25

Global Development and Production of Self-loading Service Rifles

1896 to the Present

By N.R. Jenzen-Jones

A Working Paper of the Small Arms Survey

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Published in Switzerland by the Small Arms Survey

First published in January 2017

Small Arms Survey
Graduate Institute of International and Development Studies
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1202 Geneva, Switzerland

Copy-edited by Alex Potter (alex.potter@mweb.co.za)
Proofread by Stephanie Huitson

Typeset in Optima and Palatino by Rick Jones

Printed by Gonnet in France

ISBN 978-2-940548-34-7

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Contents

List of boxes, figures, and tables **6**

Abbreviations and acronyms **7**

About the author **9**

Acknowledgements **10**

I. Introduction **11**

II. Concepts and methods **13**

III. History of the development of self-loading service rifles **15**

Historical background: early technological developments 15

Early self-loading service rifles 16

Self-loading service rifles after the Second World War 19

IV. Production of self-loading service rifles **30**

Licensed and unlicensed production 33

Production for the law enforcement and civilian markets 38

V. Durability and attrition ambiguity **40**

Durability and longevity of self-loading rifles 40

Repair, modification, and modernization of existing self-loading service rifles 43

VI. Conclusion **45**

Endnotes **47**

Bibliography **53**

List of boxes, figures, and tables

Boxes

1 Data sources and estimating techniques 14
2 Modular rifles 26
3 Cumulative and annual production of AK-type rifles 32
4 Current and historical holdings of self-loading service rifles in the Republic of Croatia 42

Figures

1 Total global production of self-loading service rifles 30

Tables

1 Global cumulative production of selected self-loading rifle types 31
2 Estimates of cumulative production of AK-type self-loading rifles 33
3 Examples of state security forces' holdings of obsolete small arms 41
4 Current status of Croatian Armed Forces' self-loading service rifles 43

Abbreviations and acronyms

AK	Avtomat Kalashnikova (Kalashnikov automatic rifle)
AK-74	Avtomat Kalashnikova obraztsa 1974 (Kalashnikov automatic rifle, model 1974)
AK-74M	Avtomat Kalashnikova obraztsa 1974 Modernizirovanniy (Kalashnikov automatic rifle, model 1974—modernized)
AKM	Avtomat Kalashnikov Modernizirovanniy (Kalashnikov automatic rifle—modernized)
AR-15	Armalite Rifle model 15
CETME	Centro de Estudios Técnicos de Materiales Especiales (Centre for Technical Studies of Special Materials)
FAL	Fusil Automatique Léger (light automatic rifle)
FAMAS	Fusil d'Assaut de la Manufacture d'Armes de Saint-Étienne (Assault rifle from the Saint-Étienne Weapons Factory)
G3	Automatisches Gewehr 3 (automatic rifle 3)
IP	Intellectual property
ISAF	International Security Assistance Force
ITI	International Tracing Instrument
Mle 17	Fusil Automatique Modèle 1917 RSC (automatic rifle, model 1917)
M1896	Model 1896 Rekylkarabin til flåden (Reculgevær) (model 1896 recoil carbine for the Navy)
M1908	Fusil Porfirio Diaz Sistema Mondragón Modelo 1908 (Porfirio Diaz Mondragon system rifle, model 1908)
NATO	North Atlantic Treaty Organization
SA80	Small Arms for the 1980s
SCAR	Special Operations Combat Assault Rifle

SCHV	Small-calibre, high-velocity
SIG	Schweizerische Industriegesellschaft (Swiss Industry Company)
StG 44	Sturmgewehr 44 (assault rifle 44)
SVT-40	Samozaryadnaya Vintovka Tokareva obraztsa 1940 (Tokarev self-loading rifle, model 1940)
TDP	Technical data package
UK	United Kingdom
US	United States
USSOCOM	US Special Operations Command

About the author

N.R. Jenzen-Jones is a military arms and munitions specialist and security analyst who focuses on current and recent conflicts. He is the Small Arms Survey's technical specialist and director of Armament Research Services (ARES), a specialist technical intelligence consultancy. He has produced extensive research and analysis on a range of small arms and small arms ammunition issues, as well as technical assessments of incendiary weapons, emergent arms technology, and arms proliferation. His other research fields include the exploitation of technical intelligence to support counter-piracy, counter-narcotics, and other operations. He is a qualified armourer and ammunition collector, and a member of the European Cartridge Research Association, the International Ammunition Association, and the International Ballistics Society.

Acknowledgements

The author would like to extend his sincere thanks to the numerous individuals and organizations that assisted in the production of this study. In particular, the contributions of Jonathan Ferguson and Ian McCollum of Armament Research Services, Frank Iannamico, Aaron Karp, and Julio Montes were critical to this study. Many other individuals also shared their insights and technical expertise. While several people cannot be named for reasons of security or commercial sensitivity, thanks are also due to Yuri Lyamin, Graeme Rice, and Michael Smallwood of Armament Research Services; to Eric Berman, Benjamin King, Glenn McDonald, and Matt Schroeder at the Small Arms Survey; and to Martin Andrew, Maxim Popenker, and Anthony G. Williams.

The author would also like to acknowledge the contribution of the British and Croatian Ministries of Defence for their willingness to provide details of current and historical holdings of self-loading rifles, and related considerations.

I. Introduction

Technological innovations in the mid-to-late 1800s paved the way for the development of self-loading rifles, which were first issued in military service in 1896. These weapons remain the primary infantry weapon for all modern military forces, although their adoption has been affected by factors such as cost, tradition, and intended role. During the Second World War, self-loading rifles attained a prominence in military forces that endures to this day. Self-loading rifles are durable, and weapons produced in the 1930s and 1940s are still documented in modern conflict zones.

This study primarily concerns itself with the development of modern self-loading service rifles, and with classifying and counting them.[1] While these rifles can be classified with little difficulty on the basis of their inherent technical characteristics and mechanical functions, counting the number of rifles that have been produced worldwide is more challenging. The development of many self-loading rifles—certainly the major types—is relatively well understood; however, this study also examines the dispersion and adoption of these designs and the cumulative production of self-loading rifles globally, to the extent allowed by available data. No international mechanism is available to facilitate the reporting of the numbers and types of self-loading rifles held by states. More effective stockpile management and preventive action to halt the illicit proliferation of self-loading rifles relies on understanding how best to classify and count these weapons.

While recognizing these limitations, the study presents the following key findings:

- Early self-loading rifles were not very reliable, particularly in the field, as a result of the complexity of their moving parts. While they saw service in the First World War, it was not until the inter-war period that state militaries acquired and used them in significant numbers.
- Self-loading service rifles of the First and Second World Wars tended to be produced by states' existing manufacturing infrastructures. After the Second

World War, significant quantities of rifles were licensed for production outside their countries of origin.

- Intermediate-calibre and, later, small-calibre, high-velocity cartridges began to be adopted after the Second World War, and it is these cartridges that are used with the majority of self-loading rifles in service with world militaries today.
- While many different models of self-loading service rifles have been produced, 4 families of rifles that remain in production to the present day have been produced in numbers exceeding 5 million units: AK-type rifles (an estimated 76 million), AR-10 and AR-15 types (est. 13 million), G3 types (est. 8 million), and FAL types (est. 5.5 million). Some 175 million self-loading service rifles are believed to have been produced to date.
- The increasing popularity of modular firearms, as well as the repair, modification, and modernization of self-loading service rifles, can impede attempts to accurately classify and count such weapons; these factors also complicate basic marking, record-keeping, and tracing practices.
- Self-loading rifles are durable manufactured goods, and it is not uncommon to find weapons in excess of 60 years old in modern conflict zones.

This study starts by reviewing the developmental history of self-loading service rifles, beginning with the technological advances that paved the way for their introduction, followed by descriptions of early self-loading rifles, their post-Second World War counterparts, and the advent of modular weapons. The study then assesses the global production of self-loading service rifles, with Table 1 providing estimated cumulative production figures for key rifle types. The study includes sections on licensed and unlicensed production, as well as production for the law enforcement and civilian markets. It pays particular attention to the production of the most prolific of all self-loading rifles, AK-type rifles, offering estimates of total, cumulative production and current annual production. Finally, the study examines the physical longevity of self-loading rifles, as well as their repair, modification, and modernization.

II. Concepts and methods

For the purposes of this study, a self-loading service rifle is defined as:

> *A rifle or carbine, which extracts and ejects the fired cartridge case immediately after firing and chambers a new round from the gun's magazine; issued as a primary combat weapon by a branch of military service within a nation's armed forces* (ARES, 2015, p. 1).

The term 'self-loading service rifle' encompasses several firearm sub-types covering a broad range of modern military rifles that have been in general service. These include:

- automatic rifles;
- assault rifles;[2]
- so-called 'battle rifles';[3]
- and some 'traditional military rifles'.[4]

The term 'self-loading service rifle' is based, firstly, on the inherent technical characteristics of this weapon class (that is, the ability to fire a shot for every pull of the trigger), and, secondly, on the intended user (that is, use by an individual soldier or fighter in ordinary infantry service and not in a specialist role). These two components of the term are each essential in their own right, allowing us to quickly identify which firearms fall within the scope of this study.[5]

Other than the fact that these rifles all extract and eject the fired cartridge case immediately after firing and chamber a new round from their magazine, the study does not examine their other technical or performance characteristics. Self-loading rifles that have been adopted by national armed forces but *not* as a 'primary combat weapon' (for example, self-loading sniper rifles or anti-materiel rifles) fall outside the scope of the definition. Nor does the study consider self-loading rifles produced for the law enforcement or civilian markets, except where their production is difficult to disaggregate from production intended for the military, as with AR-15-type[6] rifles.

Box 1 **Data sources and estimating techniques**

The derivation of accurate figures for small arms production can be difficult. Precise figures are available for some types, while production rates of other types are quite literally unknown. Contradictory data is relatively common (see Table 2). Matters of classification and counting are further complicated by factors such as civilian ownership of the same or similar weapons as those used by world militaries; the increasing military popularity of modular firearms; the production of new rifle types; and the processes of attrition, modification, and repair. This study draws on a wide range of data sources, primarily published sources that include books, journal and magazine articles, conference and symposium presentations, and websites. It supplements these sources with interviews with defence industry and other specialists, and with information received directly from governments regarding national production and holdings of self-loading service rifles.

The final estimates for global self-loading service rifle production used in this study were reached by using a combined top-down and bottom-up approach (see Table 1). These techniques alternately start from a cumulative global picture of production (either of self-loading service rifles in general or of one rifle type), on the one hand, and from smaller data points—'building-block' data—such as production and adoption estimates for one rifle type in one country,[7] on the other.

