

ARCHIVED REPORT

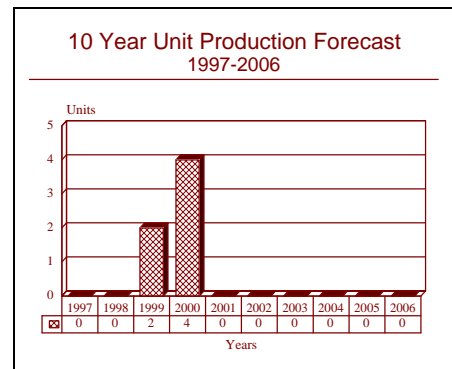
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M114/M139 155 mm Howitzers - Archived 5/98

Outlook

- Production of the M139 forecast to be very limited
- Some additional modernization of existing inventories of the M114 expected
- Graph to the right is for new production M139 systems only



Orientation

Description. Towed 155 millimeter artillery systems

Sponsor. The development and procurement of the M114 was sponsored by the United States Department of Defense through the United States Army Armament, Munitions and Chemical Command. The development of the M139 was sponsored by RDM Defence Engineering.

Contractors. The M114 was manufactured by Rock Island Arsenal and numerous other heavy industrial firms in the United States of America. The M139 was developed and, if ordered, will be manufactured by RDM Defence Engineering, Rotterdam, Netherlands.

Licensees: Daewoo Corporation in the Republic of Korea has manufactured the M114 under license although the program is presently dormant.

Status. The manufacture of the M114 in the United States terminated in 1953 but the system remains in service in the United States of America (in reserve) and

a number of other nations. A number of modernization and retrofit programs have been developed and are in various stages of implementation for this system. The development of the M139 is complete and the piece is available for production orders.

Total Produced. Through 1953, approximately 10,300 M1/M114 pieces were manufactured. Approximately 9,860 pieces still exist, with 4,008 pieces identified as being in service. As of January 1, 1997, a total of two M139 pieces had been manufactured.

Application. Fire support for the field army at the battalion level.

Price Range. Ten used M114 pieces in "good" condition were sold in November of 1984 at a unit price of \$136,000 by an international arms principal. A 1991 quote by a principal had a unit price of \$129,000. In equivalent 1997 United States dollars, the all new M139 has a unit price of \$528,700.

Technical Data

M114

Crew. Eleven or twelve
 Muzzle Brake. None
 Recoil System. Hydropneumatic
 Breech Mechanism. Interrupted screw stepped thread
 Carriage Type. Split trail
 Shield. Optional
 Ammunition. Separate-bagged - M107 (High Explosive), M449A1 (High Explosive/Sub-Munition Dispensing), M483A1 (High Explosive Dual Purpose/Sub-Munition Dispensing), M549A1 (High Explosive/Rocket Assisted Projectile, M692 and M731 Area Denial Artillery Munition (Sub-Munition Dispensing), M718 and M741 Remote Anti-Armor Munition (Sub-Munition Dispensing) M118 (Illumination), M485 (Illumination), M110A1 (White Phosphorous), M116A1 (Smoke-Base Eject), M631 (Chemical-CS), M121 (Chemical-VX or GB), M110 (Chemical-H/HD), and Nuclear (W48 or W82). The M114 (in the long barrel A2 model) can also fire the M712 Copperhead laser guided projectile.

Dimensions. The following data are for the final production standard M114.

	<u>SI units</u>	<u>US units</u>
Caliber	155 millimeters	6.10 inches
Length overall	7.32 meters	24.02 feet
Barrel length	23.39 calibers/3.63 meters	23.39 calibers/11.91 feet
Traveling width	2.44 meters	8.01 feet
Firing width (normal)	7.65 meters	25.10 feet
Traveling height	1.80 meters	5.91 feet
Firing height	2.14 meters	7.02 feet
Traveling weight	5.80 tonnes	6.39 tons
Firing weight	5.76 tonnes	6.35 tons

Performance. The range figure is with non assisted ammunition. The M114 is normally towed at a maximum speed of 85 kilometers per hour (52.8 miles per hour) behind a five ton class truck.

