mm M43, the US 5.56 × 45mm M193.**

The 5.45 × 39mm AKS74 with side-folding stock.

Both the AK74 (*top*) and the RPKS74 fire the 5.45 × 39mm cartridge.

AK-74 Assault Rifle

This new rifle is of singular importance to the European military scene. After twenty-five years of cartridge standardization at the squad level within the Eastern Bloc, the Soviets made the decision in the mid-1970s to replace their 7.62 × 39mm family of weapons—AKM assault rifle and RPK light machine gun—with new versions of those weapons firing a 5.45 × 39mm family of cartridges. When the first reports of the new cartridge and weapons reached western analysts, they assumed that this new materiel would be utilized only by specialized units because of the cost and logistical problems involved in switching calibers and retiring the 7.62 × 39mm caliber weapons. Subsequent observations indicated that the Soviets planned a complete changeover to the smaller caliber. This has caused considerable speculation in the West as to possible tactical implications of the new ammunition.

The muzzle velocity of the Soviet 5.45mm projectile is 900 meters per second, compared to the 947.5 meters per second of the NATO standard SS109 bullet. The muzzle energy of the Soviet bullet is 1,385 joules, versus 1,796 joules for the SS109. As the accompanying chart indicates, the new Soviet 5.45mm cartridge has the lowest energy level of the four cartridges compared. This limited energy level raises some questions about the lethality of this projectile and what the Soviets were attempting to accomplish when they adopted this new caliber ammunition.

The 5.45mm Soviet projectile has a considerably flatter trajectory than the Soviet's 7.62 × 39mm ammunition, which should make it easier to hit targets out to 400 meters. But what will it do to the target when it hits it? The AK-74 rifle has a barrel with tight rifling (1mm to 203mm) twist so that the bullet is spun very rapidly. As a consequence, the bullet is very stable during its entire flight. That stability ends when the bullet enters a medium denser than air—such as the human body—because of its con-

Romanian version of the 7.62 × 39mm AKMS with folding stock.

East German 7.62 × 39mm KmS 72 version of the AKMS.

struction. The basic ball projectile of the 5.45mm cartridge has a gilding metal-plated mild steel jacket. Inside that jacket there is a lead sheath that surrounds a 15mm-long mild steel core. That core is mounted with its base at the base of the jacket. At the nose of the steel core is a 3mm lead plug, which is actually an extension of the lead sheath. In front of the lead plug is an air space about 5mm long. By placing the center of gravity of the projectile toward its rear, the bullet's designer ensured that the bullet would flip when it hit a human body. When the bullet begins to tumble, it rapidly dumps its remaining energy into the target. Lethality is the product of the amount of energy deposited into the target over time. Bullets such as the 7.62mm NATO round tend to be less lethal than the smaller high velocity projectiles because they exit the body carrying with them considerable residual energy. The small caliber bullets deposit most of their energy in the body causing substantially more damage to the target. Individuals who have experimented with the Soviet 5.45mm cartridge by firing it into gelatine blocks have noted that it makes a mess of the target blocks. Some of these people have expressed the hope that the International Red Cross will investigate the humaneness of the 5.45mm Soviet round.

The AK-74 assault rifle itself is essentially the same as the AKM, with the exception of a modified bolt head, which accommodates the smaller diameter case head of the 5.45 × 39mm cartridge, and a new and improved extractor, a new fiberglass reinforced plastic magazine, and very effective muzzle brake. Based upon fluidic principles of gas flow, this muzzle brake not only reduces the blast and noise levels produced when the weapon is fired, but also reduces recoil by counteracting the recoil with a forward and downward movement. As a result, this muzzle device is probably the most effective small caliber recoil reducer ever employed. The AK-74 is currently issued in two forms: one with a standard fixed wooden or plastic stock and one with a folding stock patterned after that used on the RPKS. The latter is designated AKS-74. For additional details see Chapter 46.

RPKS-74 Light Machine Gun

The Soviets have also issued a squad automatic weapon, *Ruchnoi pulemet Kalashnikov* (Kalishnikov light machine gun), chambered to fire the 5.54 × 39mm. Again, with the exception of a modified bolt, new magazine and new muzzle brake, this weapon is the same as the 7.62 × 39mm RPKS. A quick comparison of the muzzle brakes used with the AK-74 and the RPKS-74 disclose their differences. The muzzle device used on the RPKS-74 is patterned after the one used with the United States M16A1 Rifle. Accompanying photographs illustrate the operation of the RPKS-74 folding stock. For additional details see Chapters 2 and 46.

New Romanian Weapons

The Romanian armed forces have introduced three new versions of the AKM assault rifle; a folding stock AKM, a Romanian version of the RPK, and a Romanian-designed sniper rifle built around the operating mechanism of the RPK. These weapons are significant because they demonstrate a domestic small arms design capability in Romania and because at least the sniper rifle appears to have been created for the export trade. All of the new Romanian weapons begin with the basic AKM assault rifle mechanism. The Romanians have manufactured the AKM since the late 1960s, but only recently have they introduced the folding stock version or AKMS. All Romanian AKMs are distinguished by the forward pistol grip, which is fabricated from laminated wood.

Romanian RPK. The Romanian version of the RPF is essentially the same as the standard 7.62 × 39mm Soviet RPK. In the RPKs of both countries a heavier and longer barrel (591mm versus 414mm) has been substituted for the standard AKM barrel. Both RPKs can use a variety of magazines (30-, 40- and 75-shot) and both have bipods. Only the bipod is significantly different. The legs of the Romanian bipod can be adjusted for height, and the method of attaching the bipod is different.