Where possible, information on quantities was derived from published sources (for example, the US M1 Garand). Generally, these constitute the more reliable sources. Where available figures were aggregated, an attempt was made to separate reported quantities by model (for example, the Belgian FN Herstal F2000), with an inevitable loss of precision. Where available figures were outdated, an attempt was made to update them based on published information, if available, and, failing that, on estimates using factors such as the size of the relevant armed forces, purchasing trends for new self-loading rifles, and the production of similar small arms. These figures are thus less definitive (for example, the Brazilian MD1 FAL variant). The least reliable figures are pure estimates, used in cases in which no data was available from either published or unpublished sources. In these instances a conservative, rough estimate was produced based on published information on quantities of the prior service rifle produced and/or held and the size of the country's military forces (for example, the Chilean-produced SG 540).

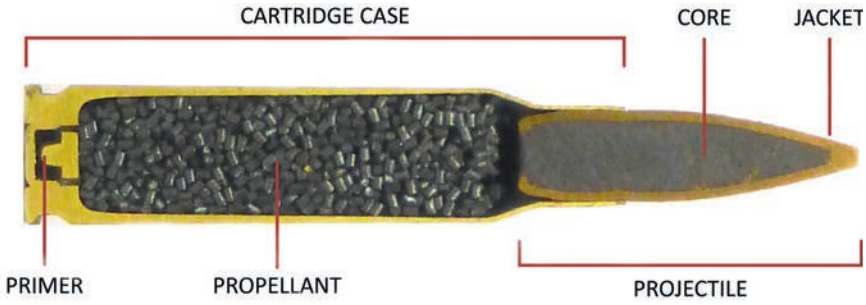
III. History of the development of self-loading service rifles

Historical background: early technological developments

As with any firearm, the self-loading rifle is largely dependent on its ammunition for its battlefield effects. Two revolutionary developments in small-calibre ammunition paved the way for the development of the self-loading rifle: the self-contained metallic cartridge and smokeless propellants (Wilson, 1934/1990).

In the 1840s and 1850s, the advent of metallic cartridge cases allowed for a single round of ammunition to be packaged in a self-contained format (Smith and Smith, 1965). In the field of small-calibre ammunition, the terms 'cartridge' and 'round' are synonymous: both refer to a complete unit of ammunition, including the projectile, which is fired from the gun; the propellant, which deflagrates and generates the gas pressure that propels the projectile up the barrel; the primer, which is initiated by the gun and ignites the propellant; and—with the exception of caseless ammunition—the cartridge case itself, which contains the components of a complete round of ammunition and provides the airtight seal known as obturation that allows pressure to build up behind the projectile (Goad and Halsey, 1982). Photo 1 shows the component parts of

Photo 1 **A sectioned (cutaway) 7.62 × 51 mm cartridge, showing the projectile, propellant, primer, and metallic cartridge case**



Source: Anthony G. Williams/ARES

a typical small-calibre cartridge. Before the introduction of the self-contained metallic cartridge, ammunition components were carried and loaded separately, ruling out any sort of self-loading mechanism. While the metallic cartridge case increased the weight of a round and necessitated mechanisms such as extractors and ejectors for a weapon, it did allow for the introduction of small arms that extract and eject a fired cartridge case and chamber a new round from the gun's magazine without requiring an external power source—self-loading weapons, in other words.[8]

The development of smokeless propellants—commonly known as 'smokeless gunpowder' or 'smokeless powder'—provided the second necessary innovation for the development of practical self-loading rifles. Earlier black powder—the revolutionary mixture of sulphur, charcoal, and potassium nitrate thought to have been developed in 9th century China—left considerable residue in gun barrels and actions after burning, making cleaning essential after a limited number of shots. The significantly higher rates of fire possible with self-loading rifles, together with the more complicated operating mechanisms, meant that the residue from black powder would foul the weapons so quickly as to render them impractical (ARES, 2015). In 1884, French chemist Paul Vieille developed the first practicable smokeless propellant, a dense colloided substance known as *poudre B*.[9] *Poudre B* was nearly three times more energetic and burned far cleaner than its predecessor (Davis, 1943/1990; Medard, 1994). This new powder allowed a weapon to be reliably fired hundreds of times before cleaning became necessary, allowing for the use of the more complicated mechanical assemblies necessary in a self-loading rifle.

The first rifle to be chambered for a self-contained metal cartridge using smokeless propellant was the influential Lebel Model 1886 bolt-action rifle. This widely issued, manually operated rifle was an ideal proof-of-concept for these two innovations, and the development of self-loading rifles proceeded apace (Smith and Smith, 1965).

Early self-loading service rifles

Work began on the first self-loading rifles shortly before the introduction of smokeless propellants. Two Danish firearms designers, Willhelm H.O. Madsen

and Julius A.N. Rasmussen,[10] began the development of their *Model 1888 Forsøgsrekylgeværet* as early as 1883, but this design was not adopted by the Danish military, probably due to the use of black-powder cartridges (Arma-Dania, n.d.a; McCollum, 2013a). As smokeless propellants were introduced, work on self-loading rifles and machine guns continued, with the latter initially more successful and more widely adopted, because machine guns lacked the lower weight requirements of a personal firearm and were thus easier to produce using the technology of the time (Wilson, 1934/1990). Madsen and Rasmussen later refined their design, producing the *Model 1896 Rekylkarabin til flåden (Reculgevær)* (M1896) in 1896, which the Danish Navy adopted in limited numbers,[11] making this weapon the first self-loading rifle issued to a state military (Arma-Dania, n.d.b).

Mexican artillery officer General Manuel Mondragón refined one of his earlier rifle designs in the later 1800s and early 1900s,[12] producing a weapon that was adopted by the Mexican military in 1908 as the *Fusil Porfirio Diaz Sistema Mondragón Modelo 1908* (M1908).[13] Production was contracted to the Swiss firm Schweizerische Industriegesellschaft (SIG), and an order was placed for 4,000

Photos 2 and 3 **The Danish *Model 1896 Rekylkarabin til flåden (Reculgevær)* (top) and the Swiss-made *Fusil Porfirio Diaz Sistema Mondragón Modelo 1908* adopted by Mexico (below)**

Source: Royal Danish Arsenal Museum; Rock Island Auction House

rifles. The M1908 proved to be unreliable when it was used with low-quality Mexican ammunition, particularly under field conditions, and this, together with political complications, led to the cancellation of the order after some 1,000 rifles had been delivered. The Mexican Army's adoption of the M1908 is often cited as the first adoption of a self-loading rifle by a nation's armed forces; however, while adopted in larger quantities than the Danish M1896, the M1908 did not play a major part in any armed conflict (Johnston and Nelson, 2010; McCollum, 2011a).

The problems arising from the use of the M1908 were representative of those faced by early self-loading rifles more broadly. Many early rifles had complex assemblies of moving parts, and while several models of self-loading rifles introduced in the early 20th century gained a commercial market share as sporting rifles,[14] the operating systems remained too delicate for military service. A variety of self-loading service rifles saw action during the First World War,[15] but it was not until the inter-war period that many states began to focus on developing a self-loading rifle of sufficient reliability for general military service (ARES, 2015; Canfield, 2013; McCollum, 2013b).

The United States was the first nation to adopt a self-loading rifle as a standard military service rifle. The successful design was developed by John C. Garand in the mid-1920s, and was adopted by the US Army as the 'United States Rifle, Caliber .30, M1' in January 1936 (Canfield, 2013). With the outbreak of the Second World War, demand for the rifle increased rapidly, and numerous US manufacturers were tasked with its manufacture (ARES, 2015). At the time, the M1 Garand was capable of the highest rate of fire among the standard-issue service rifles of the belligerents,[16] which proved to be advantageous in infantry engagements. In the Pacific theatre, anecdotal evidence suggests that the Garand's rate of fire helped repel Japanese *banzai* charges (so-called 'human wave' attacks). The Japanese were so impressed with the rifle that they produced limited numbers of a Garand copy (George, 1948; McCollum, 2011b). By 1956, the United States had produced nearly 5.5 million M1 Garand rifles (Thompson, 2012).

Other nations developed and fielded successful self-loading rifles during the Second World War, but, like the M1 Garand, these were primarily chambered for full-power rifle cartridges. Designers of the time tended to develop rifles

around the long-range, high-power potential of existing cartridges, resulting in significant recoil impulse and comparatively heavy rifles. The Soviet Union and Germany each produced in excess of 1 million self-loading rifles during the Second World War, most chambered for full-power rifle cartridges (Smith and Smith, 1965). The capabilities of rifles such as these were rarely exploited to their fullest, with the chaotic realities of warfare (limited visibility, targets behind concealment or cover, etc.) meaning that most engagements took place at far shorter ranges than anticipated (ARES, 2015; Johnston and Nelson, 2010). Despite the limitations of full-power rifle cartridges, significant logistical and economic investment had been made in these calibres, and these investments, along with idealized military doctrine and the exigencies of an ongoing war, meant that innovation was met with some resistance.[17]

Self-loading service rifles after the Second World War

The success of the Garand rifle spurred production of self-loading service rifles worldwide. During the two world wars, licensed production of these weapons was rare, with nations able to produce sufficient quantities within their existing manufacturing infrastructure and preferring to retain exclusive control over production. This can be seen, by way of example, in the Mauser Model 98-pattern rifle, the most numerous manually operated rifle in history, most of which were produced in Germany by Mauser.[18] After the Second World War, however, a substantial reduction in demand saw self-loading rifles licensed to foreign manufacturers. The Garand design was licensed to Italy—and Taiwan,[19] which went on to produce some 1 million examples (Johnston and Nelson, 2010; Jones, 2012; Walter, 2006). Italy took this one step further, redesigning the weapon to suit its military needs. The Italian Beretta BM59 rifle was the result. It was adopted by the Italian military in 1959 and subsequently exported to national armed forces in several countries. In turn, this rifle was produced under licence by Indonesia and Morocco. From these sources, Garand-derivative rifles ended up in the inventories of a further six nations (ARES, 2015). The United States, after testing smaller-calibre alternatives, adopted the M14 rifle, a derivative of the Garand rifle chambered for the 7.62 × 51 mm cartridge. The M14 was formally accepted as the 'United States Rifle, 7.62 mm, M14' in 1957 (Rayle,

Photos 4 and 5 **US M1 Garand (top) and Soviet Union SVT-40[20] (bottom) self-loading rifles. Both were produced in notable quantities during the Second World War and are chambered for full-power rifle cartridges**

Source: Armémuseum (Swedish Army Museum) and C&Rsenal

1996). In addition to copies and derivatives, both the M1 Garand and the M14 remain in limited service in the United States to the present day. Ultimately, more than 8.2 million Garand-type rifles were produced (see ARES, 2015). At the behest of the United States, the T65 cartridge was adopted as the 7.62 × 51 mm NATO standard in 1953, and NATO member states began to adopt rifles in this calibre (Arvidsson, 2009; Walter, 2006). Several self-loading rifles were designed (or redesigned) to chamber this cartridge, several of which have since seen extensive production and use worldwide (Johnston and Nelson, 2010). The United States itself adopted the M14 rifle, chambered for this cartridge, in 1957, as described above.

