

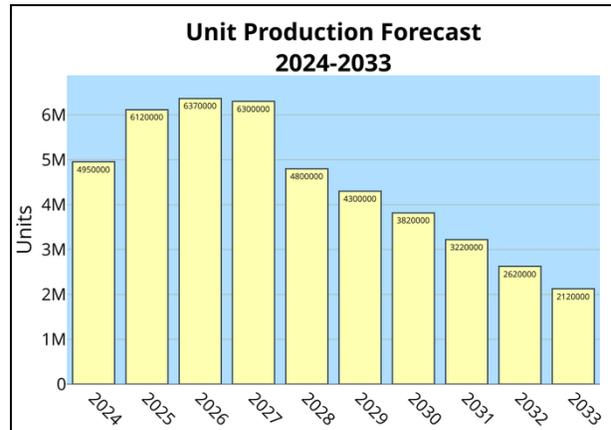
ARCHIVED REPORT

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Artillery Ammunition

Outlook

- Combined output from European manufacturers will average nearly 1 million rounds per year
- Combined output from non-U.S. and non-European manufacturers will average nearly 1.5 million rounds per year
- U.S. DoD requirements will maintain a base sustainment level of U.S. production averaging at least 277,000 rounds per year



Orientation

Description. Artillery ammunition, 75mm to 203mm.

Sponsor. In the European and international markets, both individual contractors and various governments sponsor the development of artillery ammunition.

The U.S. Army sponsors the development and U.S. procurement of artillery ammunition.

Licensees. A number of firms and state-owned organizations around the world produce European- and U.S.-pattern artillery ammunition, with and without license.

Status. Development through serial production.

Total Produced. This number varies per year and exact numbers, especially from non-NATO producers, are difficult to ascertain however with the current war in Ukraine, yearly worldwide production is likely in the low tens of millions.

Application. Ammunition for tube artillery.

Price Range. In 2024 U.S. dollars, new-production European unguided artillery ammunition ranges in unit price from \$28.52 for the 76mm OF-350 High Explosive Fragmentation (HE-Frag) round to \$2,252 for the 155mm OGRE F1 submunition-dispensing round.

In 2024 U.S. dollars, new-production non-European and non-U.S. unguided artillery ammunition ranges in unit

price from \$19.88 for some of the 85mm HE rounds to \$2,131 for some of the Israeli cargo rounds.

According to the U.S. Army's budget request documentation, unit prices for artillery ammunition are as follows:

- 75mm Blank M337A1: \$101.27
- 105mm Blank M395: \$76.84
- 105mm HE M1: \$266.13
- 105mm HE-BB PFF M1130: \$2,747.99
- 105mm Extended-Range HE-BB PFF M1130A1: \$2,893.46
- 105mm IR Illum M1064: \$1,208.18
- 155mm Extended-Range Spotting, M110A3: \$840.10
- 155mm HE M795: \$2,440.78
- 155mm IM HE Training M1122: \$511.89
- 155mm IR Illum M1066/M1123: \$1,361.73
- 155mm Illum M485/M1124: \$1,359.29
- 155mm M982-U Excalibur: \$84,212.00

Artillery Ammunition

Contractors

Prime

American Ordnance LLC, Milan Army Ammunition Plant	https://www.milancommercialcomplex.com , 2280 Hwy 104 W, Suite 2, Milan, TN 38358-3177 United States, Tel: + 1 (731) 686-6261, Fax: + 1 (731) 686-6709, Email: amy.allison@aolc.biz, Prime
Ammotec, SwissP Defence AG	https://ammotec.com , Uttigenstrasse 67, Thun, Switzerland, Tel: + 41 33 854 44 00, Fax: + 41 33 854 44 04, Email: info.ammotec@ruag.com, Prime
BAE Systems Inc, Platforms & Services	https://www.baesystems.com , Bofors Ind Omr, Karlskoga, Sweden, Tel: + 46 586 733 000, Fax: + 46 586 733 0012, Email: info.bofors@baesystems.se, Prime
BAE Systems, Combat Vehicles (UK)	https://www.baesystems.com , Golf Course Ln, New Filton House, Filton, S Gloucestershire, United Kingdom, Tel: + 44 0117 9888560, Fax: + 44 0117 9888502, Prime
China North Industries Corp (NORINCO)	https://www.norinco.cn , 12A Guang An Men Nan Jie, PO Box 100053, Beijing, China, Tel: + 86 10 6352 9988, Fax: + 86 10 6354 0398, Email: norinco@norinco.cn, Prime
Denel SOC Ltd	https://www.denel.co.za , Nellmapius Dr, Irene, South Africa, Tel: + 27 12 671 2700, Fax: + 27 12 671 2751, Email: marketing@denel.co.za, Prime
Elbit Systems Land, (IMI Systems Ltd)	https://elbitsystems.com/products/land-systems/ , PO Box 1044, Bialik St 64, Ramat HaSharon, Israel, Tel: + 972 3 548 5222, Fax: + 972 3 548 6125, Email: imimrktg@imi-israel.com, Prime
Federal State Unitary Enterprise, Rosoboronexport, Rosoboronexport State Corp	https://www.roe.ru , 27/3 Stromynka St, Moscow, Russian Federation, Tel: + 7 495 534 6183, Fax: + 7 495 534 6153, Prime
Hellenic Defence Systems (EAS) SA, (EBO-PYRKAL)	1 Ilioupoleos Ave, Hymettus, Athens, Greece, Tel: + 30 210 979 0900, Fax: + 30 210 979 0800, Email: info@eas.gr, Prime
Hsing Hua Electric Innovative Corp, Hsing Hua Arsenal	https://www.thh-electric.com.tw , No 7 Alley 29 Ln 29, Sec 1 Anjhong Rd, Tainan City, Annan District, Taiwan, Tel: + 886 6 245 6156, Fax: + 886 6 255 8586, Email: hsinhua.edos@msa.hinet.net, Prime
KNDS France, Munitions	https://www.knds.fr/en , Route de Villeneuve, La Chapelle, Saint-Ursin, France, Tel: + 33 02 48 68 71 71, Fax: + 33 02 48 68 70 54, Prime
Northrop Grumman, Federal Cartridge Co	https://www.northropgrumman.com , 900 Bob Ehlen Dr, Anoka, MN 55303 United States, Tel: + 1 (763) 323-2300, Fax: + 1 (763) 323-2506, Email: ammunition.group@atk.com, Prime
Ordnance Factories Organization of India, Ordnance Factory Board - Export Division	https://www.ofb.gov.in , 10 A, S K Bose Rd, Kolkata, India, Tel: + 91 33 2248 5077 80, Fax: + 91 33 2248 9744, Email: ofbtrade@dataone.in, Prime
Pakistan Ordnance Factories	Wah Cantt, Pakistan, Tel: + 92 51 9055 21019, Fax: + 92 51 9316253, Email: exports@pof.gov.pk, Prime
Patria Oy	https://www.patriagroup.com , Kaivokatu 10 A, Helsinki, Finland, Tel: + 358 20 469 1, Fax: + 358 20 469 2022, Email: info@patria.fi, Prime
Posco Daewoo, (Daewoo International Corp)	https://www.daewoolife.com , 541 5-Ga Namdaemunno, Chung-gu, Seoul, Korea, South, Tel: + 82 2 759 2114, Fax: + 82 2 753 9489, Prime
Raytheon	https://www.rtx.com/raytheon , 1151 E Hermans Rd, Tucson, AZ 85706 United States, Tel: + 1 (520) 794-3000, Prime
Rheinmetall AG	https://www.rheinmetall.com/en , Rheinmetall Platz 1, Düsseldorf, Germany, Tel: + 49 211 473 01, Fax: + 49 211 473 4727, Email: info@rheinmetall-defence.com, Prime
S.C. Arsenal-Resita SA, (formerly Arsenal Armatei)	https://www.arsenal.ro , Barzavitei St, 4, Resita, Jud. Caras-Severin, Romania, Tel: + 40 0255 250502, Fax: + 40 0255 225011, Email: arsenal_resita@yahoo.com, Prime