Elevation	+63°	+63°
Depression	-2°	-2°
Traverse	25°left/24°right	25°left/24°right
Maximum range	14,600 meters	15,966.56 yards
Maximum rate of fire	4 rounds per minute	4 rounds per minute
Sustained rate of fire	1.2 rounds per minute	1.2 rounds per minute

M139

Crew. Eleven
 Muzzle Brake. Multiport
 Recoil System. Hydropneumatic
 Breech Mechanism. Interrupted screw stepped thread
 Carriage Type. Split trail
 Shield. Optional
 Ammunition. Separate-bagged - M107 (High Explosive), M449A1 (High Explosive/Sub-Munition Dispensing), M483A1 (High Explosive Dual Purpose/Sub-Munition Dispensing), M549A1 (High Explosive/Rocket Assisted Projectile, M692 and M731 Area Denial Artillery Munition (Sub-Munition Dispensing), M718 and M741 Remote Anti-Armor Munition (Sub-Munition Dispensing) M118 (Illumination), M485 (Illumination), M110A1 (White Phosphorous), M116A1 (Smoke-Base Eject), M631 (Chemical-CS), M121 (Chemical-VX or GB), M110 (Chemical-H/HD), and Nuclear (W48 or W82). The M139 can also fire the M712 Copperhead laser guided projectile and is also compatible with all types of Extended Range Full Bore projectiles including Base Bleed types.

Dimensions. The following data is for the latest prototype of the M139 which is the production standard weapon. The barrel length DOES NOT include the muzzle brake.

	<u>SI units</u>	<u>US units</u>
Caliber	155 millimeters	6.10 inches
Length overall	10.09 meters	33.10 feet
Barrel length	38.81 calibers/6.016 meters	38.81 calibers/19.737 feet
Traveling width	2.44 meters	8.01 feet
Firing width (normal)	7.71 meters	25.29 feet
Traveling height	2.31 meters	7.58 feet
Firing height	2.44 meters	8.01 feet
Traveling weight	7.61 tonnes	8.39 tons
Firing weight	7.57 tonnes	8.34 tons

Performance. The maximum range figure is with the High Explosive Extended Range Full Bore/Base Bleed projectile with the M203 charge. The M139 is normally towed at a maximum speed of 90 kilometers per hour (55.9 miles per hour) behind a five ton class truck.

Elevation	+63°	+63°
Depression	-2°	-2°
Traverse	25°left/24°right	25°left/24°right
Maximum range	32,400 meters	35,432.64 yards
Maximum rate of fire	4 rounds per minute	4 rounds per minute
Sustained rate of fire	2 rounds per minute	2 rounds per minute

Variants/Upgrades

Variants. No specific variants of the M114 were developed. As the M139 is a completely new system, it is covered as such below.

Retrofit and Modernization Program Overview. Due to the fact that the M114 is still a battlefield viable system existing in substantial numbers, it should be no surprise that there have been a number of proposals to upgrade the system with a modern (longer) ordnance. All the carriage related retrofit programs listed below have as their goal the retrofit of a new 39 caliber ordnance.

Carriage Inspection. Out of the 10,000-odd M1/M114 pieces remaining in the world today, our research finds that about 6,000 are felt to be in a good enough condition to retrofit with a 39 caliber ordnance. Before any plan is undertaken, the complete carriage must be inspected by magnaflux or similar technology to ascertain whether the individual piece is capable of withstanding the differing and increased weights and moments of the 39 caliber ordnance.

Modified Spade Position. As the increased weight and different moments of a 39 caliber ordnance affect the center of gravity and stability of the piece both when traveling and firing, the spades must be repositioned. In an effort to reduce the weight of the piece, spades of a

modern lightweight high strength steel may well be substituted.

New Equilibrator. The different moments of the 39 caliber ordnance necessitate a new equilibrator. Since a simple spring equilibrator cannot effectively deal with the increased moment of the 39 caliber ordnance, a hydropneumatic or pneumatic equilibrator is necessary.