During the Second World War, German designers determined that full-power rifle cartridges were unnecessarily powerful for the standard service rifle and that the excessive recoil generated by the cartridges, together with their size and weight, meant a more suitable alternative needed to be developed for infantry use. The higher rate of fire achieved by self-loading rifles increased concerns over cartridge size and weight. The German military therefore developed and introduced an 'intermediate' cartridge[21]—lighter and shorter than

its predecessors, with physical characteristics somewhere between the full-power rifle cartridges of the infantry rifles of the time and the handgun-calibre cartridges used in sub-machine guns (Jenzen-Jones, 2016a, pp. 14–15). Chambering this new, lower-recoil cartridge, the resultant rifle was capable of delivering comparatively accurate automatic fire at close ranges, in the manner of a sub-machine gun, while retaining enough range to be effective in most infantry engagements. This new weapon was issued as the *Sturmgewehr 44* (StG 44[22]), literally 'assault rifle'. Today, so-called assault rifles[23] are the most numerous sub-category of self-loading rifle in service with military forces (Hogg, 1979).

While the StG 44 is widely acknowledged as the archetypal assault rifle, only limited numbers were produced,[24] and the weapon was never manufactured outside Germany. Its legacy is most prominent in the later *Avtomat Kalashnikova* (AK[25]) rifle, the first in an influential series of self-loading rifles designed and

Photos 6 and 7 **German StG 44 (top) and Russian AKM (bottom) assault rifles.[26] Both are chambered for 'intermediate-calibre' cartridges, which were developed during and immediately after the Second World War**

Source: Armémuseum (Swedish Army Museum)

produced in the Soviet Union and, later, the Russian Federation. The original AK was introduced into Soviet service in 1949, and, having been modernized several times in the intervening years, its derivatives remain the primary service rifles of the Russian Federation military today.[27] The AK became a political tool as much as a weapon, and was widely produced in significant numbers under Soviet programmes intended to foster both cooperation and a measure of dependency on the part of allied nations and client states (Sulashvili, 2007, pp. 11–12). The advent of the Kalashnikov rifle marked an important turning point in the global production of self-loading rifles—not solely in terms of quantity, but also in how widely the weapon was adopted and manufactured, in terms of both licensed and unlicensed production (see below).

While several NATO countries experimented with intermediate-calibre rounds as early as the 1940s, full-power cartridges remained the NATO standard until well after the Second World War. In 1947, the final report of the UK Ministry of Supply's Small Arms Calibre Panel suggested that 'the standard round chosen should be of the smallest calibre possible [within the specification]', and recommended the selection of a .25 or .27 inch (6.35 or 6.86 mm) projectile (UK Ministry of Supply, 1947, p. 10).[28] British experiments led to the development of the EM.2 self-loading rifle, chambered for a .280 (7 × 43 mm) calibre cartridge. The UK government requested a competitive test of the British rifle and cartridge against recent US prototype models. As had been the case in the Eastern Bloc with the AK rifle and other small arms, many in NATO saw significant value in a standardized NATO rifle and calibre (Jenzen-Jones, 2016a). The EM.2, together with two Belgian rifles developed by FN Herstal and also chambered for the .280 British cartridge,[29] was submitted for trials held in the United States in February 1950.[30] The United States submitted a rifle derived largely from the M1 Garand, designated the T25, chambered for the T65 .30 calibre cartridge (Rayle, 1996).

These trials concluded that the US T65 cartridge was 'not suitable for Army Field Forces use because of its excessive recoil, blast, flash and smoke', and that 'of the basic types submitted for the test, the British .280 round is preferred' (*Spokesman-Review*, 1951). However, these findings were later overturned by the US Board of Ordnance, which refused to accept any cartridge less powerful than the .30-06 in service with the M1 Garand[31] (*Spokesman-Review*, 1951;

Williams, 2014). While other nations explored intermediate cartridges during this period, the British initiative represents the earliest attempt by a NATO nation to replicate the battlefield advantages of the German 7.92 × 33 mm round. At the behest of the United States, the T65 cartridge was adopted as the 7.62 × 51 mm NATO standard in 1953,[32] and NATO member states began to adopt rifles in this calibre[33] (Arvidsson, 2009; Walter, 2006). Several self-loading rifles were designed (or redesigned) to chamber this cartridge, several of which have since seen extensive production and use worldwide (Johnston and Nelson, 2010).

While NATO was able to settle on the 7.62 × 51 mm cartridge, a consensus was not found on rifle selection. The Belgian FN Herstal *Fusil Automatique Léger* (FAL) self-loading rifle, developed by a team led by Dieudonné Saive, was intended to serve as a NATO standard rifle (Stevens, 1979; 2011).[34] Ultimately, while the United States adopted the M14 (manufacturing some 1.4 million rifles between 1959 and 1964), many nations adopted the FAL as their standard service rifle after it entered production in 1953 (Emerson, 2009; Stevens, 1980; Stevens and Van Rutten, 1981). FN Herstal pursued an aggressive marketing and licensing strategy, resulting in the adoption of the FAL by more than 90 coun-

Photos 8 and 9 **British EM.2 (top) and Belgian FN Herstal FAL 50.00 (bottom) self-loading rifles. The EM.2 is chambered for .280 British, while the FAL is chambered for 7.62 × 51 mm**

Original sources unknown

tries, across the politico-economic spectrum[35] (Jenzen-Jones and Spleeters, 2015). Today, the largest producer of FAL-type rifles is Indian Ordnance Factories, which manufactured 6,000 rifles in 2012, the last year for which official data is available (Karp and Rajagopalan, 2014, p. 6, Table 3). Research indicates that some 5.5 million FAL-type rifles have been produced to date (see ARES, 2015).

Although the Heckler & Koch G3 was introduced some five years after the FAL, its design dates back to the final years of the Second World War, with key operating features adapted from the widespread MG 42 general-purpose machine gun. The operating mechanism of the G3[36] formed the basis of many Heckler & Koch weapons to follow, contributing to the company's significant international success. First produced by Spain in 1958 as the *CETME Modelo 58*, the design was refined by Heckler & Koch in West Germany and adopted as the standard service rifle by the new German Army, the *Bundeswehr*, in 1959 (Stevens, 2006). G3-type self-loading rifles were subsequently exported to or licensed by some 55 nations worldwide, with production estimated at around 7.8 million units (see ARES, 2015). The FAL and G3 proved to be trendsetters for self-loading service rifle production over the following decades, with their manufacturers providing licences for production to users seeking significant quantities or with specific design requirements, while themselves producing rifles under contract for smaller clients and stopgap orders.

In 1952, the release of two influential reports signalled early US (and, by extension, NATO) steps towards adopting an intermediate calibre. The Hall and Hitchman reports concluded that small-arms fire was largely ineffective beyond 300 yards, and that the adoption of a 'small-calibre, high-velocity' (SCHV) cartridge would both improve hit probability within anticipated engagement ranges and significantly reduce the weight burden on the soldier (Hall, 1952; Hitchman, 1952; Jenzen-Jones, 2016a, pp. 11–12). In the late 1950s, arms designers in the United States examined the intermediate-calibre concept, experimenting with SCHV cartridges featuring a projectile of reduced diameter fired at an increased velocity. SCHV ammunition became standard issue in the 1970s, with the US adoption of the AR-15 assault rifle (known in military service as the M16).[37] The AR-15 followed the assault rifle principle, but the smaller, lighter cartridges allowed the rifleman to carry even more ammunition[38] and the increased projectile velocity allowed for better armour penetration. At least 13 million AR-15-

Photos 10 and 11 **German Heckler & Koch G3A4 (top) and US M16A1-style AR-15-type (bottom) self-loading rifles. The G3 is chambered for the full-power 7.62 × 51 mm cartridge, while the M16 is chambered for the SCHV 5.56 × 45 mm cartridge. Note that the magazine is absent from the M16A1 shown here**

Source: Armes Occasion and 'damcv62' (AR15.com forum user)

type rifles have been produced for military service to date (see ARES, 2015).

Neither NATO nor Eastern Bloc forces expected SCHV systems to completely replace small arms chambered for full-power cartridges, retaining a variety of precision rifles and general-purpose machine guns in those calibres. China developed an indigenous SCHV (5.8 × 42 mm) cartridge in the late 1980s for use with the Type 95 family of weapons[39] (Andrew, 2015; Jenzen-Jones, 2016a, p. 20). Numerically, the Type 95 family is composed mostly of self-loading rifles, at least 3 million of which have been produced to date (see ARES, 2015). SCHV rifles continue to predominate today, although there are signs of an increasing interest in new so-called 'general-purpose' calibres.[40]

Many full-power calibres have remained in military service worldwide, often supplementing later intermediate-calibre and SCHV systems (Ferguson et al., 2015). The range requirements of self-loading rifles as standard issue infantry arms—deemed to be no more than 300 yards in the Hall (1952) and Hitchman (1952) reports—have been reconsidered by some states in light of recent battlefield experiences (Jenzen-Jones, 2016a, pp. 21–22). In Afghanistan after the 2001 invasion, infantry small arms played a more pivotal role than was anticipated on

Box 2 **Modular rifles**

Modular firearms are generally accepted to be weapons that can be easily reconfigured to meet different operational requirements and accommodate a range of accessories (Persi Paoli, 2015). The degree to which this must be possible in order for a weapon to be considered 'modular' is not universally agreed on, however. Traditional firearms designs—broadly speaking, those produced prior to the Second World War—often lacked any modularity, requiring gunsmiths or armourers to make permanent modifications to a weapon if a change in capabilities was wanted. Later weapons allowed semi-permanent changes, such as the addition of an optical sight, to be made by the manufacturer or a unit armourer. The split-receiver design[41] of the FN Herstal FAL self-loading rifle marked an important shift towards increasing modularity in self-loading rifle design (Ferguson and Jenzen-Jones, 2014a). While the split-receiver architecture of the FAL enabled different top covers to be installed, this capability was primarily exploited at the factory level rather than in the field.[42] It was not until the introduction and widespread adoption of the AR-15-type rifle that user-configurable weapons became commonplace.

AR-15 rifles were initially supplied in standard configurations with little user configurability (primarily as the M16 and its variants); later generations began to exploit the inherent parts commonality of various models. The AR-15 also featured split-receiver architecture that allowed for customization at the user and armourer levels, with upper receivers with differing barrel lengths and weights, gas systems, and muzzle attachments being largely interchangeable. Early Colt CAR-15-series weapons were marketed as a 'family' of small arms, including carbines, assault rifles, and so-called 'heavy assault rifles' (Stevens and Ezell, 1992). Similarly, the Stoner 63 self-loading rifle family was designed with limited parts commonality, allowing for the configuration of the so-called 'basic group' into one of six weapons. The system was offered with a wide range of accessories, including flash hiders, feed devices, furniture,[43] and a grenade launcher. The British SA80 was conceived as a 'family of weapons' (Antill, 2009; Raw, 2003). Developed in the 1970s, the SA80 family was designed from the outset to have a high degree of parts commonality. Initially consisting of a self-loading rifle and a light machine gun, designated the L85A1 and L86A1, respectively, the family later grew to include other models (Raw, 2003). The Colt CAR-15, Stoner 63, and SA80 weapons were some of the earliest NATO weapons adopting the so-called 'family approach':[44] the calibre of each model cannot be changed, but other features such as the barrel length, furniture, and attachments are often modifiable and interchangeable (Jacobs, 2013; Peri Paoli, 2015).