Artillery Ammunition

Singapore Technologies Land Systems Ltd, (ST Land Systems)	https://www.stengg.com/en/defence/land , 249 Jalan Boon Lay, Singapore, Singapore, Tel: + 65 6265 1066, Fax: + 65 6261 6932, Email: comms.kinetics@stengg.com , Prime
Thales Australia, Armaments & Ammunition	https://www.thalesgroup.com , 7 Murray Rose Ave, Sydney Olympic Park, New South Wales, Australia, Tel: + 61 2 9562 3333, Email: communications@thalesgroup.com , Prime

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 75 Glen Road, Suite 302, Sandy Hook, CT 06482, USA; rich.pettibone@forecast1.com

Technical Data

Europe

Note: *This report addresses artillery projectiles only; it does not list separate cartridge or bag propellant components. Likewise, this report does not deal with the Modular Artillery Charge System (MACS).*

In this report, we use the following standard abbreviations for cartridge types:

AP-T	Anti-Personnel - Tracer
HE	High Explosive
HEAT	High Explosive Anti-Tank
HEAT-T	High Explosive Anti-Tank - Tracer
HE-ICM	HE Improved Conventional Munition
WP	White Phosphorous

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
<u>Manufacturer – S.C. Arsenal-Resita SA</u>		
76mm	OF-350	High Explosive Fragmentation
76mm	OF-350A	High Explosive Fragmentation
76mm	BR-350B	Armor Piercing - Tracer
76mm	MK-354	Blank
76mm	BK-354M	High Explosive Anti-Tank Fin Stabilized - Tracer
76mm	Unknown	High Explosive
76mm	Unknown	High Explosive Anti-Tank
76mm	D-350	Smoke
76mm	POR-350	Target Practice - Tracer
98mm	OF-402	High Explosive
98mm	OF-403	High Explosive
98mm	BK-1	High Explosive Anti-Tank
122mm	OF-462	High Explosive Fragmentation
122mm	S-463	Illumination
122mm	Starshel 122	Cargo (radio jamming)
130mm	Unknown	High Explosive
152mm	OF-550	High Explosive
152mm	M350/1	Cargo (Improved Conventional Munition)
152mm	M350/1 ER	Cargo (Improved Conventional Munition)
152mm	Unknown	High Explosive Anti-Tank - Tracer
<u>Manufacturer – BAE Systems Land & Armaments</u>		
105mm	L31A1/A2/A3	High Explosive
105mm	L37A1/A2	Red Smoke
105mm	L38A1/A2	Orange Smoke
105mm	L42A3	High Explosive Squash Head
105mm	L43A2	Illumination
105mm	L45A2	White Smoke
105mm	RO 37-05A1	Target Practice (flash)
105mm	RO 38-05A1	Target Practice (flash)

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
105mm	ERM 1-HE BBU	High Explosive Base Bleed
105mm	ERHE2 BB	High Explosive Base Bleed
105mm	HE X/RO 03E1	High Explosive (extended range)
155mm	RO 18-05A1/A2	Target Practice (flash)
155mm	RO 22 (M107)	High Explosive
155mm	RO 23-05A1	Target Practice (flash)
155mm	RO 24 (L15A2)	High Explosive
155mm	RO 24-05A1	Target Practice (flash)
155mm	RO 25A1	Target Practice (flash)
155mm	RO 30	High Explosive Base Bleed
155mm	M110	White Phosphorous Smoke
155mm	M116B	White Phosphorous Smoke
155mm	M118A2	Illumination
165mm	L33A3	High Explosive Squash Head
175mm	M437	High Explosive
203mm	M106	High Explosive
<u>Manufacturer – BAE Systems Bofors</u>		
105mm	LUMA Mk 2	Illumination
105mm	M60	White Phosphorous Smoke
105mm	Mona	Illumination
105mm	Type 4140	High Explosive
120mm	SGR M/70	High Explosive
120mm	SMGR M/70	High Explosive Armor Piercing
120mm	HCER	High Explosive Armor Piercing
155mm	MIRA	Illumination
155mm	MIRA ER	Illumination (extended range)
155mm	F1	High Explosive Base Bleed
155mm	M/60	High Explosive
155mm	M/77B	High Explosive
155mm	PRB Mk 10	High Explosive (Extended Range Full Bore)
155mm	BOSS	High Explosive Anti-Tank
155mm	JUSTUS	Illumination
155mm	HEER	High Explosive Base Bleed
155mm	BONUS	Cargo (submunition dispensing)
155mm	FFV 431	Smoke
155mm	FFV 007	Smoke
155mm	FFV 007 IR	Smoke (infrared screening)
155mm	FFV 007 ER	Smoke
<u>Manufacturer – Rheinmetall Defence (includes former Eurometaal line)</u>		
105mm	M1	High Explosive
105mm	WP M60	White Phosphorous Smoke
105mm	BE M84	Hexachlorethane Smoke
105mm	ERM1-HE BBU	High Explosive Base Bleed
155mm	DM21 (M107)	High Explosive
155mm	DM105	Smoke
155mm	DM106	Illumination
155mm	DM652 (M864)	Cargo (Improved Conventional Munition)
155mm	M107	High Explosive
155mm	M110	White Phosphorous Smoke
155mm	M116	Hexachlorethane Smoke
155mm	M483A1	Cargo (Improved Conventional Munition)
155mm	M864	Cargo (Improved Conventional Munition)
155mm	NR109	Illumination
155mm	ERFB-HE	High Explosive (Extended Range Full Bore)
155mm	ERFB-BB-HE	High Explosive (Extended Range Full Bore Base Bleed)
155mm	ERFB-I	Illumination (Extended Range Full Bore)
155mm	ERFB-I	Illumination (Extended Range Full Bore Base Bleed)