New Bracket. Since hydropneumatic or pneumatic equilibrators have to be able to compensate for temperature changes, a new equilibrator bracket is necessary. A new equilibrator requires new attachment points to the new 39 caliber ordnance. Also, a new yoke is required; the yoke has to be of a more robust construction to accommodate the increased weight of the new barrel.

Modified Recoil System. Due to the differing moments of the 39 caliber ordnance, the recoil system has to be modified. Differing recoil distances have to be accommodated for different tube elevations. An automatic recoil limiting device, which turns a metering rod in the hydraulic component which in turn provides the appropriate hydraulic flow for the required recoil length, is required.

New Hydraulic Seals. In conjunction with the above modification, new hydraulic seals are almost always

incorporated into the recoil mechanism to deal with the increased pressures.

Traverse & Elevation Modifications. New gear ratios in the traverse and elevation assembly are usually incorporated with the addition of the 39 caliber ordnance. The new gear ratios provide about the same mechanical advantage to move the new ordnance as did the old system with the original M1/M1A1 ordnance.

Auxiliary Power Unit. Although the M114 is traditionally a towed artillery piece, RDM Defense Engineering has developed a diesel powered auxiliary power unit that can be installed on the forward part of the carriage. The unit is based on a Volkswagen air cooled diesel engine which develops 45 kilowatts (60.32 horsepower) to allow the M114 to move under its own power at a maximum rate of 10 kilometers (6.21 miles) per hour. This power assist would aid in "manhandling" the gun in position or for rapid movement within a limited area. As of this writing, there is no evidence that this option has yet been sold.

39 Caliber Ordnance. The reason for all the modifications listed above is the installation of a 39 caliber ordnance. Such a modification not only increases the range of the piece but also makes it compatible with all the new enhanced projectiles presently available. Examples of these projectiles are the Extended Range Full Bore projectiles and various submunition/sensor dispensing projectiles.

In the United States, the United States Army previously considered installing the M199 39 caliber ordnance of the M198 on the M114 as a cheap method of greatly enhancing the number of modern 155 millimeter pieces in the inventory. However, the required funding has never been available for such a program. Instead, the United States Army opted to install a ballistic match for the M126 ordnance used in the basic M109 155 millimeter self-propelled howitzer. This ordnance is designated M1A2 and can fire all the ammunition types certified for the M126; in addition, the range is increased to 20,100 meters (21,981.36 yards). The revised system is designated M114A2; with this plan, the United States Army achieved its goal of greater range and increased ammunition flexibility while still reducing the cost. This retrofit program was accomplished at the various arsenals in the United States.

In 1986, a memorandum of understanding was signed by Denmark, Norway, and the Netherlands for the modernization of their M114 inventories, a total of 226 pieces. The actual breakout is 82 for the Netherlands, 96 for Denmark and 48 for Norway. The Netherlands company, RDM Defense Engineering, was contracted

as prime for the program, with DISA of Denmark and Norsk Forsvarsteknologi of Norway as their countries' respective integration subcontractors. The upgrade, known as the M114/39, was originally developed by SRC International (the original Belgian firm set up by the original Space Research Corporation in the late seventies) and features a 39 caliber ordnance manufactured by Bofors of Sweden. Canada also had interest in the M114/39 and decided to purchase the program for its M114 inventory (55 pieces) in January of 1985.

The Dutch modification kit features the new 39 caliber ordnance that can be fitted with a fume extractor as an option, plus a multi-baffle muzzle brake and a larger chamber. The Dutch rifling twist and other interior ballistics are optimized for Extended Range Full Bore/Base Bleed ammunition, the reason for the assistance from the former Poudres Reunies de Belgie. The Dutch system also incorporates a new breech band. System integration in Denmark was handled by DISA and in Norway by Norsk Forsvarsteknologi.