Many producers began to manufacture self-loading rifles with greater parts commonality for reasons of cost and practicality, reducing the requirement for spare parts holdings and increasing parts commonality under field conditions. As a result, commonality of parts has led to a degree of modularity for some common rifles. For example, no design changes were made to the Diemaco C8 carbine when UK special operations forces adopted it in the late 1990s as the L119A1. Instead, a number of upper receivers were later acquired with 10.0, 15.7, and 20.0 inch barrels, and these could be quickly swapped out by the user as necessary[45] (Ferguson, 2014a).

Several later 'families' of rifles were developed that incorporated increasing levels of modularity. An example is the XM8 family, derived from the earlier Objective Individual

Combat Weapon programme,[46] which featured different barrels and other modules that could be swapped out according to operational requirements (see Photo 12). Many weapons systems that may be considered modular under the family approach lack purpose-made user-configurable features, however. Although the XM8 design did not allow for calibre conversion, the rifle proved a turning point for modular designs: the programme was seriously evaluated by the US Army in the early 2000s, which initially envisaged replacing the M16/M4 series weapons as the standard service rifle with up to 900,000 XM8-type rifles (H&K Defense, n.d.).

In January 2004, the US Special Operations Command (USSOCOM) launched the Special Operations Forces Combat Assault Rifle (SCAR) programme. The FNH USA[47] SCAR was to prove the first assault rifle procured by US forces through open competition since the M16/M4

Photo 12 **Heckler & Koch XM8 family of modular weapons. Note common receiver at centre right**

Source: H&K Defense (n.d.)

types (FNH USA, 2006). Although the rifles were intended to replace a variety of USSCOM's existing weapons, the long-term goal of the SCAR programme was to develop and deploy one common-receiver platform (Persi Paoli, 2015). The SCAR is available in two configurations: a 'light' configuration chambered for 5.56 × 45 mm (SCAR-L) ammunition and a 'heavy' configuration chambered for 7.62 × 51 mm (SCAR-H). While both were originally selected for procurement, USSCOM later cancelled the acquisition of SCAR-L rifles after having received only a small portion of its original requirement, and instead issued a solicitation for a 5.56 × 45 mm calibre conversion kit for the SCAR-H (Kit Up!, 2010).

Weapons that we might today consider 'fully' modular—user configurable for both role and calibre—have continued to evolve. Despite only limited adoption by nations' armed forces, modularity remains a key selling point for a number of firearms manufacturers at present. New modular, calibre-convertible self-loading rifles continue to be introduced, including the SIG SAUER SIG556xi, Colt CM901, and Česká Zbrojovka CZ 805 BREN types.

Generally speaking, the more modular the weapon is by design, the more variety exists in production and procurement. Today, end users may not procure a 'complete' self-loading rifle as they would have in the past. Militaries may now opt to purchase complete upper receivers or even a fully modular upper receiver with a range of barrel lengths and calibre options. In this way, an individually serial-numbered rifle may effectively become several weapons over time (see 'Repair, modification, and modernization of existing self-loading service rifles', below).

The design of modular weapon systems complicates basic marking, record-keeping, and tracing practice (Persi Paoli, 2015). Critical components of firearms, typically pressure-bearing components, may be broadly separated into the 'primary controlled component'[48] and 'additional critical components'. The primary controlled component is that which is regulated under relevant international and national law (Ferguson, Jenzen-Jones, and McCollum, 2014). Internationally, and for the purposes of this study, the primary controlled component is described in the International Tracing Instrument (ITI)[49] in the following terms:

> a unique marking should be applied to an essential or structural component of the weapon where the component's destruction would render the weapon permanently inoperable and incapable of reactivation, such as the frame and/or receiver (UNGA, 2005, para. 10).

This 'essential or structural component' is the primary controlled component under the ITI. Some countries, notably the United States, have not consistently regulated the 'essential or structural component' of certain firearms, blurring the distinction between the primary controlled component and additional critical components at the national level.[50] Additional critical components vary by firearm, but typically include the barrel, bolt group, and other essential pressure-bearing parts (Ferguson, Jenzen-Jones, and McCollum, 2014). The ITI contains no specific requirement to mark additional critical components of a firearm; however, paragraph 10 goes on to recommend the following:

> States are encouraged, where appropriate to the type of weapon, to apply the marking prescribed in subparagraph 8 (a) above or other markings to other parts of the weapon such as the barrel and/or slide or cylinder of the weapon, in order to aid in the accurate identification of these parts or of a given weapon (UNGA, 2005, para. 10).

The marking of additional critical components is valuable for the tracing of both complete firearms and individual components, and can provide investigators with important information about repairs, refurbishment, or modifications that may have been made to the weapon. Such markings may also prove useful when a firearm's primary serial number has been altered or removed[51]—a practice that has become increasingly commonplace in conflict zones (Jenzen-Jones, 2015, p. 6).

The question of how to count such systems has not yet been adequately addressed, however. Logically, the primary controlled component of a modular weapon is the one that must be assessed for the purposes of determining total rifle production; however, there is not yet agreement as to what these components are. Another challenge lies in properly classifying modular weapons. If a firearm is sold with the components needed to serve as both a self-loading rifle and a light machine gun, for example, in which category is it recorded?

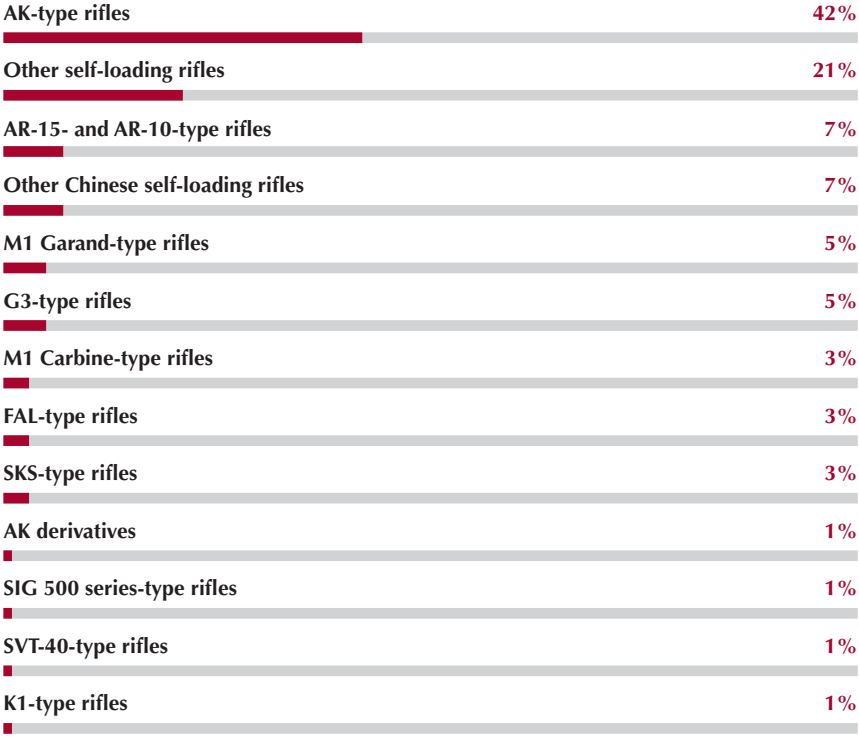
a 'modern' battlefield. Systems that would ordinarily deliver heavier supporting fires were often restricted by operational practices that were generally concerned with limiting civilian casualties. As a result, infantrymen were frequently forced to engage enemies at longer ranges than anticipated, regularly beyond 300 m and often beyond the 500 m effective range of the standard M4-series rifles[52] (Ehrhart, 2009).

Despite the broad global adoption of self-loading service rifles, manually operated rifles remain relevant to modern military forces. Bolt-action rifles, in particular, are still employed by many modern military forces as sniper rifles[53] (British Army, 2015; US Army, 2003). In some cases a bolt-action rifle remains the primary service weapon for a particular component of the armed forces. The Canadian Rangers,[54] for example, have been equipped with the bolt-action Lee Enfield No. 4 Mk 1* rifle from 1942 until the present day. A replacement weapon, referred to as the New Canadian Ranger Rifle and designated the C19, has recently been identified. It is also a bolt-action rifle, this time based on the successful SAKO Tikka T3 Compact Tactical Rifle design (Jenzen-Jones, 2016b). Specialist snipers have widely preferred bolt-action rifles for accuracy reasons; however, a number of semi-automatic systems have also been adopted in recent years, including the US Army's M110 Semi-Automatic Sniper System and the Heckler & Koch G28 adopted by the German Bundeswehr.

IV. Production of self-loading service rifles

Recent research suggests that some 175 million self-loading service rifles have been produced to date (ARES, 2015). This figure does not include civilian-owned rifles, except in limited cases where civilian-owned rifles of the same type were too difficult to disaggregate from their military counterparts. Similarly, this figure does not account for attrition, deliberate destruction, or the refurbishment and modification of existing rifles. Nonetheless, the figure is likely to be an

Figure 1 **Total global production of self-loading service rifles**[a]



[a] The chart includes rifle types with an estimated total production exceeding 1 million units.
Source: ARES (2015)

Table 1 **Global cumulative production of selected self-loading rifle types**

Rifle type	Production dates	Approximate quantity produced	Source(s)
Model 1896[a]	1896	60	Arma-Dania (n.d.a)
M1908 Mondragón[b]	1908–11	1,000	Johnston and Nelson (2010); McCollum (2011a)
Mle 1917 and Mle 1918	1917–19	89,333	Huon (1995)
M1 Garand types	1936–79	8,200,000	Thompson (2012; 2014); Johnston and Nelson (2010); Walter (2006); Jones (2012)
SVT-40	1940–42	1,379,177	Bolotin (1995)
StG 44	1943–45	440,000	Johnston and Nelson (2010)
SKS types	1945–present	5,000,000	Kehaya and Poyer (1996); Survivor's SKS Boards (2011); Drumheller (n.d.); Monetchikov (2005); Burton (2005)
AK types[c]	1949–present	76,000,000[d]	Numerous. See ARES (2015)
FAL types	1953–present	5,500,000	Stevens and Van Rutten (1981); SSAA (1997); The FAL Files (2015); Eger (2014b); Long (1998); Cashner (2013); Johnston and Nelson (2010)
G3 types[e]	1958–present	8,000,000	Kersten and Schmid (1999); Walter (2006); Gangarosa (2001); Nazarian (n.d.); Bekdil (2014); Huon (2012)
AR-15 and AR-10 types	1959–present	13,000,000[f]	Bartocci (2004); Abas (2014); WeaponsMan (2014); Stevens and Ezell (1992); Military Factory (2013); AR15.com (2005); Retro Black Rifle (n.d.)
Type 95 types	1995–present	3,000,000	Johnston and Nelson (2010)

Notes:

All quantities are production estimates.

a *Model 1896 Rekylkarabin til flåden (Reculgevær)*.

b Properly, the *Fusil Porfirio Diaz Sistema Mondragón Modelo 1908*.

c Including derivative designs with substantial changes, such as the Israeli Galil series.

d Note that this can be considered a conservative estimate.

e Including CETME rifles; including variants chambered for 5.56 × 45 mm cartridges.

f Some 3 million AR-15 and AR-10 rifles are further estimated to have been produced for the civilian and law enforcement markets (see ARES, 2015).