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
155mm	ERFB-S	White Phosphorous Smoke (Extended Range Full Bore)
155mm	ERFB-S(BE)	White Phosphorous Smoke (Extended Range Full Bore)
155mm	Rh 49	Cargo (submunition dispensing)
155mm	RB 63	Cargo (submunition dispensing)
175mm	Unknown	High Explosive
203mm	M106	High Explosive

Manufacturer – Nexter Munitions

105mm	HE BT G1	High Explosive
105mm	HE ER G1	High Explosive Base Bleed
105mm	HE ER G2	High Explosive
105mm	M1	High Explosive
105mm	HE BT G1	High Explosive
105mm	WP M60	White Phosphorous Smoke
105mm	WP ER G1	White Phosphorous Smoke Base Bleed
105mm	WP BT G1	White Phosphorous Smoke
105mm	M84A1	Hexachlorethane Smoke
105mm	M314A3	Illumination
105mm	M395	Blank
130mm	Unknown	High Explosive (Extended Range Full Bore Base Bleed)
130mm	Unknown	White Phosphorous Smoke Base Bleed
142mm	Unknown	High Explosive (demolition round)
155mm	NR 265	High Explosive (Extended Range Full Bore Base Bleed)
155mm	NR 267	White Phosphorous Smoke (Extended Range Full Bore)
155mm	NR 269	Cargo (Extended Range Full Bore)
155mm	NR 173	High Explosive (Extended Range Full Bore)
155mm	OE 155 F1	High Explosive
155mm	OE 155 H2	High Explosive Base Bleed
155mm	OE 155 H3	High Explosive Rocket Assisted Projectile
155mm	OE 155 56/69	High Explosive
155mm	OECL 155 F1	Illumination
155mm	OFUM 155 F1A	White Phosphorous Smoke
155mm	OFUM 155 F2A	White Phosphorous Smoke
155mm	OGRE 155 F1	Cargo
155mm	OMI 155 H2	Cargo
155mm	OX 155 F1	Target Practice
155mm	OX 155 56/69	Target Practice
155mm	155 PRAC SRF1	Target Practice

Manufacturer – Nexter Munitions/Luchair

105mm	OE	High Explosive
105mm	OFUM M60	White Phosphorous Smoke
105mm	M107	High Explosive
105mm	PL/PN	Practice
105mm	ECL	Illumination
155mm	ECL 155 F1	Illumination
155mm	FUM (M110)	White Phosphorous Smoke
155mm	155 LU 111 HB	High Explosive
155mm	155 LU 111 BB	High Explosive Base Bleed
155mm	155 LU 112 HB	Inert
155mm	155 LU 112 BB	Inert
155mm	155 LU 114 HB	White Phosphorous Smoke
155mm	155 LU 114 BB	White Phosphorous Smoke-Base Bleed
155mm	155 LU 118 HB	White Phosphorous Smoke
155mm	155 LU 118 BB	White Phosphorous Smoke-Base Bleed
155mm	M107	High Explosive
155mm	M118A2	Illumination
155mm	OE	High Explosive
155mm	OFUM 155 F1A	Smoke

Artillery Ammunition

Caliber	Designation	Type
155mm	OFUM 155 F2A	Smoke
155mm	PL/PN	Practice
155mm	PRAC SR F1	Target Practice
155mm	X ECO	Target Practice (reduced range)
175mm	M437A1/A2	High Explosive
203mm	M106	High Explosive
<u>Manufacturer – Hellenic Defence Systems (EAS) SA</u>		
105mm	M1	High Explosive
155mm	M107	High Explosive
155mm	M110A2	White Phosphorous Smoke
203mm	M106	High Explosive
<u>Manufacturer – RUAG Ammotec (former Hirtenberger Defence Systems line)</u>		
105mm	BE M84	White Phosphorous Smoke
105mm	M1	High Explosive
105mm	M60	White Phosphorous Smoke
105mm	M314A2	Illumination
105mm	M395	Blank
122mm	Unknown	High Explosive
122mm	Unknown	White Phosphorous Smoke
122mm	Unknown	Illumination
130mm	SEN-HE	High Explosive (Extended Range Full Bore)
130mm	Unknown	White Phosphorous Smoke
130mm	Unknown	Illumination
155mm	M107	High Explosive
155mm	M110	White Phosphorous Smoke
155mm	M116B	White Phosphorous Smoke
155mm	M118A2	Illumination
155mm	SEN-HE	High Explosive (Extended Range Full Bore)
155mm	SEN-HE/BB	High Explosive (Extended Range Full Bore Base Bleed)
<u>Manufacturer – Patria plc</u>		
122mm	Unknown	High Explosive
122mm	Unknown	Illumination
122mm	Unknown	White Phosphorous Smoke
122mm	Unknown	Cargo
130mm	Unknown	High Explosive
130mm	Unknown	Illumination
130mm	Unknown	White Phosphorous Smoke
152mm	Unknown	High Explosive (Extended Range Full Bore)
152mm	Unknown	High Explosive (Extended Range Full Bore Base Bleed)
152mm	Unknown	High Explosive
155mm	Unknown	High Explosive (Extended Range Full Bore)
<u>Manufacturer – FSUE Rosoboronexport</u>		
76mm	BK-354M	High Explosive Anti-Tank - Fin Stabilized - Tracer
76mm	BR-354P	High Explosive Armor Piercing
76mm	OF-350/350A	High Explosive Fragmentation
76mm	BR-350B	Armor Piercing Tracer
85mm	BK-2M	High Explosive Anti-Tank - Fin Stabilized
85mm	BR-365	Armor Piercing-Tracer
85mm	BR-365P	High Velocity Armor Piercing - Tracer
85mm	O-365K	High Explosive Fragmentation
100mm	BM-8	High Velocity Armor Piercing Discarding Sabot - Tracer
100mm	BR-412	Armor Piercing Capped Tracer
100mm	BR-412B	Armor Piercing Capped Tracer
100mm	3UOF32	High Explosive Fragmentation
100mm	OF-214	High Explosive Fragmentation
100mm	ZBK-5M	High Explosive Anti-Tank - Fin Stabilized
120mm	Unknown	High Explosive