Romanian Sniper Rifle. Technologically the Romanian Sniper Rifle is more interesting than the other two weapons because it fires the M1891 Russian cartridge, which is 15mm longer than the 7.62 × 39mm. Because the bolt of the AKM travels 30mm farther to the rear than is necessary to accommodate the 7.62 × 39mm cartridge, the Romanian designers were able to modify the standard AKM-type mechanism to fire the more powerful 7.62 × 54mm rimmed cartridge. First, they altered the bolt face to accommodate the larger rimmed base of the M1891 rifle cartridge, and they added a new barrel and lengthened the RPK-type gas piston system. The gas system of the Soviet Dragunov sniper rifle is more like that of the World War II Tokarev gas system than the Kalashnikov-type. Second, the Romanians developed their own 10-shot magazine, and they fabricated a skeleton stock from laminated wood. This butt stock, with its molded cheek rest, is probably slightly superior to the one used on the Dragunov. Third, the Romanians have riveted two steel reinforcing plates to the rear of the receiver to help absorb and spread the increased recoil of the more powerful M1981 cartridge. Finally, the Romanian designers have attached a muzzle brake of their own design. The standard AKM wire cutter bayonet can be used with this muzzle attachment. Perhaps the single most interesting feature of this Romanian sniper rifle is the markings on the telescope. The use of "right" and "left" in English on the windage markings seems to indicate that the Romanians plan to export this rifle. For additional details, see Chapters 5 and 39.

Yugoslavian Sniper Rifle

The Yugoslav arms designers have also introduced a sniper rifle based upon the AKM mechanism, but they have chambered it for the 7.9 × 57mm Mauser Rifle cartridge which they also use in their company machine gun. For additional details see Chapters 5 and 50.

German AKMS

The East German Army introduced a folding stock version of their AKM in 1972, but it was identified only recently by Western intelligence analysts. This weapon, the MPiKS 72, has a unique folding stock made of heavy gage wire. Unlike most folding stocks, this one swings to the right and lays along the right side of the weapon instead of the left. For additional details see Chapter 20.

The proliferation of Kalashnikov-type weapons—there is also the PK medium machine gun, which was introduced in 1961 and the new 12.7mm armor machine gun, which is believed to be a Kalashnikov design—indicates the flexibility and adaptability of Kalashnikov's basic rifle design. These variations on a basic theme also indicate that weapons can be given extended life if they can continue to be adapted to tactical requirements. The Soviets seem to have mastered the concept of preplanned product improvement.

COMPARATIVE DATA FOR SELECTED 5.56mm (AND SMALLER CALIBER) RIFLES

Model	Caliber	Barrel mm	Length (inches)	Overall mm	Length (inches)	Weight (Without Magazine) kg	(pounds)	Average Muzzle Velocity m.p.s.	(f.p.s.)
M16A1	5.56 × 45	508	(20)	990	(39)	3.3	(7.3)	991.75	(3250)
AR-18	5.56 × 45	457	(18)	965	(38)	3.1	(6.6)	990	(3250)
Stoner Rifle (XM22)	5.56 × 45	500	(20)	1006.3	(40.25)	3.6	(7.9)	991.75	(3250)
Stoner Carbine (XM23)	5.56 × 45	392.5	(15.7)	896.9	(35.9)	3.5	(7.7)	915	(3000)
HK33A2	5.56 × 45	390	(15.4)	920	(36.25)	3.65	(8.05)	920	(3018)
AR70/.223	5.56 × 45	442.5	(17.4)	925	(36.4)	3.4	(7.5)	969.9	(3182)
SIG 530	5.56 × 45	460	(18.1)	1005	(39.59)	3.55	(7.8)	970	(3183)
SIG 540	5.56 × 45	460	(18.1)	950	(37.4)	3.26	(7.18)	980	(3215)
Ruger Mini 14/20GB	5.56 × 45	470	(18.5)	984	(38.76)	2.89	(6.38)	1058	(3471)
FA-MAS	5.56 × 45	488	(19.23)	757	(29.82)	3.38	(7.45)	960	(3150)
MKS	5.56 × 45	467	(18.4)	868	(34.2)	2.75	(6.06)	9.75	(3200)
MKR	4.5 × 26RF	600	(23.64)	840	(33.1)	3.0	(6.6)	1020	(3347)
U.K. 4.85 I.W. XL64	4.85 × 49	510.3	(20.1)	757.5	(29.85)	3.09	(6.81)	900	(2953)
U.K. 5.56 I.W. XL70	5.56 × 45	518	(20.4)	770	(30.33)	3.12	(6.88)	900	(2953)
Steyr AUG	5.56 × 45	508	(20.02)	790	(31.13)	3.6	(7.93)	ca990	ca(3250)
Galil	5.56 × 45	460	(18.12)	979	(38.57)	3.9	(8.6)	980	(3215)
Taiwan Type 68	5.56 × 45								
FNC	5.56 × 45	450	(17.73)	997	(39.28)	3.8	(8.38)	9.65	(3166)
Valmet M82	5.56 × 45			710	(27.97)	3.3	(7.27)		
HKG11	4.7 × 21	540	(21.27)	750	(29.55)	3.6	(7.93)	930	(3051)
AK74	5.45 × 39	400	(15.76)	930	(36.64)	3.6	(7.93)	900	(2953)
Leader T2-MK5	5.56 × 45	410	(16.15)	910	(35.88)	3.4	(7.5)	975	(3200)
CIS SAR 80	5.56 × 45	459	(18.08)	970	(38.22)	3.7	(8.16)	970	(3183)
FAA 81	5.56 × 45	440	(17.34)	980	(38.6)	3.9	(8.6)	ca970	ca(3183)
HKG41	5.56 × 45	480	(18.9)	997	(39.3)	3.6	(7.94)	ca990	ca(3250)