Source: Draws on sources in ARES (2015). See ARES (2015) for full details.

underestimate: the total number of self-loading rifles produced to date is very likely to be higher. The data also highlights the prominence of AK-type rifles in the global arms landscape, with these weapons constituting more than 40 per cent of self-loading service rifles produced up to the present day (see Figure 1).

Box 3 **Cumulative and annual production of AK-type rifles**

AK-type rifles are the most common self-loading service rifle in the world today by a considerable margin, and are thought to constitute in excess of 40 per cent of the total number of self-loading rifles produced up to the present day. Their ubiquity means that they are encountered in almost every modern conflict zone. Nearly 200 variants, copies, and derivatives of the AK rifle have been identified to date. These are produced:

> . . . in a wide range of calibres, including 7.62 × 25 mm, 9 x 18 mm, 9 × 19 mm, 5.45 × 39 mm, 5.56 × 45 mm, 7.62 × 39 mm, 7.62 × 54R mm, 7.92 × 33 mm, 7.92 × 57 mm, and smoothbore variants chambered for various shotshell cartridges (McCollum, 2014).

According to Russian sources, IZHMASH (now Kalashnikov Concern) only patented the weapon's design in 1997, and in 2006 Russian Federation AK-type rifles accounted for only 10 per cent of the world's production of this type (VoR, 2013).

At least 76 million AK-type rifles, including variants, copies, and derivatives, have been produced to date, according to research conducted by Armament Research Services for the Small Arms Survey (ARES, 2015).[55] This estimate, which is likely conservative, largely agrees with several other sources, including Walter (2006; estimate of 70 million), Kalashnikov and Joly (2006; 60–80 million), Rottman (2011; 75 million), and primary Russian Federation small arms manufacturer Kalashnikov Concern's own estimate of 'more than 70 million Kalashnikovs' (Johnson, 2015). Calhoun (1998) estimated 50–80 million in the late 1990s. The figure of 76 million is also consistent with the top end of Edward Ezell's 30–50 million estimate, made in 1986, if production in the intervening decades is factored in (Ezell, 1986). Some estimates, such as those from Control Arms (2006), are lower, in the 50–70 million range, while others are higher, with figures of 100 million units (Chivers, 2011; Ezell, 2000; Francis, 2013) or more (VoR, 2013; Pyadushkin, 2003). Table 2 offers a selective comparison of estimates of cumulative AK-type rifle production.

There is agreement among Russian sources that global AK-type rifle production is relatively stable at around 1 million per year (VoR, 2013). According to Kalashnikov producer IZHMASH, the Russian Federation accounts for only 10–12 per cent of the 1 million AK-type rifles produced each year, with the rest being unlicensed copies (RIA Novosti, 2006; 2010). In 2013 it was estimated that some 50 per cent of the AK-type rifles produced by 2009 were unlicensed (VoR, 2013). AK-type rifle production in the Russian Federation has been increasing in recent years, according to Russian Federation sources (RIA Novosti, 2014; RT, 2014). In 2014 Kalashnikov Concern reportedly manufactured 150,000 AK-type rifles, and had planned to modernize arms production and increase this output to meet international demand, primarily from the civilian market (*Moscow Times*, 2015).

Table 2 **Estimates of cumulative production of AK-type self-loading rifles**

Year of estimate	Estimated total production	Source type	Source
2015	(At least) 76 million	Research organization	ARES (2015)
2015	(More than) 70 million	AK manufacturer	Johnson (2015)
2013	150 million	Media	VoR (2013)
2011	75 million	Academic text	Rottman (2011)
2011	100 million	Book	Chivers (2011)
2009	100 million	Media	Francis (2013)
2007	50–100 million	Research organization	Killicoat (2007)
2006	70–100 million	Research organization	Karp (2006)
2006	70 million	Academic text	Walter (2006)
2006	50–70 million	Advocacy group	Control Arms (2006)
2006	60–80 million	Book	Kalashnikov and Joly (2006)
2003	(More than) 100 million	Research organization	Pyadushkin (2003)
2000	8–100 million	Media	Ezell (2000)
1998	50–80 million	Government	Calhoun (1998)
1997	30–55 million	United Nations	UNGA (1997)
1986	30–50 million	Academic text	Ezell (1986)

Licensed and unlicensed production

Intellectual property (IP)[56] and data rights, including the licensing of such rights, are a fundamental feature of the production landscape for self-loading service rifles. Some 60–80 per cent of all self-loading service rifles are produced by manufacturers who did not originate the technology (Sulashvili, 2007, pp. 7, 8, 23, 32). Up to the present day, manufacturers of military small arms can be divided primarily into large-scale manufacturers, often entirely or partially state controlled, and smaller private or state-controlled manufacturers. While many designs are developed by large-scale manufacturers, several significant models have been developed by individuals or smaller companies and licensed to large manufacturers or states. For example, while the AR-15 was developed and

prototyped by Armalite, the rights were sold to the much larger Colt's Manufacturing Company in 1959, which produced the rifles as the M16 for the US military (Stevens and Ezell, 1992).

Manufacturers have increasingly sought to license the production of self-loading rifles. With the introduction of the FAL rifle, FN Herstal pursued an aggressive licensing strategy, supporting at least 15 manufacturers in producing hundreds of thousands of copies or minor variants of the FAL (ARES, 2015; Johnston and Nelson, 2010). Australian, British, and Canadian FAL rifles built to imperial specifications and with minor modifications from the Belgian originals were developed from extensive trials that included locally produced prototypes.[57] Heckler & Koch also issued licences widely, risking serious competition from their own products as a result of this policy. However, the strategy allowed the company to indirectly reach alternative markets: Gabon, Ivory Coast, Lebanon, Mauritania, Morocco, Niger, Senegal, and Upper Volta[58]—all former French colonies—were supplied with G3 rifles produced under licence by Manufacture d'Armes de Saint-Étienne, a state-owned French arms manufacturer (Gangarosa, 2001). This flexibility has been a hallmark of the modern era of self-loading rifle production. Modern arms licensing deals do, however, include various constraints, including time or quantity limits or exclusivity clauses giving the holder of the original design a measure of control over the sale—including export—of manufactured weapons (ARES, 2015; Sulashvili, 2007, pp. 8–10).

Licence rights are commonly described as 'unlimited', 'limited', or 'government purpose', or can feature negotiated terms that do not fit these three broad categories.[59] Applicable rights types depend on factors such as whether development was wholly or partially funded by a government or private entity (Ryan and Chen, 2010). For example, in the United States, the government has unlimited rights to several types of technical data, such as designs developed exclusively with government funding (US Department of Defense, 2014[60]). Depending on the nature of the IP and the terms of any licensing agreements, rights may also be extended to entities outside of the licensing government; for example, in cases of maintenance, emergency repair, or evaluation by foreign governments or private entities.

The right to manufacture a given weapon is not necessarily linked to the ownership of the technical data relating to its design, often referred to in modern usage as the 'technical data package' (TDP). The US Department of Defense (2009, p. 8) defines a TDP as 'A technical description of an item adequate for supporting an acquisition strategy, production, and engineering and logistics support'.[61] Under a licensed production arrangement, the owner of the TDP relating to a weapon's design confers the right to manufacture the weapon on another. The US government, for example, holds a non-transferable right to use Colt's TDP in the manufacture of M16 rifles and repair parts.[62] The licence agreement includes a provision restricting these rights to rifles and components manufactured in the United States and its territories (US Army, 2009). In some cases, governments have sought to retain ownership of both the TDP and all manufacturing rights. Many governments, such as that of the United States, have implemented data-acquisition strategies intended to ensure that technical rights are held by the military over the life cycle of a weapon (Ryan and Chen, 2010; United States, 2012; US Army, 2008b).

As with any commercial contract, licensing agreements for arms and munitions are often subject to interpretation and may be the subject of heated debate or even litigation. Penalties may be incurred, for example, by the provision of exclusively licensed designs to third parties. When the US Navy licensed production of the 40 mm Bofors Gun from the Swedish Bofors Company in 1941, US negotiators secured a change in the contract's wording specifying that production would be 'for United States Forces only', to 'for United States use'. The Judge Advocate General of the US Navy subsequently issued an opinion indicating that this allowed the navy to give, lend, and sell guns and mounts manufactured under the contract to allied nations under the Lend-Lease Act[63] (US Navy Bureau of Ordnance, n.d.[64]). In subsequent judicial proceedings, however, the United States was ordered to pay costs to Bofors after supplying Bofors Guns to allies under the Lend-Lease Act (US Court of Claims, 1957; Gander, 1986).

In some cases, the licence to manufacture particular weapons may be provided free of charge. Such was the case in 1951, when FN Herstal of Belgium offered to provide manufacturing rights to the FAL rifle to the United States at no cost.[65] The US Army's Office of the Chief of Ordnance discussed the offer, but rejected it due to fears that royalties might nevertheless be owed (Rayle, 1996).

A paid production licence for self-loading rifles is often coupled with engineering assistance from the licensor. For example, Sweden licensed the Egyptian government to manufacture the Swedish AG-42B Ljungman as the Hakim, while the Dutch produced a copy of the AR-10 under licence from Armalite. Both received significant engineering assistance from the originating firms in establishing their manufacturing capabilities (McCollum, 2015b). Large, modern arms manufacturers are increasingly awarded contracts for the licensing of rifle production based on their ability to deliver not just engineering assistance, but a complete 'production solution' to the client. For example, Heckler & Koch was awarded a large contract in Saudi Arabia, selling the client the weapons, rights to the relevant TDP, training (both domestically and at the company's facilities), engineering assistance, specialized machinery, and in-service support.[66] Companies may also sub-contract government-owned factories to produce the arms for which they hold production rights. Orbital ATK, a US firm, has considerable experience operating under this model in Turkey and Saudi Arabia (Defense World.net, 2011).

Unlicensed production of self-loading rifles takes many forms, ranging from the infringement of specific, minor patents to the direct copying of an entire weapon. Several states, most notably China, have been accused of producing exact copies of competitors' firearms. It is widely understood, for example, that the Chinese Type Triple-10 was an exact copy of the Browning M1917. An example of the M1917 was seized from a travelling arms dealer and reverse engineered at the Hanyang Arsenal. The finished copy entered production on 10 October 1921 (Shih, 2011). Chinese arms manufacturers continue to copy and produce unlicensed firearms to the present day, including the CQ series of self-loading rifles, apparently copied from the US AR-15-type rifle (see Photos 13 and 14) (Bartocci, 2014).