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
120mm	Unknown	High Explosive Anti-Tank
120mm	Unknown	High Explosive Rocket Assisted Projectile
122mm	G-462	Cargo (leaflet)
122mm	G-463	Cargo (leaflet)
122mm	BK-6M	High Explosive Anti-Tank - Fin Stabilized
122mm	BK-13	High Explosive Anti-Tank - Fin Stabilized Tracer
122mm	BK-13M	High Explosive Anti-Tank - Fin Stabilized Tracer
122mm	BP-463	High Explosive Anti-Tank
122mm	BR-472	Armor Piercing Capped Tracer
122mm	Unknown	High Explosive Rocket Assisted Projectile
122mm	D-462	Smoke
122mm	OF-462	High Explosive Fragmentation
122mm	OF-471N	High Explosive Fragmentation
122mm	OF-472	High Explosive Fragmentation
122mm	3OF56	High Explosive Fragmentation
122mm	PVM-ZA	Target Practice Tracer
122mm	PVM-ZRU	Target Practice Tracer
122mm	PVM-ZRB	Target Practice Tracer
122mm	S-462	White Phosphorous Smoke
122mm	S-463	Illumination
122mm	Unknown	Incendiary
122mm	Unknown	Chemical
122mm	Unknown	Anti-Personnel (flechette)
130mm	BR-482B	Armor Piercing Capped Tracer
130mm	DTs-1	Smoke
130mm	3OF33	High Explosive Fragmentation
130mm	OF-482M	High Explosive Fragmentation
130mm	SP-46	Illumination
130mm	Unknown	Chemical
130mm	Unknown	High Explosive Rocket Assisted Projectile
152mm	BR-540	Armor Piercing Tracer
152mm	D-540	Smoke
152mm	3-O-13	Cargo (submunition dispensing)
152mm	Unknown	Cargo (smart submunition dispensing)
152mm	G-530	Concrete Piercing
152mm	G-545	Concrete Piercing
152mm	OF-530	High Explosive Fragmentation
152mm	OF-530A	High Explosive Fragmentation
152mm	OF-540	High Explosive Fragmentation
152mm	3OF9	High Explosive Fragmentation
152mm	3OF25	High Explosive Fragmentation
152mm	3OF45	High Explosive Fragmentation
152mm	3OF56	High Explosive Fragmentation
152mm	3OF59	High Explosive Fragmentation
152mm	3OF61	High Explosive Fragmentation Base Bleed
152mm	3OF64	High Explosive Fragmentation
152mm	3OF66	High Explosive Fragmentation
152mm	S-540	Illumination
152mm	Unknown	Chemical
152mm	Unknown	High Explosive Rocket Assisted Projectile
152mm	3RB30	Cargo (electronic)
152mm	BR-540	Armor Piercing Tracer
152mm	Unknown	Nuclear
180mm	F-372	High Explosive
180mm	G-572	Concrete Piercing
180mm	OF-23	High Explosive Fragmentation Rocket Assisted Projectile
180mm	Unknown	Nuclear

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
203mm	3OF43	High Explosive Fragmentation
203mm	3OF44	High Explosive Fragmentation
203mm	3-0-14	Cargo (submunition dispensing)
203mm	Unknown	High Explosive Rocket Assisted Projectile

International

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
<u>Manufacturer – Thales Australia (formerly ADI Ltd)</u>		
105mm	M1	High Explosive
105mm	M314A2	Illumination
105mm	M60	White Phosphorous Smoke
105mm	L31	High Explosive
105mm	L45	Smoke
105mm	L43	Illumination
105mm	L37/38	Marker
105mm	M84	Hexachlorethane Zinc Smoke
155mm	M107	High Explosive
155mm	M485A2	Illumination
155mm	M825	White Phosphorous Smoke
<u>Manufacturer – China North Industries Corp (NORINCO)</u>		
76mm	Unknown	High Explosive Fragmentation
76mm	Unknown	Armor Piercing - Tracer
76mm	Unknown	High Explosive Anti-Tank Fin Stabilized - Tracer
105mm	Unknown	High Explosive
122mm	Type 54	High Explosive
122mm	Unknown	High Explosive Fragmentation
122mm	Unknown	High Explosive (Extended Range Full Bore)
122mm	Unknown	High Explosive (Extended Range Full Bore Base Bleed)
122mm	Unknown	High Explosive Anti-Tank Fin Stabilized
122mm	Unknown	High Explosive Anti-Tank Fin Stabilized - Tracer
122mm	Unknown	High Explosive Anti-Tank - Tracer
122mm	Unknown	Incendiary
122mm	Unknown	White Phosphorous Smoke
122mm	Unknown	Illumination
122mm	Unknown	Cargo (submunition dispensing)
130mm	Unknown	Armor Piercing Capped - Tracer
130mm	Unknown	High Explosive
130mm	Unknown	High Explosive Incendiary
130mm	Unknown	High Explosive (Extended Range Full Bore Base Bleed)
130mm	Unknown	High Explosive (Extended Range Full Bore)
130mm	Unknown	Cargo (submunition dispensing)
130mm	Unknown	High Explosive Shrapnel
130mm	RAP-130	High Explosive Rocket Assisted Projectile
130mm	Unknown	White Phosphorous Smoke
130mm	Unknown	Illumination
152mm	Type 66	Cargo (submunition dispensing)
152mm	Unknown	High Explosive
152mm	Type 83	High Explosive Fragmentation
152mm	MP-152	High Explosive Rocket Assisted Projectile
152mm	Unknown	White Phosphorous Smoke
152mm	Unknown	Incendiary (magnesium alloy)
155mm	Unknown	High Explosive (Extended Range Full Bore)
155mm	Unknown	High Explosive (Extended Range Full Bore Base Bleed)
155mm	Unknown (M107)	High Explosive
155mm	Unknown	Cargo (Extended Range Full Bore Base Bleed)
155mm	Unknown	Smoke (Extended Range Full Bore)
155mm	Unknown	Illumination (Extended Range Full Bore)
155mm	Unknown	White Phosphorous Smoke (Extended Range Full Bore)

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
155mm	Unknown	Illumination Base Bleed (Extended Range Full Bore)
203mm	Unknown	High Explosive (Extended Range Full Bore)
203mm	Unknown	High Explosive (Extended Range Full Bore Base Bleed)

Manufacturer – Daewoo Ammunition Corp (Daewoo International Corp)

105mm	M1	High Explosive
105mm	M60	White Phosphorous Smoke
105mm	M314A1	Illumination
105mm	PS390	Cargo
155mm	M107	High Explosive
155mm	M110A2	White Phosphorous Smoke
155mm	M549A1	High Explosive Rocket Assisted Projectile
155mm	PS491	Cargo
203mm	M106	High Explosive