As a means of expanding foreign sales, RDM has reached an agreement with BMY Combat Systems (now United Defense Limited Partnership) to assume prime contractorship for M114/39 conversions where Foreign Military Sales financing can be used. In these cases, United States industry would receive 50 percent of the work.

A blow to this program took place in mid-1994 when Denmark, Norway, and the Netherlands all withdrew their M114/39 pieces from service. The reason for this action was that cracks had been discovered at the joint between the upper and lower gun mount. This particular component was not modified during the modernization/retrofit program. While the exact cause of the cracking is not yet known, corrective work was undertaken by RDM Defense Engineering and the problem put right.

As noted above, RDM Defense Engineering has developed to production status a complete new artillery piece that is essentially the same as the M114/39. This artillery piece is designated M139 and is described below.

Soltam of Israel (M114S), KIA Machine Tool Company of the Republic of Korea (KH179), Giat Industries of France (M114F), OTOBREDA of Italy (155/39 TM), Rheinmetall Industrie of the Federal Republic of Germany (M114/39) and Hellenic Arms Industry of Greece (M114/39) also offer 39 caliber conversions for the M114. The Austrian firm NORICUM had an offering which featured a new semi-automatic breech assembly of the GHN-45 and carriage modifications with an optional pneumatic ramming system. Since the

1994 reformation of a new NORICUM firm, the status of this program is not known.

The retrofit from Giat Industries, called the M114F, features the 39 caliber cannon of the new TR 155 piece and carriage modifications. OTOBREDA's upgrade, called the 155/39 TM, features the 39 caliber cannon from the M109L; since this is ballistically matched to the ordnance of the FH 155-1 towed howitzer, range performance is enhanced. Soltam's private effort, called the M114S, uses an indigenous 39 caliber barrel that is optimized for Extended Range Full Bore projectiles. The KIA Machine Tool's upgrade, called the KH 179, features a complete rebuild with a new 39 caliber cannon that is compatible with Extended Range Full Bore pattern ammunition. This program was adopted by the Republic of Korea for its M114 inventory. The Greek and German programs, both no longer offered, both integrated a new 39 caliber cannon with major carriage upgrades.

45 Caliber Ordnance. Previous research indicated that, while it would be possible to integrate a 45 caliber ordnance with the M114, both the static and firing moments of this still longer tube would be extremely difficult and expensive to accommodate in the M1A1/A2 carriage of the M114. However, one firm, SITECSA of Spain decided that the development expense was worth the potential and went ahead to develop an M114/45. Actually, the SITECSA firm of Spain has developed both 39 and 45 caliber retrofit programs for the M114. In both cases, a new ordnance, similar to that used in SITECSA's 155/45 ST 012 is used. This barrel features an automatically operated screw breech assembly and a new multi-baffle muzzle brake. A pneumatically operated ramming system and new low maintenance equilibrators are also integrated with the piece. These features are in addition to the general

refurbishment and strengthening of the carriage and other components. The contractor claims that only seven men are required to operate the modernized M114. As of early 1997, no known sales of SITECSA's 39 or 45 caliber versions of the M114 had been made.

Opportunities. Despite the recent setback suffered by the RDM Defense Engineering M114/39 upgrade program, the market potential for the M114/39 caliber upgrade is still there. Our research indicates that it is sufficiently large to warrant the addition of at least one more firm to offer this type of conversion. Over the last several years, France's Giat Industries, Italy's OTOBREDA and Spain's SITECSA have joined the pack that originally included KIA Machine Tool Company, followed by RDM Defense Engineering, the former NORICUM, and Hellenic Arms Industry. While the SITECSA program is probably dead and the (new) NORICUM program on unsure footing, the market is still there.

There are still a very large number of M114 pieces in active service and that qualify for this upgrade. Turkey has negotiated among several contractors for the 39 caliber conversion that would cover as many as 350 M114 pieces.

In the Asian market, Pakistan and Thailand all have sizable numbers of the M114 in their parks. Middle East inventories are quite small in comparison. In all, we expect a moderate portion of M114 users to convert to the M114/39 through the nineties.