In some cases, unlicensed copies of a firearm may be produced legally in one jurisdiction while still infringing on the rights of IP holders according to their legislation. In the early 20th century, for example, Spanish patent law dictated that patent protection would be void if the patent owner did not begin production of the patented item in Spain within three years of protection being issued. The major arms producers of the time did not have manufacturing branches in Spain, allowing the country's arms producers to freely copy numerous firearms,

Photos 13 and 14 **Chinese CQ-A (top) and US M4A1 (AR-15 type; bottom) self-loading rifles**

Source: Poly Technologies, Inc. and Wikimedia

especially handguns. Smith & Wesson, Browning, and Mauser handguns were all widely copied; indeed, Spanish arms companies, many of which were based in the town of Eibar, would supply hundreds of thousands of copied handguns to the French Army during the First World War. While unlicensed, these weapons were produced in conformity with Spanish law of the time (Antaris, 2009).

Major types of self-loading rifles have typically been manufactured under a variety of different production models. AK-type rifles, for example, have been produced under most conditions and methods applied from the 1960s to the present day. They have been manufactured by hand, in much the same

way as the earliest rifles, and produced on the most modern machinery; they have been mass produced by state-owned manufacturers, with and without a licence, and produced by small companies for domestic markets; they have been produced under contract for other nations by both licensors and licensees; they have been sold commercially, both as licensed models and as blatant copies; and they have both been faithfully replicated and formed the basis of distinct derivative designs (ARES, 2015).

Production for the law enforcement and civilian markets

Private and state-owned firearms manufacturers also produce self-loading rifles for the law enforcement and civilian markets. In some countries, such as the United States, self-loading rifles that are very similar to those in military service around the world have seen an increase in popularity in both of these market sectors. In the law enforcement sector, self-loading rifles are typically semi-automatic in operation. Law enforcement use of semi-automatic rifles dates back to early self-loading rifles such as the Remington Model 8 and Winchester Models 1905, 1907, and 1910. While never adopted by a state military as a primary service arm,[67] the Sturm, Ruger & Co. Mini-14 gained popularity with law enforcement agencies in the United States and abroad (Johnston and Nelson, 2010). At present, AR-15-type rifles are increasingly being marketed to, and adopted and employed by, US and foreign law enforcement agencies (Colt, 2015; Cramer, 2013).

Civilian firearm ownership is thought to account for some 75 per cent of global totals (Karp, 2007). Self-loading rifles are increasingly popular in the civilian market, with some estimates indicating that US production of AR-15-type rifles more than doubled in 2011–12 (NRA-ILA, 2014; Singer, 2013). AK-type rifles are also becoming increasingly popular with civilian buyers. It can be difficult to disaggregate production figures for the civilian and law enforcement markets from those for the domestic military and military export markets, particularly in the United States. This can lend some uncertainty to production numbers; however, a conservative estimate indicates that at least 3 million AR-15-type rifles have been produced for the law enforcement and civilian markets up to the present day (see ARES, 2015). Weapons produced for the

civilian market are not included in the production totals considered in this study. Civilian buyers, particularly in conflict and post-conflict areas, may also purchase self-loading service rifles illicitly. These have been included in the production figures reported in this study, since many of them reach civilian hands after passing through military arsenals, such as the millions of firearms which have fallen outside of state control in Iraq, Libya, Syria, or the former Yugoslavia. In most cases, it is difficult to determine how many rifles are no longer in state arsenals as a result of such a transfer of ownership. The exception is for states with documented programmes for the transfer of self-loading service rifles to civilian owners, such as the US Civilian Marksmanship Program (CMP, n.d.).

V. Durability and attrition ambiguity

Durability and longevity of self-loading rifles[68]

Firearms are highly durable products: they can be stored for long periods of time with minimal degradation. This is primarily due to the mechanical requirements of firearms, in particular the requirement that their construction materials be able to withstand the significant heat and pressure effects of firing. Self-loading rifles in particular must be able to withstand rapid, repeated firing. As a result, the critical components of self-loading rifles are typically constructed of highly durable materials such as steel or other alloyed metals (McCollum, 2015a).

Given that the most commonly worn and damaged components of self-loading rifles (such as a weapon's furniture or springs) are easily repaired or replaced, it is not uncommon for such weapons to have a service life of several decades. The US Civilian Marksmanship Program, for example, is still selling M1 Garand rifles produced in the 1940s and 1950s (CMP, n.d.). Even weapons in regular use and suffering from poor maintenance are likely to remain functional, albeit less accurate (McCollum, 2015a). Nonetheless, weapons requiring repair will only be returned to a functional state according to the capacity of their users. US military armourers, for example, can restore a large proportion of service rifles to full function during both high-tempo operations and training (Russell, 2006). Loss from breakage affects civilian owners at a higher rate, with dysfunctional guns estimated to constitute 25 per cent of all civilian-owned firearms (Weisser, 2013).

AK-type rifles, for example, have proved to be very durable. Kalashnikov-type weapons dating from the 1960s and earlier are regularly documented in conflict zones around the world. International Security Assistance Force (ISAF) troops in Afghanistan captured several well-worn but functional examples of AK and AKM rifles manufactured in the 1950s (Iannamico, 2015). Years of firing corrosive ammunition with limited cleaning usually severely degrades the bores of these weapons, and will also expose a weak point of the AK design—the gas tube. This component, produced from a relatively thin sheet metal,

corrodes if not properly cleaned, eventually degrading to the point where the weapon will malfunction (US Army Captured Materiel Exploitation Center, 1968). Nonetheless, this process takes considerable time and can be mitigated with proper cleaning. While the AK has a well-deserved reputation for reliability, the fact is that many self-loading rifles will remain functional over extended periods of time—particularly when properly stored and receiving appropriate preventive maintenance.

The oldest self-loading rifles to be mass produced date from the 1930s and 1940s, and it is not uncommon to see rifles from this period in modern conflict zones. German StG 44 assault rifles have been documented during the ongoing conflict in Syria on numerous occasions, likely transferred to Syria by East Germany or the Soviet Union several decades ago (Al-Tawhid Brigade, 2012). StG 44 rifles have also been documented in Algeria, Ethiopia, Iraq, and Somalia, and while it appears that only some 440,000 of these weapons were manufactured, 7.92 × 33 mm ammunition—compatible primarily with these weapons—remains available today (see ARES, 2015; Madriñán, 2012; Prvi Partizan, n.d.). In Mali, SKS and Type 56[69] self-loading rifles that were likely 60 to 70 years old were documented together with even older bolt-action rifles in a cache seized from suspected militants in 2014 (Ferguson, 2014b). The current conflict in Ukraine has featured decades-old rifles in service with pro-Russian Federation militants, including SKS rifles and other Second World War-era weapons such as PPSh-41 and PPS-43 sub-machine guns and PTRS-41 and PTRD anti-tank rifles (Ferguson and Jenzen-Jones, 2014b).

Table 3 **Examples of state security forces' holdings of obsolete small arms**

Country	Rifle type	Action	Number	Year of estimate
Brazil	Unknown	Bolt-action	823,000	2010
India	Lee-Enfield[a]	Bolt-action	2,155,000	2014
Russian Federation	Various	Various	9,000,000	2009
South Korea	M1 Garand	Self-loading	850,000	2010
Ukraine	Various	Various	3,500,000	2014

[a] Chambered primarily for .303 British and .410 musket.

Source: Dreyfus et al. (2010); Fox News (2010); Karp and Rajagopalan (2014); Luhn (2014); Russian Federation (2010)

Besides irreparable breakage or deterioration, states lose possession of military small arms in other ways. They may be transferred to other state militaries, changing ownership but staying in military control, although this does not necessarily make them easier to quantify. They can be diverted from military control when taken (often illegally) by former soldiers, insurgents, or civilians (see above). They can be destroyed through formal demilitarization. Some states also maintain significant holdings of obsolescent firearms that are no longer in service with their military or internal security forces (see Table 3).

Box 4 Current and historical holdings of self-loading service rifles in the Republic of Croatia[70]

When the Republic of Croatia was recognized as an independent state in January 1992, the Croatian Army had no standard service rifle. The Croatian military was equipped with a range of AK-type rifles originating in Albania, Bulgaria, China, Egypt, the former East Germany, Hungary, Romania, the former Soviet Union, the former Yugoslavia, and elsewhere. While attempts were made to standardize AK-type rifles of different provenance within military units, it was not until 2009 that a phased replacement programme was launched. This programme has sought to replace the existing mixture of rifle models with the domestically produced HS Produkt VHS-K1 and VHS-D1 self-loading rifles. In 2015 the newer VHS-K2 and VHS-D2 models supplemented these rifles.

Correspondence from the Croatian Ministry of Defence indicates that many of the AK-type rifles in the possession of the Croatian Army were seized from military depots of the former Yugoslav Army during the conflict in the 1990s. Limited numbers were also imported. All of the VHS-series rifles are domestically produced by HS Produkt d.o.o. in Karlovac. They are selective-fire bullpup rifles chambered for the 5.56 × 45 mm SCHV cartridge. Croatia is moving away from the Eastern Bloc 7.62 × 39 mm calibre in favour of NATO-standard calibres, simplifying interoperability during peacekeeping operations such as the recent deployment of Croatian troops to Afghanistan alongside ISAF partners. The VHS-K1 and VHS-K2 are short-barrelled variants (410 mm) of the VHS-D1 and VHS-D2 (500 mm) (HS Produkt, 2014). Table 4 shows the current status of all self-loading service rifles held by the Armed Forces of the Republic of Croatia, according to the Croatian Ministry of Defence.

Newer, domestically produced rifles now account for more than one-third of the 24,109 self-loading service rifles in active use with the Croatian Armed Forces. Nonetheless, Croatia still maintains extensive stockpiles of other rifles. Nearly three times the number of self-loading service rifles in active use have been sold or donated to other states since 1992, and more than four times the number of active service rifles remain stockpiled in Croatia. These rifles are now considered obsolete by the Croatian Ministry of Defence, but are likely held with a view to further sale, because the sale of surplus small arms and light weapons is Croatia's preferred method of disposal (Gobinet, 2011). The total number of self-loading service rifles (197,193[71]) held by Croatia is generally in line with estimates of total small arms and light weapons holdings ('over 260,000') given in Croatia's 2006 Long-term Development Plan (SEESAC, 2006).

Table 4 **Current status of Croatian Armed Forces' self-loading service rifles**

	AK-type rifles	VHS-series rifles
Active service	16,450	7,659
Storage or reserve	103,029	272
Sold or donated	63,884	0
Decommissioned or destroyed	5,899	0
Missing or unaccounted for	0	0

Source: Figures provided by the Croatian Ministry of Defence to ARES/the Small Arms Survey, 22 September 2015

The largest known stockpiles of legacy military firearms belong to the Russian Federation and Ukraine. Ten years ago the Ukrainian surplus numbered some 6–15 million excess firearms (Griffiths and Karp, 2008). More recent estimates account for subsequent surplus destruction and Ukrainian exports, and put the total at 3.5 million small arms and light weapons (Luhn, 2014). Less data is available on stockpiles in China or the Russian Federation. The latter's government has in the past announced plans to dispose of more than 9 million small arms and light weapons (Russian Federation, 2010). Surplus military small arm destruction has been an important theme for the international community. Between 1991 and 2006, organized destruction projects eliminated at least 8.5 million obsolescent, obsolete, or unwanted small arms; some three-quarters of these were from state armed services (Karp, 2007).