Manufacturer – Denel SOC Ltd

76mm	HE-OM	High Explosive
76mm	HE-PFOM	High Explosive Fragmentation
76mm	FNF-MOM	Target Practice
76mm	FNF-OM-1	Target Practice
76mm	FNF-OM-2	Target Practice
87.6mm	Mk 1D	High Explosive
87.6mm	Unknown	White Phosphorous Smoke
87.6mm	Mk 1D	Illumination (star shell)
130mm	M1A1	High Explosive (Extended Range Full Bore)
130mm	M1A1	High Explosive (Extended Range Full Bore Base Bleed)
130mm	Unknown	Target Practice
139.7mm	Mk 1D	High Explosive
139.7mm	M1A2	High Explosive Base Bleed
139.7mm	213	Smoke
155mm	ERFB-HE	High Explosive (Extended Range Full Bore)
155mm	ERFB-HE/BB	High Explosive (Extended Range Full Bore Base Bleed)
155mm	ERFB-SCR SMK	Smoke (Extended Range Full Bore)
155mm	ERFB-WP	White Phosphorous Smoke (Extended Range Full Bore)
155mm	ERFB-IL	Illumination (Extended Range Full Bore)
155mm	ERFB-C	Cargo (Extended Range Full Bore)
155mm	ERFB-HE/BBV-LAP	High Explosive (Extended Range Full Bore Rocket Assist)
155mm	Assegai M2000	High Explosive (Extended Range Full Bore Rocket Assist)
155mm	Assegai M2001	Cargo (Extended Range Full Bore Rocket Assist)
155mm	Assegai M2002	Cargo (Extended Range Full Bore Rocket Assist)
155mm	Assegai M2003	Illumination (Extended Range Full Bore Rocket Assist)
155mm	Assegai M2004	Red Phosphorous Smoke (Extended Range Full Bore Rocket Assist)

Manufacturer – Hsing Hua Electric Innovative Corp

75mm	M48	High Explosive
75mm	M66	High Explosive Anti-Tank
75mm	M64	White Phosphorous Smoke
105mm	M1	High Explosive
105mm	M60	White Phosphorous Smoke
105mm	M314A2	Illumination
105mm	M548	High Explosive Rocket Assisted Projectile
155mm	M101	High Explosive
155mm	M104	Smoke
155mm	M107	High Explosive
155mm	M110A2	White Phosphorous Smoke
155mm	M116B	Smoke
155mm	M118A2	Illumination

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
155mm	ERFB-HE	High Explosive (Extended Range Full Bore)
203mm	M106	High Explosive

Manufacturer – Ordnance Factories Organization of India

75mm	75/24 HE 1C	High Explosive
87.6mm	Unknown	High Explosive
87.6mm	Unknown	Smoke
87.6mm	Unknown	Blank
105mm	L31 series	High Explosive
105mm	L37 series	Smoke
105mm	L38 series	Smoke
105mm	L42A3	High Explosive Squash Head
105mm	L43 series	Illumination
105mm	L45A2	Smoke
140mm	DA117	High Explosive
140mm	213	Smoke
155mm	Unknown	High Explosive
155mm	Unknown	Cargo (submunition dispensing)
155mm	Unknown	Illumination
155mm	Unknown	Smoke

Manufacturer – Israel Military Industries Ltd (IMI)

105mm	M1	High Explosive
105mm	M60	White Phosphorous Smoke
105mm	CL 3131	Cargo (submunition dispensing)
120mm	APAM	Cargo (submunition dispensing)
125mm	CL 3254	Armor-Piercing Fin-Stabilized Discarding Sabot
130mm	OF-482M	High Explosive
152mm	DP-IC M350/351	Cargo (submunition dispensing)
152mm	CL 3023	Cargo (Improved Conventional Munition)
155mm	M56	High Explosive
155mm	M107	High Explosive
155mm	M110A2	Illumination
155mm	M116A1	White Phosphorous Smoke
155mm	M395	Cargo (submunition dispensing)
155mm	M485A2	Illumination
155mm	Unknown	High Explosive Rocket Assisted Projectile
155mm	CL 3109	Cargo (submunition dispensing)
155mm	CL 3013-C	Cargo (submunition dispensing)
155mm	CL 3013-U	Cargo (submunition dispensing)
175mm	CL 3014	Cargo (submunition dispensing)
203mm	CL 3046	Cargo (submunition dispensing)

Manufacturer – Pakistan Ministry of Defense/Pakistan Ordnance Factories

87.6mm	Mk 1D	High Explosive
87.6mm	Unknown	White Phosphorous Smoke
87.6mm	Mk 1D	Illumination (star shell)
87.6mm	Unknown	Blank
105mm	M1	High Explosive
105mm	M60	White Phosphorous Smoke
105mm	M314A2	Illumination
122mm	Type 54	High Explosive
122mm	M1938	High Explosive
130mm	OF-482M	High Explosive
130mm	DTs-1	Smoke
155mm	M107	High Explosive
155mm	M110	Smoke
203mm	M106	High Explosive

Artillery Ammunition

<u>Caliber</u>	<u>Designation</u>	<u>Type</u>
<u>Manufacturer – Singapore Technologies Kinetics Ltd</u>		
155mm	M107	High Explosive
155mm	M110A2	White Phosphorous Smoke
155mm	ERFB-HE	High Explosive (Extended Range Full Bore)
155mm	Unknown	Illumination

United States

<u>Designation</u>	<u>Caliber</u>	<u>Cartridge Type</u>
M337A1	75mm	Blank
M1	105mm	HE
M14	105mm	Dummy
M60	105mm	Chemical (H/HD)
M60	105mm	WP Smoke
M67	105mm	Target Practice Tracer
M84	105mm	Hexachlorethane-Zinc Smoke
M84B1	105mm	Cargo (leaflet dispensing)
M314	105mm	Illumination
M327	105mm	HE Plastic Tracer
M360	105mm	Chemical (GB)
M395	105mm	Blank
M413	105mm	HE (M35 anti-personnel grenades)
M444	105mm	HE (M39 anti-personnel grenades)
M489A1	105mm	HE
M546	105mm	AP-T
M548	105mm	HE Rocket-Assisted
M622	105mm	HEAT-T
M629	105mm	Chemical (CS)
M760	105mm	HE
XM909	105mm	Smart Top Attack Fire and Forget HEAT
M913	105mm	HE Rocket-Assisted
M915	105mm	HE-ICM (XM80)
XM916	105mm	HE-ICM (XM80)
M927	105mm	HE Rocket-Assisted
M1040	105mm	Canister
M1130	105mm	HE Base-Bleed Pre-Formed Fragmentation
M1130A1	105mm	HE Base-Bleed Pre-Formed Fragmentation – Extended Range
GB-2	155mm	Binary Chemical
M4B5A2	155mm	Illumination
M7	155mm	Dummy
M107	155mm	HE
M110	155mm	WP Smoke
M110A1	155mm	WP Smoke
M110A2	155mm	WP Smoke
M110	155mm	Chemical (H/HD)
M116	155mm	Hexachlorethane Smoke
M116A1	155mm	Hexachlorethane Smoke
M116B1	155mm	Hexachlorethane Smoke
M118	155mm	Illumination
M118A1	155mm	Illumination
M118A2	155mm	Illumination
M121A1	155mm	Chemical (GB/VX)
M449	155mm	HE-ICM (M43A1)
M449A1	155mm	HE-ICM (M43A1)
M454	155mm	Nuclear
M483	155mm	HE-ICM (M42/M46)
M483A1	155mm	HE-ICM (M42/M46)
M485	155mm	Illumination
M485A1	155mm	Illumination