Despite the undeniable ballistic performance of the SITECSA 45 caliber version of the M114, it was never received on the market. Our research indicates that there is a rather widespread feeling that a 45 caliber barrel is simply too much for even the modified M1A1/A2 carriage of the M114.

Program Review

Background. In the late thirties, the United States Army began the development of a new 155 millimeter howitzer to replace the M1917 and M1918 pieces, both French designs. The new howitzer was type designated Howitzer, 155 millimeter, M1 in April of 1941. During the Second World War, production of this howitzer was heavy, the demand being met not only by Rock Island Arsenal, but numerous other heavy industrial firms in the United States. By the end of the war, over 6,000 pieces had been produced.

In 1947, the M1 was redesignated Howitzer, Medium, Towed: 155 millimeter M114. Production continued on a relatively low basis until 1953. Since 1953, the

production of M114 components has continued in a mercurial manner to support normal replacements due to wear and attrition. It was not until 1968 that the United States Army decided to develop a new 155 millimeter howitzer, the M198. Even though the M198 is no longer in front line service with the United States Army, a large inventory of the M114 continues to be held in reserve formations.

M139. As described above, RDM Defence Engineering, located in Rotterdam in the Netherlands, has long been involved in the modernization and retrofit market for the M114. In the eighties, the firm decided to develop and manufacture an all new artillery piece based on its

M114/39 modernization and retrofit program. The development and testing of the new piece, called the M139, was completed in 1990 and the weapon is available for purchase. Aside from being manufactured from new components, the M139 is identical in appearance and ballistic performance to the M114/39.

The main selling points of the M139 is its highly competitive unit price, among the best for new 155 millimeter towed artillery systems of Western manufacture in the world today as well as the high level of performance for the system.

Funding

The original development and procurement funding for the M1/M114 towed howitzer was supplied by the United States Department of Defense. The development of the various modernization and retrofit programs covered in this report was privately funded by the contractors; their implementation was funded by the governments involved. The funding for the development of the M139 was provided by RDM Defence Engineering.

Recent Contracts

None

Timetable

This timetable relates to the complete history of the M114, even as the M1.

	1937	Design of new 155 millimeter howitzer began
Apr	1941	New piece type designated as M1
Sep	1941	Serial production began
Mid	1946	System redesignated M114
	1953	Production terminated
Through	1970s	Production of spare M1/M1A1 ordnance, components continued
Late	1970s	Development of M114/39 by various firms began
	1980s	Various M114/39 plans implemented; M139 developed and tested
Mid	1994	Denmark, Netherlands and Norway withdraw their M114/39 pieces due to cracking
Early	1997	Various retrofit programs ongoing; M139 available for purchase orders

Worldwide Distribution

Export Potential. The M114 has been and should continue to be traded on the open market, as well as through various military aid channels by the United States of America and possibly several other nations.

The potential for the new M139 is somewhat less than sanguine due to the tremendous glut of both new and used towed artillery pieces of this caliber in the world today. Contributing to the expected potential is the general trend toward self-propulsion in this caliber.

Countries. The following data are correct as of early 1997.

<u>Africa</u>	Morocco	20
	Sudan	18
	Tunisia	12
	Laos	15
<u>Asia</u>	Pakistan	60
	Philippines	9
	Republic of China	250
	Republic of Korea	786
	Singapore	16
	Thailand	56

	Vietnam	130
<u>Central America</u>	El Salvador	6
<u>Europe</u>	Austria	24
	Denmark (M114/39)	96
	Greece	267
	Italy	421
	Netherlands (M114/39)	82 (being reduced to 51)
	Norway (M114/39)	48
	Portugal	40
	Spain	84
	Turkey	517
	Yugoslavia (Serbia-Montenegro)	9
<u>Middle East</u>	Iran	76
	Iraq	14
	Israel	63
	Jordan	30
	Lebanon	15
	Saudi Arabia	16
	Yemen	12
<u>North America</u>	Canada	57
	United States	419
<u>South America</u>	Argentina	6
	Brazil	98
	Chile	36
	Ecuador	12
	Peru	36
	Uruguay	5
	Venezuela	12

In addition, international arms merchants have over 850 pieces in storage available for sale; about 30 percent of these pieces are said to be in new condition. Other M114 pieces are held by various unidentified countries in dead storage. Two M139 prototype/developmental pieces are held by RDM Defence Engineering in the Netherlands.