Repair, modification, and modernization of existing self-loading service rifles

The repair, modification, and modernization of self-loading service rifles complicates the task of quantifying the number of these weapons systems in existence. Different militaries have their own standards for wear and replacement. The official life of a US military M9 pistol is 17,000 rounds, although future US Army pistols are expected to have a 25,000-round service life (Parsons, 2014). Self-loading rifles operate to similar standards. China's 'Type 81 [rifle] was built to last 20,000 rounds compared to AK copies [Type 56] of 10,000–15,000 rounds' (Johnston and Nelson, 2010, p. 175). For non-state armed groups, of course,

these standards are often meaningless. Self-loading rifles are often documented in service with these groups in a state of disrepair or wear that would be unacceptable to most state militaries.

Self-loading rifles in the service of state militaries may be refurbished or rebuilt by armourers, which can complicate efforts to classify or, in particular, to count rifles. In some countries with substantial inventories of cold war-era weapons, armourers frequently rebuild in-service rifles from existing stocks of spare components or by breaking down rifles for parts. In some cases, these spares are in 'as-new' condition. Between 1975 and 1985, the United Kingdom purchased 385,250 SA80 rifles and light support weapons to equip its armed forces, which numbered some 330,000 personnel. Defence budget cuts have continued to reduce these forces, which now number around 82,000, and the corresponding stockpile of unassigned weapons has meant that no new SA80-type rifles have been manufactured since 1994 (ARES, 2015; *The Guardian*, 2011).

Militaries may also rely on newly manufactured components supplied by third parties to repair or modify existing self-loading rifles. When the UK military decided in the early 2000s to upgrade its SA80-type rifles from the L85A1 model to the L85A2, it purchased new complete receivers from Heckler & Koch. Weapons fitted with new receivers during this upgrade process retained the serial number of the original weapon, even though the serial-numbered component (the 'primary controlled component'; Ferguson, Jenzen-Jones, and McCollum, 2014) was replaced in its entirety. According to the UK Ministry of Defence, 200,000 upgraded SA80-type rifles remain in service (ARES, 2015). The UK government gave 400 such rifles to the Royal Bermuda Regiment in 2015[72] (UK MoD, 2016). Similar practice occurs in a number of militaries, including in France with the FAMAS and in Israel with weapons rebuilt from legacy AR-15-type carbines and rifles.

With the advent of increasingly modular weapons, rifles may not be procured as a 'complete' weapon in the traditional way. Complete upper receivers or modular systems may be purchased and allocated to rifles with existing serial numbers, which may complicate the process of categorizing, counting, and tracing military small arms (see 'Box 2, Modular rifles', above).

VI. Conclusion

Since the introduction in the mid-to-late 1800s of self-contained metallic cartridges and smokeless propellants enabled the production of the earliest self-loading rifles, these weapons have been produced for and used by national armed forces. Following the adoption of limited quantities of rifles, such as the Danish M1896 and Swiss-made *M1908 Mondragón* around the turn of the century, the First and Second World Wars saw the production, adoption, and use of significant numbers of self-loading service rifles. Types such as the SVT-40 and M1 Garand, chambered for full-power rifle cartridges, were supplemented in the mid-to-late 1940s by intermediate-calibre rifles such as the StG 44, SKS, and AK. While rifles, including the FAL and G3, continued to be produced in full-power calibres, a trend towards small-calibre, high-velocity ammunition soon took hold, heralding the adoption of types such as the AR-15, Type 95, and AK-74 from the 1970s onwards. SCHV rifles continue to predominate today, although there are signs of an increasing interest in new so-called 'general-purpose' calibres.

A variety of different models of self-loading service rifles have been produced, both under licence and without a licence. As with any commercial good manufactured today, intellectual property and data rights are fundamental features of the production landscape for these weapons. States' own manufacturing facilities tended to produce self-loading service rifles of the First and Second World Wars. After the Second World War, significant quantities of rifles were licensed for production outside their countries of origin. Modern arms manufacturers are increasingly securing contracts for the licensing of rifle production based on their ability to deliver complete 'product solutions', including IP rights, training, engineering assistance, and specialized machinery.

Estimates of small arms production numbers are an important part of the global small arms picture. Understanding how best to classify and count these weapons, including self-loading rifles, is critical in supporting efforts to counter illicit proliferation. While precise figures are not available for some types, this

study's final estimates of cumulative global production make optimal use of available data sources. A great many models of self-loading service rifles have been produced; however, only 4 families of rifles still in production have been manufactured in quantities exceeding 5 million units: AK-type rifles (an estimated 76 million), AR-10 and AR-15 types (est. 13 million), G3 types (est. 8 million), and FAL types (est. 5.5 million). These account for nearly 60 per cent of all self-loading service rifles produced to date.

However, data constraints limit the precision of these figures. Production for the civilian and law enforcement markets, for example, is sometimes difficult to disaggregate from production for the military in the case of certain self-loading rifles. Similarly, the acquisition of arms formerly in state arsenals by civilians, including non-state armed groups, can be difficult to quantify: except in a few cases, records are either non-existent or inaccessible. The increasing popularity of modular firearms, particularly those offering calibre conversion, and the repair, modification, and modernization of self-loading service rifles can impede attempts to accurately classify and count such weapons. It is clear that state holdings may decline through attrition—or remain stable as a result of the retention of older weapons following their repair or refurbishment—but available information does not currently permit the quantification of these factors. The study's estimates of total production to date can therefore only approximate the actual figures.

This study has sought to classify and quantify the cumulative global production of self-loading service rifles, conservatively estimated at around 175 million rifles. It has examined the most significant rifle types that have been produced and considered factors that complicate the derivation of useful figures. The next step is to examine these factors of attrition, retention, and ongoing annual production in greater detail so as to increase our understanding of self-loading service rifles.

Endnotes

1 This report was finalized in 2015 and therefore does not include more recent production.

2 Including the term 'military assault rifle'. The term 'assault rifle' has become increasingly blurred by both technical developments and the operational employment of self-loading rifles. Generally, assault rifles are understood to be self-loading rifles capable of automatic fire ('automatic rifles') chambered for an intermediate cartridge (typically producing between 1,300 and 2,600 joules of muzzle energy). The term 'assault weapon' was defined in a US legal context by means of various cosmetic features found on various designs of rifle (primarily, but not exclusively, assault rifles) rather than the operating characteristics of the weapon itself. This definition in the 1994 Assault Weapons Ban actually covered civilian-owned, semi-automatic rifles (ATF, 2015). The popular media have also adopted the term 'assault weapon' as a synonym for 'assault rifle'. The former term was already in limited specialist use to describe certain light weapons. It has never been authoritatively applied to firearms outside the United States. Without qualifying language, the term is so indefinite as to apply to almost any offensive weapon. For a fuller discussion of these issues, see Ferguson et al. (2015).

3 A term that is found predominantly in amateur rather than military or other arms professional use.

4 See Bevan (2014). The term 'traditional military rifle' is unclear in meaning and is not preferred by experts.

5 It is important that policy-makers in the small arms field are able to readily understand the issues surrounding the development, employment, and production of self-loading service rifles. Key to this is specific, technically accurate terminology that correctly reflects the self-loading rifles and other small arms and light weapons that policy-makers intend to regulate. Clear, technically accurate definitions are also essential to the comprehensive analysis of specific rifle types, models, countries, and manufacturers.

6 The full meaning of the abbreviations for well-known types of self-loading rifles—for example, the AR-15—are given in the list of 'Abbreviations and acronyms', unless their names need further explanation.

7 Or even smaller data points, such as the production of one variant of one rifle type in one country.

8 Early automatic arms such as the Gatling and Gardner guns required the user to cycle the weapon by turning a crank handle, while modern externally powered guns, such as chain guns, are driven by electric motors. Self-loading weapons make use of the energy generated by the propellant, which would otherwise be wasted (Goad and Halsey, 1982).

9 For '*poudre blanche*', or white powder, differentiated from *poudre N*, for '*poudre noire*', or black powder (Davis, 1943/1990).

10 Rasmussen later changed his family name to Bjarnov (Popenker, n.d.)

11 Approximately 60 rifles were purchased for use in defending coastal fortifications, including Middelgrundsfortet. Fifty-six examples remained in service until 1932; however, they were never used in combat (Arma-Dania, n.d.b).

12 Mondragón's self-loading rifle received a US Patent on 14 May 1907, and as such is sometimes referred to as the *M1907 Mondragón* (McCollum, 2011a; Mondragón, 1907).

13 The weapon's designation includes reference to Porfirio Diaz, the then-president of Mexico and widely acknowledged as Mondragón's patron (Johnston and Nelson, 2010).

14 The Remington Model 8 and Winchester Models 1905, 1907, and 1910, for example, proved very popular in the United States. Some 69,000 Model 8 rifles were produced between 1906 and 1936, and approximately 108,383 Model 1905/1907/1910 rifles were produced between 1905 and 1957. These were overwhelmingly for civilian sales, with some law enforcement use (Henshaw, 1993; Woodall, 2016).

15 These included the Russian Avtomat Federova; the French Fusil Automatique Modèle 1917 RSC (Mle 17); the German Mauser M1916; and the British Rifle, .303 inch, Pattern 1918 (Farquhar-Hill). The French Mle 1917 and Mle 1918 were the only self-loading rifles produced in notable quantities during the First World War, with a combined total of some 89,333 weapons (Huon, 1988; 1995). It should be noted that this is a comparatively low number compared to how many manually operated rifles were produced in the same period.

16 Although the German military nominally adopted the StG 44 in 1944, in practice the Karabiner 98k remained the standard-issue rifle for the duration of the war. By comparison, approximately 440,000 StG 44 rifles and 888 million 7.92 × 33 mm cartridges were produced by Germany during the Second World War, whereas nearly 9 million Karabiner 98K bolt-action rifles and some 8.4 billion 7.92 × 57 mm cartridges were produced (Boelcke, 1969; Johnston and Nelson, 2010).

17 Contemporary acquisitions programmes have shown similar resistance to the so-called 'general-purpose cartridge', notwithstanding increasingly compelling evidence of its superior ballistics and utility (Jenzen-Jones, 2016a).

18 Like the later AK, numerous copies and derivatives—both licensed and unlicensed—of the Model 98 were produced; however, Mauser, a commercial entity, actively sought to maintain control of its patents. Approximately 102 million have been made from 1898 to the present (ARES, 2015; Ball, 2006).