Artillery Ammunition

<u>Designation</u>	<u>Caliber</u>	<u>Cartridge Type</u>
M485A2	155mm	Illumination
M549	155mm	HE Rocket-Assisted
M549A1	155mm	HE Rocket-Assisted
M631	155mm	Chemical (CS)
M687	155mm	Binary Chemical (GB)
M692	155mm	HE-ICM (M67)
M712 Copperhead	155mm	Guided HEAT
M718	155mm	HE-ICM (M73)
M731	155mm	HE-ICM (M72)
M741	155mm	HE-ICM (M70)
M785	155mm	Nuclear (enhanced radiation) Rocket-Assisted
M795	155mm	HE-ICM
XM802	155mm	Smoke
XM803	155mm	Smoke
M804	155mm	Target Practice
M823	155mm	Target Practice
M825	155mm	WP Smoke
M825A1	155mm	WP Smoke
XM860	155mm	HE-ICM
M864	155mm	HE-ICM (M42, M46)
XM867	155mm	Cargo (electronic)
M898	155mm	Sense and Destroy Armor Submunition Carrier
M975	155mm	HE
M982 Excalibur	155mm	HE Rocket-Assisted/Base Bleed ICM (M42, M46, XM80)
M982-U Excalibur	155mm	HE Rocket-Assisted/Base Bleed Unitary Warhead

Variants/Upgrades

Variants. Not generally applicable. Upgraded rounds usually carry new designations to distinguish them from other projectiles of a similar design.

Modernization and Retrofit Overview. Not applicable. The contractors integrate product improvements as production cut-ins.



M109A6 Paladin 155mm Self-Propelled Howitzer

Source: U.S. Army

Artillery Ammunition

Program Review

Background. Since the first cast-iron cannon appeared on the continent in the 14th century, Europe has remained the center of artillery development. However, as the 21st century progresses, the period of domination over the international artillery ammunition market by a select group of U.S. and European players is unquestionably gone.

In today's artillery market, ammunition development exhibits three major trends:

- Refinements in ballistics and propellants technology
- Development of delayed-action submunitions
- Development of terminal guidance for artillery projectiles

Europe

Market Trends.

Finland

Patria plc. In 1991, the merger of the old government-owned Vammaskoski Works and the Defense Division of Tampella Ltd created this firm, which now operates as the Patria Group. This player has also absorbed the Valmet firm, which produced 122mm and 130mm ammunition. Patria is the major supplier of artillery ammunition to the Finnish Army. Its products include 105mm, 122mm, 130mm, 152mm, and 155mm rounds, including Base Bleed and Hollow Bleed variants.

Patria ERFB Rounds

More recently, Patria began developing Extended-Range, Full-Bore projectiles in the standard and base bleed versions for both Russian-standard 152mm and NATO-standard 155mm artillery. What is unique about the Patria version is that the projectiles do not feature barrel riding nubs. Instead, they have an advanced, streamlined design to reduce drag. The company claims this design feature is easier and less costly to manufacture; it also reportedly offers reduced bore wear and a slightly increased payload. Patria has not reported any sales of this new line of ammunition; unconfirmed reports suggest the Finnish Army may have purchased some of this ammunition.

France

KNDS France. Reorganized as a private entity in 1990 (Nexter), this French firm (formerly the Giat Industries Weapon Systems and Ammunitions Division) has become a major player in the artillery ammunition market.

Corporate Evolution

In addition to acquiring the assets of Poudreries Reunies de Belgique, Giat Industries also acquired Luchaire. The Luchaire artillery ammunition line remains in production under the Nexter banner.

In October 2006, Giat Industries approved reorganization and an associated name change to Nexter. Under the restructuring, the group maintains four core operations:

- Nexter Systems
- Nexter Munitions
- Nexter Electronics
- Nexter Mechanics

The move reportedly better prepared the firm for consolidation with another corporate entity.

In 2015, Krauss-Maffei Wegmann and Nexter signed an agreement on a merger plan (Now KNDS France).

As part of the process, the two companies contributed their shares to a newly incorporated joint holding company based in the Netherlands. They each received 50 percent of the shares of this holding company, which became the sole shareholder in KMW and Nexter. Completion of the merger of KMW and Nexter was formally announced in January 2016.

The merged firm is the third-largest land defense contractor in the world, behind General Dynamics and BAE Systems. Ownership is split between the French government's Giat Industries holding company and KMW parent the Wegmann Group (controlled by Germany's Bode family). At time of merger, the single entity employed around 6,000 people and had an order book of approximately EUR9 billion (\$9.9 billion), with turnover of around EUR2 billion.

Extensive Product Line

These acquisitions have allowed KNDS France to market an extensive line of standard-pattern projectiles and extended-range artillery ammunition, including standard base bleed and hybrid external burning rounds. The OE DTC 155 H2 base bleed round has found significant success on the export market, as have other Extended-Range, Full-Bore types.

On a private basis, KNDS France has been conducting research into improved-effect cargo ammunition. The two prototypes to emerge from this work are the OMI 155 F2 (an anti-vehicle/anti-personnel bomblet round carrying 88 submunitions) and the OMI 155 H1 (a

Artillery Ammunition

round carrying anti-tank mines). Since the introduction of this ammunition with the French Army in 1990 as the OGRE 155 G1, the contractor has secured at least five export orders for the ammunition.

In response to perceived demand, KNDS France has also developed and produced 130mm base bleed ammunition for the Russian M-46 field gun. In 2000, an unidentified African nation reportedly purchased this round.

More recently, (then) Giat Industries and Bofors teamed up for continued development of the 155 BONUS smart submunition-dispensing projectile. For more information on this round, see the "BONUS" report in this service.

The Luchaire Line. As indicated above, the internationally famous Luchaire firm no longer acts as a distinct entity; it has operated as a component of Giat Industries (now KNDS France) since the early 1990s. Luchaire's ammunition types and base bleed units were essentially identical to those of Poudreries Reunies de Belgique, another Giat acquisition. These base bleed units have the advantage of being "add-on" units compatible with the F1 standard high-explosive round. Luchaire also exported a 130mm variant of the base bleed unit for use in the Soviet M-46 towed artillery system.

French industry is also involved in advanced fuze and terminally guided projectile development. Luchaire has been working on optronic fuze development, which is an area of interest to a number of German firms, including AEG, Diehl, and Junghans.

Federal Republic of Germany. The German players continue to be among the world leaders in all aspects of artillery, including ammunition.

Rheinmetall Defence. Germany is sponsoring a wide range of research and development programs related to artillery ammunition, including advanced fuze technology work. Rheinmetall has conducted research into enhanced lethal-effect ammunition, particularly for 155mm and 203mm projectiles. These rounds employ submunition and fragmentation effects to defeat hard and semi-hardened targets.