Forecast Rationale

Despite its ancient heritage, the still effective M114 remains an integral component of many nations' artillery parks. Due to the large, widespread worldwide inventory and robust design of the piece, the M1/M114, both in original and modernized form, is expected to remain in service for several more decades.

Despite the setback suffered some years ago by the RDM updated M114/39, the implementation of the various existing 39 caliber modernization and retrofit programs for the M1/M114 are expected to continue in a mercurial manner through the coming ten years.

Regarding the M139, the all-new production program, our outlook remains less than sanguine. Due to the glut of both new and used towed artillery of all types, plus the general trend toward self-propulsion in this caliber, the marketing of this piece has been and will continue to be a very sporting proposition. Our research indicates that the M139 is viewed in the marketplace as an M114 dressed up in modern clothes that can not compare with much more modern (and often cheaper) 155 millimeter artillery systems. However, we are still persuaded that some nation should come in for a few M139 pieces by the late nineties.

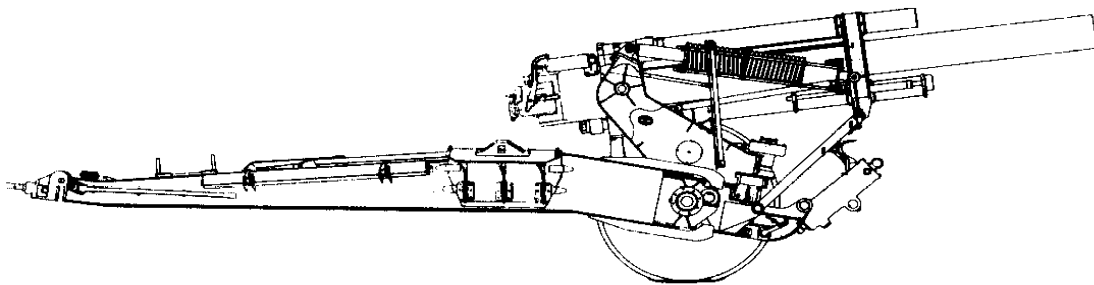
Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

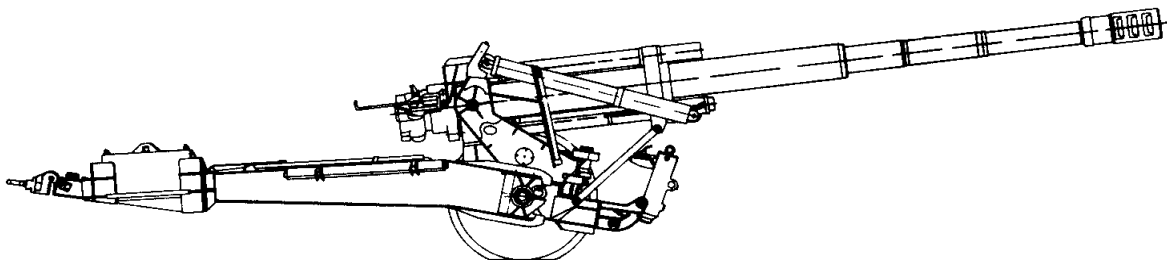
Ordnance	(Engine)	through	High Confidence Level				Good Confidence Level			Speculative			Total 97-06
			96	97	98	99	00	01	02	03	04	05	
RDM DEFENCE ENGINEERING													
M139(a)	NO ENGINE		2	0	0	2	4	0	0	0	0	0	6
Total Production			2	0	0	2	4	0	0	0	0	0	6

(a) This production forecast line is for COMPLETE NEW PRODUCTION M139 pieces ONLY!

M114



M114/39



Source: RDM Defense Engineering