19 In 1971 the UN recognized Taiwan as a province of China.

20 Samozaryadnaya Vintovka Tokareva obraztsa 1940 ('Tokarev self-loading rifle, model of 1940').

21 Early articulation of the intermediate-cartridge concept in German military thinking can be found in a study by Hauptmann Piderit of the Gewehr-Prüfungskommission in 1918, in which he makes the case for a reduced-power cartridge and a rifle capable of automatic fire. He notes that very few infantry engagements take place at more than 800 m, and that contemporary cartridges, which were capable of engaging targets at over twice that distance, were unnecessary for a service rifle (Erenfeicht, 2013).

22 Also known as the MP 43 and MP 44 (Johnston and Nelson, 2010).

23 Modern definitions of what constitutes an assault rifle vary. Ferguson et al. (2015) define assault rifles as 'Rifles capable of firing multiple shots with each trigger pull, primarily intended to be fired from the shoulder, and chambered for a rifle calibre cartridge typically producing between 1,300 and 2,600 Joules muzzle energy'.

24 Some 440,000 StG 44-type rifles were manufactured (Johnston and Nelson, 2010).

25 Many sources refer to the AK as the AK-47. This is, strictly speaking, incorrect, with the term 'AK-47' only applicable to the original prototype design (Ferguson and Jenzen-Jones, 2014a).

The media have widely adopted the term AK-47 to refer to any AK-type rifle, and often to other, unrelated weapons (Iannamico, 2015).

26 The Avtomat Kalashnikov Modernizirovanniy (AKM) was introduced in 1959. It is an updated model of the earlier AK rifle, which was developed immediately after the Second World War (Ferguson and Jenzen-Jones, 2014a).

27 The AK was first issued in noteworthy quantities between 1949 and 1952, and was replaced in Soviet service by the AKM from 1959, the Avtomat Kalashnikova obraztsa 1974 (AK-74) from 1974, and then the Avtomat Kalashnikova obraztsa 1974 Modernizirovanniy (AK-74M) from 1991 (Ferguson and Jenzen-Jones, 2014a; Hogg, 1979). The latest incarnation, the AK-12, was accepted by the Russian Federation military in January, 2015 (Wilks, 2015). It is unclear when or how many AK-12 rifles will be adopted by the Russian military.

28 While there were earlier cartridges than the post-Second World War British developments that possessed similar characteristics—such as the Japanese 6.5 × 50SR mm and Danish 7 × 44 mm—the British initiative represents the first comprehensive push towards a self-loading service rifle chambered for an intermediate-calibre cartridge undertaken by a NATO member state (Dugelby, 1980; Ford, 2008).

29 Early prototypes of the FN Herstal FAL (see below).

30 FN Herstal had earlier been involved with the development of the .280 cartridge, and began to develop early versions of the FAL rifle chambered for this round (Ford, 2008).

31 The US Board of Ordnance stated: 'the Army is firmly opposed to the adoption of any less effective smaller caliber cartridge for use in either its present rifle or in new weapons. Any new rifle cartridge adopted must have the wounding power, penetration performance, and ballistics at least equal to that in use today [the .30-06]' (*Spokesman-Review*, 1951).

32 NATO Standardization Agreement 2310 was ratified in 1957 (Pellegrino and Kirkman, 2011).

33 While the United Kingdom had adopted the EM.2 rifle and its ammunition as the 'Rifle, 7mm, No.9 Mark 1' and 'Cartridge, SA, Ball, 7mm Mark 1' in August 1951, this decision was quickly reversed following the general election of that year. The United Kingdom later adopted a modified FN Herstal FAL chambered for 7.62 × 51 mm as the 'Rifle, 7.62mm, L1A1' in 1954 (Edwards, 2014).

34 The earliest FAL prototypes were chambered for the German 7.92 × 33 mm cartridge. Later examples were chambered for the British .280 calibre round.

35 Several countries, including the United Kingdom, adopted so-called 'inch-pattern' FAL rifles manufactured to slightly different imperial unit specifications.

36 The so-called 'roller-locking' breech mechanism is a retarded blowback design with a development story beginning in the inter-war period and in Second World War-era Germany, and with subsequent post-war chapters in France, Spain, and Germany. For a fuller discussion of the development of the roller-locking breech, see Stevens (2006).

37 While the Soviet Union later introduced the 5.45 × 39 mm SCHV cartridge (still standard issue for the Russian Federation armed forces), the 5.56 × 45 mm and 7.62 × 39 mm cartridges remain the predominant military rifle cartridges in service (ARES, 2015).

38 By way of comparison, 104 7.62 × 51 mm M80 cartridges weigh approximately the same as 210 5.56 × 45 mm M855 cartridges (5.5 lbs, or almost 2.5 kg) (Schatz, 2015).

39 The Type 95 family of weapons includes assault rifles, carbines, and light machine guns, as well as a sniper rifle, a general-purpose machine gun, and a machine gun intended for armoured fighting vehicle use (Andrew, 2015).

40 For a fuller discussion of general-purpose-calibre cartridges, see Jenzen-Jones (2016a).

41 A split-receiver design is one in which the main 'body' of the rifle consists of two parts, generally known as an 'upper receiver' and a 'lower receiver'. This design may allow for ease of access to operating components and the easier replacement of either receiver portion.

42 One notable exception was the installation of top covers with 'Sight Unit, Infantry, Trilux' (SUIT) optical sight mounts on the UK's version of the FAL—the L1A1 Self-loading Rifle—which occurred at the armourer level (Stevens, 1980).

43 'Collectively, the buttstock and the fore end (along with other non-critical, ergonomic components of the weapon, such as the pistol grip) are often referred to as "furniture". A weapon's furniture may be wooden, synthetic, metallic, or made of other materials' (Jenzen-Jones, 2015, p. 4).

44 Eastern Bloc counterparts can be seen in the AK and its derived RPK light machine gun, which were eventually followed by the AK-74 series of weapons, including the RPK-74 light machine gun and AKS-74U automatic carbine.

45 Special operations forces may change barrel lengths according to operational needs; for example, a shorter barrel may be preferred for close-quarters battle operations in urban environments, while a longer barrel may prove advantageous where longer-range engagements are expected.

46 From 1994 until its cancellation in stages during the mid-2000s, the US Objective Individual Combat Weapon programme sought to develop a 'modular' weapon system, consisting of a 5.56 × 45 mm carbine and a semi-automatic 20 mm grenade launcher. These two components could each be employed separately or as a 'dual munition weapon system' (TACOM/ARDEC, 1998). While the US military did not adopt a combined self-loading rifle/grenade launcher, the programme did spawn many further developments, including the XM8 rifle.

47 A subsidiary of FN Herstal of Belgium.

48 Sometimes known simply as the 'control component'—as in, for example, Persi Paoli (2015).

49 Full name: International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons. See UNGA (2005).

50 For example, the primary controlled component of typical AR-15-type rifles in the United States is the lower receiver, whereas the upper receiver plays a more integral role in the operation of the weapon (and would more properly fulfil the definition of an 'essential or structural component' under the ITI) (Ferguson, Jenzen-Jones, and McCollum, 2014).

51 Most commonly, such marks are abraded by filing, grinding, or milling.

52 The M4 is a shorter and lighter 'carbine' variant of the M16A2 self-loading rifle and shares many common parts. It was adopted by the US military in 1994 (Bartocci, 2004). The maximum effective range for the M4 carbine when engaging point targets is given as 500 m in FM 3-22.9 (US Army, 2008a). The US Army (2008a, Glossary-7) defines 'maximum effective range' as 'the greatest distance at which a soldier may be expected to deliver a target hit'.

53 Examples include the L96A1 and L115A3 in British service, the Steyr SSG 69 in Austrian service, and the Parker Hale C3 series in Canadian service.

54 The Canadian Rangers are a sub-component of the Canadian Armed Forces Reserve, serving as Canada's military presence in the sparsely settled northern, coastal, and isolated areas of the country. In the course of their military duties members frequently employ their issued rifles for hunting and defence against predators (Jenzen-Jones, 2016b).

55 AK-type rifles have been considered together, regardless of calibre. It is often difficult to disaggregate AK-type rifle production data by calibre, because many manufacturers produce very similar weapons in different calibres (most commonly 7.62 × 39 mm and 5.45 × 39 mm, although other calibres such as 5.56 × 45 mm are also found).

56 'IP' is taken to mean patents, copyrights, trademarks, and trade secrets (Ryan and Chen, 2010).

57 In one notable case, FN Herstal refused to grant Germany a production licence for a significant number of rifles. Germany had purchased over 100,000 rifles and would have adopted the FAL as a standard-issue rifle if not for this political hurdle. Instead, Germany adopted the G3, and Heckler & Koch began to widely issue licences for this competitor to the FAL.

58 Now Burkina Faso.

59 Unlimited rights apply to technical data developed entirely at government expense, and generally allow for unlimited use both within and outside of government (e.g. commercial use); government purpose rights usually apply to technical data developed with mixed funding, and generally allow for unlimited use within government, but not for external or commercial use; limited rights apply to technical data developed entirely at private expense, and generally may not be used by government for manufacturing purposes. Permitted uses outside of government may include emergency repair or evaluation by foreign governments (Ryan and Chen, 2010).

60 See DFARS 252.227-7013(b)(1) (US Department of Defense, 2014).

61 MIL-STD-31000 goes on to say, 'The description defines the required design configuration or performance requirements, and procedures required to ensure adequacy of item performance. It consists of applicable technical data such as models, drawings, associated lists, specifications, standards, patterns, performance requirements, QAP [quality assurance provisions], software documentation and packaging details' (US Department of Defense, 2009, p. 8).

62 These provisions are described in Contract No. DAAF03-67-C-0108 and the 'Technical Data Sales & Patent License Agreement' (Ryan and Chen, 2010).

63 More properly, An Act to Promote the Defense of the United States (Pub.L. 77–11, H.R. 1776, 55 Stat. 31, enacted 11 March 1941).

64 Correspondence from S. Naval Attaché to Chief, Bureau of Ordnance, US Navy on 1 September 1941, in US Navy Bureau of Ordnance (n.d.).

65 FN Herstal also offered to produce the first FAL rifle chambered for the T65 cartridge for the United States at no cost (Rayle, 1996).

66 Interviews with confidential defence industry sources.

67 The Mini-14 was adopted by the Bermuda Regiment, a territorial defence unit subordinate to the British Army.

68 For a fuller assessment of the factors contributing to the durability of self-loading rifles, see McCollum (2015a).

69 The Chinese copy of the SKS, designated the Type 56; not to be confused with the Chinese AK/AKM derivative also designated the Type 56.

70 This section draws on correspondence between ARES/the Small Arms Survey and the Croatian Ministry of Defence conducted specifically for this study.

71 Figure provided by the Croatian Ministry of Defence to ARES/the Small Arms Survey, 22 September 2015.

72 The Royal Bermuda Regiment is a territorial defence unit for the British Overseas Territory of Bermuda. In addition to the transfer of 400 L85A2 rifles, the regiment also received 1,600 magazines, 440 TA31 optical weapons sights, and 4 collimator-type weapons sights (UK MoD, 2016).

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