DM642 ICM Round. In the field of Improved Conventional Munitions (ICM), Rheinmetall (the leading German manufacturer in this field) and Simmel Difesa of Italy have conducted joint development of the DM642 (company designation RB 63) submunition-dispensing round for the German and Italian armies. The current production standard of this round carries 63 DM1383 submunitions. Germany, Italy, and one undisclosed export customer have procured the DM642. A similar but more aerodynamically refined projectile is

the DM652 (company designation Rh 49), which carries 49 DM1383 submunitions to a maximum range of 30 kilometers (32,808 yd).

In June 1996, Rheinmetall and Israel Military Industries (IMI) announced that they would cooperate on development of Improved Conventional Munitions projectiles and the associated submunitions.

Acquiring the Eurometaal Line

With its acquisition of Eurometaal Holding NV (Zaandam, the Netherlands), Rheinmetall inherited this Dutch player's extensive line of artillery ammunition products. The former Eurometaal catalog includes a full line of NATO-standard ammunition; Eurometaal also held the European license for production of the U.S. 155mm M483A1 ICM round. This round, along with the company's extended-range ammunition, gave Eurometaal opportunities for substantial sales, particularly with regard to Europe's growing demand for Extended-Range, Full-Bore ammunition.

Eurometaal also produced (under license) the M864, the follow-on to the M483 projectile. In 1989, Eurometaal began developing the ERM1-HE BBU Extended Range round in conjunction with (then) Royal Ordnance. The round is optimized for the L119, the LG1, and enhanced versions of M101 artillery pieces. Development and qualification were completed in 1997. The ERM1-HE BBU is reportedly 30 percent more lethal than the standard M1 round.

Greece. In 1991, the Greek Powder & Cartridge Company (PYRKAL) and Hellenic Arms Industry (EBO) merged, with Hellenic absorbing PYRKAL under a unified corporate structure.

Hellenic Defence Systems (EAS) SA. This firm has developed two extended-range projectiles, ERMIS and ERA. The M107/B ERMIS (Enhanced-Range Modified Integration System) is a base bleed version of the standard M107 projectile. The ERA (Extended-Range Ammunition) utilizes base bleed in conjunction with a new aerodynamic shape. Compatible with 39-caliber artillery (such as the 155mm M109 self-propelled howitzer), it forms a complete family of ammunition, featuring extra explosive content for destructive effect at the target.

Hellenic Defence Systems is expanding its activities to such an extent that the factory at Lavrion has become one of the largest in Europe.

Romania

S.C. Arsenal-Resita SA. Formerly the state-owned Arsenalul Armatei organization, this contractor operates four ammunition facilities in Romania. The firm produces several specialized rounds for the Romanian

Artillery Ammunition

76mm Mountain Gun (the Russian pattern OF-350) and the 100mm Mountain Howitzer. In addition, the contractor produces a line of unique 98mm rounds for the Model 93 Mountain Howitzer, an indigenous design that Romania has not exported.

Arsenal-Resita may also produce some Russian-pattern ammunition. The Romtehnica organization handles international marketing; Romania has not released sales data.

A somewhat mysterious development is the M350/1 cargo Improved Conventional Munition (ICM) round, which dispenses 56 anti-armor/anti-personnel submunitions. This round is available in standard and extended-range (base bleed) versions. IMI may have participated in development of this round, as it appears in IMI sales literature.

Russian Federation. The Russians offer a significant portion of their huge stock of artillery ammunition on the international market at bargain-basement prices.

The Russian Federation continues to consolidate its ammunition-manufacturing infrastructure while developing new ammunition types employing modern technology. State-owned and -operated facilities still produce the majority of artillery ammunition in the Russian Federation. Over the next several years, semi-private organizations should become increasingly active in the export market.

FSUE 'Rosoboronexport'. This organization acts as the primary conduit between the Russian defense industry and the international market. All Russian defense contractors thus effectively operate under the auspices of Rosoboronexport. Major Russian contractors (under Rosoboronexport) involved in the unguided artillery ammunition market include the following:

The *Engineering Research Institute* (NIMI), located in Moscow, claims to be the major developer of artillery rounds in the Russian Federation. In addition to conventional designs, this organization has also developed a submunition-dispensing projectile with anti-armor submunitions similar to those of the long-troubled U.S. Sense and Destroy Armor program. NIMI is developing its munition to be compatible with NATO-standard 155mm ordnance.

The *Nitro-Vzryv* organization produces explosive fillings and possibly propelling charges.

The *State Engineering Research Institute GosNIII* develops and produces submunitions (mines) for carrier projectiles.

The *State Research and Production Enterprise Bazalt* develops and produces 120mm 2A60 gun/mortar ammunition.

One of the latest unguided artillery projectile developments from the Russian Federation is a 152mm projectile dispensing two top-attack anti-armor submunitions. The projectile has a projected weight of 40.7 kilograms (89.54 lb) and a maximum range of 20 kilometers (21,872 yd). The two available submunitions are similar in concept to the now-dead U.S. Sense and Destroy Armor type.

Sweden

BAE Systems AB. Formerly Bofors Defence AB, this reorganized Ordnance Division of Bofors again operates under the famous Bofors name. In this latest of several complex acquisitions, mergers, and name changes, Bofors absorbed the Forenade Fabriksverken firm, along with its product line.

Corporate Evolution

In 2000, United Defense Industries purchased Bofors. The contractor then began operating as Bofors Defence AB, a wholly owned subsidiary of UDI. In June 2005, BAE Systems acquired United Defense, and with it, Bofors Defence AB. The prime contractor now operates as BAE Systems Land & Armaments, BAE Systems Bofors.

Focus on NATO Standard

BAE produces a full line of 105mm and 155mm ammunition, including 105mm projectiles for the Type 4140 light howitzer and NATO-standard 155mm projectiles for the FH-77 and FH-77B. The relevant HE M/77B ammunition is fully compatible with any NATO-standard 155mm artillery system. Bofors continues production of the MIRA illumination round, in both standard and extended-range versions.

BAE is involved in separate projects to develop an all-Swedish Extended-Range, Full-Bore/Base Bleed round and an extended-range charge system for standard ammunition. Bofors currently produces the Poudrieres Reunies de Belgique ERFB Mk 10 round and the Luchaire High Explosive Base Bleed round under contract.

BAE has also been working on the development of two sophisticated artillery projectiles. As mentioned earlier, BAE and KNDS have teamed to further develop the BONUS dedicated submunition-dispensing anti-armor round in a two-phase deployment system.

The HEER (High Explosive Extended Range) round is compatible with all NATO-standard 155mm howitzers; it is available in "boat tail" and base bleed versions. By early 2001, Bofors had produced around 414,000 HEER

Artillery Ammunition

rounds. In 1999, after its self-imposed embargo, India resumed its procurement of ammunition (including the HEER round) from Bofors.

BAE is increasing its efforts to license its designs around the world.

Switzerland

RUAG Ammotec. With its acquisition of Hirtenberger Defence Systems (Hirtenberg, Austria), RUAG continues to offer the Hirtenberger line of Extended-Range, Full-Bore ammunition, optimized for the extended-range Voest Alpine GHN-45 howitzer. Hirtenberger had originally developed its line of Extended-Range Full-Bore ammunition from the PRB Mk 10 round. This spawned the advanced-model SEN ERFB shell and the SEN-BB, a base bleed variant capable of 39.6-kilometer ranges. While the specialized ammunition is no longer in production, it remains in widespread service, especially in the Middle East.

United Kingdom

BAE Systems Land & Armaments. Once the world-famous RO Defence firm, this contractor has been a component of BAE Systems since mid-2000. Its Munitions & Ordnance division continues to produce artillery ammunition for the British Army, despite its loss of preferred status following privatization and the loss of the 155mm modular artillery charge contract to South Africa in 1999.

In addition to producing NATO-standard ammunition for the M107, M109, and new Artillery System 90 Braveheart self-propelled systems, BAE Systems produces 155mm ammunition for the towed FH 155-1 howitzer. This ammunition was the result of trilateral cooperation in the design phase by the United Kingdom, Italy, and Germany. When it was originally introduced, the ammunition had greater lethality and range than most other ammunition of the same caliber. BAE Systems ammunition products enjoy wide use by countries that employ U.S. and British field artillery.

Extended-Range Technology

BAE Systems currently devotes its development efforts to extended-range technology, with work continuing on range-enhancing charge increments. The contractor's latest line of 155mm ammunition – actually a private venture – has been well received on the international market. The high-explosive member of this line is capable of achieving 30,000-meter (32,808-yd) ranges for use in 39-caliber guns.

BAE Systems also continues its cooperation with the former Eurometaal (now a component of Rheinmetall Defence) on the 105mm ERM1-HE BBU extended-range round. In 1997, RO Defence and Eurometaal completed development of the ERHE2 BB round,

offering greater range and lethality than the long-standard L31A3 projectile or the ERM1-HE BBU. This munition, since redesignated the HE X/RO 03E1, has reportedly scored at least one significant export sale.

A Tough International Market

With the major reductions in ammunition procurement by the U.K. Ministry of Defence, the contractor has striven to gain more international contracts. This effort received a blow back in 1996 when India refused to sign a contract worth \$72 million for 80,000 155mm projectiles on the basis that RO Defence did not include any manufacturing technology transfer support with the contract.

At home, the contractor lost out to IMI for a 1995 contract worth \$79.2 million to supply the British Army with 155mm extended-range submunition-dispensing projectiles.

More recently, BAE Systems has been addressing the British Army's Tubed Artillery Conventional Ammunition System (TACAS) requirement. For this program, the contractor has teamed with Denel of South Africa.

International

Market Trends. The number of non-U.S. and non-European players producing artillery ammunition continues to grow as nations seek to become self-sufficient for political and strategic reasons. Many non-U.S. and non-European players in the international market can take advantage of economies of labor and increasingly sophisticated industrial bases to produce highly competitive artillery ammunition.

In general, in countries beyond the U.S. and Europe, the importation of American or European munitions leads to licensed production, which in turn serves to establish the capability (manufacturing infrastructure and skilled personnel) for indigenous development and production. Given the dynamics of this progression, it comes as no surprise that the international artillery ammunition producers are careful to identify, then follow, the prevalent trends in U.S. and European artillery ammunition development. Witness the growing worldwide standardization around NATO-standard 155mm ammunition.

At present, over 20 major non-U.S. and non-European contractors are involved in the artillery ammunition market. In this report, we briefly review only the most active players in the international market so as to present a cross-section of the entire market.

AFRICA

Artillery Ammunition

Republic of South Africa

Denel SOC Ltd. In 1992, the state-owned umbrella arms firm ARMSCOR reorganized, transferring its manufacturing companies to Denel Ltd. This holding company continues to supply all of South Africa's requirements for artillery ammunition, including World War II-vintage and advanced types.

ARMSCOR was one of the first manufacturers to commercially produce a full line of Extended-Range, Full-Bore (ERFB) and base bleed ammunition. Denel remains a world leader in the field of 155mm artillery pieces and ammunition.

Export Success

South Africa's military hardware has enjoyed a measure of success on the international arms market, despite the country's years of political and commercial ostracism. Since the lifting of long-standing United Nations sanctions against South Africa in 1994, the country has found it much easier to export its military products.

Indeed, in the late 1990s, the United Kingdom became a customer for Denel's modular artillery charge system, beating out RO Defence (then Royal Ordnance; now a component of BAE Systems Land Systems). In 1999, South Africa reportedly secured a major sale of 155mm projectiles to an unidentified South American nation; in early 2000, an undisclosed Asian nation reportedly purchased "several thousand" 130mm projectiles.

Denel (including the Naschem, Somchem, and Swartklip subsidiaries, as well as the fuze house Fuchs Electronics) offers a full line of 155mm artillery ammunition, including High Explosive, High Explosive Base Bleed, White Phosphorus Smoke, Illuminating, and Base Ejection Smoke.

Denel's ERFB Line

Denel completed development of a new ERFB 155mm submunition round in 1987. This projectile can deliver 56 dual-purpose (hollow charge/fragmentation) submunitions (mines) out to a maximum range of 35,000 meters (38,276 yd). The fuzes for the submunitions feature a self-destruct mechanism to eliminate the danger presented by unexploded submunitions littering a battlefield.

A more recent ERFB round is the Velocity-Enhanced Long-Range Projectile (V-LAP), which mounts a rocket motor to enable a maximum range of slightly over 50,000 meters (54,680 yd). Denel revealed this round in 1996; the first export order (to an undisclosed customer) occurred in 2000.

Denel's Assegai line of 155mm ammunition has generated considerable interest worldwide, including in Europe and the U.S. (U.S. Army). The Assegai

projectile features ERFB technology, in which a new-design bourrelet replaces the bore-riding nubs of the original ERFB projectile design. The Assegai line is currently available in the following types:

- M2000 High Explosive
- M2001 Dispenser, Dual-Purpose Improved Conventional Munitions (DPICM)
- M2002 Smoke Dispenser (four smoke canisters)
- M2003 Illumination
- M2004 Smoke (red phosphorous)
- M2005 V-LAP

The Assegai projectiles offer greater range than the earlier ERFB types, as they are optimized for 52-caliber barrels. The Assegai projectiles are also compatible with 39-, 45-, and 47-caliber barrels. Although Denel has not released sales information on the Assegai projectiles, unconfirmed reports suggest that the South African National Defence Force (SANDF) has purchased this ammunition.

ASIA

India

Ordnance Factories Organization of India. As a component of India's Ministry of Defence, the Indian Ordnance Factories Organization produces various types of Russian-pattern artillery ammunition under license; it also produces some Western-pattern artillery projectiles.

Struggling to Meet Demand

While India is largely self-sufficient in artillery ammunition production, clashes with Pakistan in the northern Kashmir region have outstripped domestic production capacity. While the Indian ordnance factories have repeatedly increased their production levels and initiated innovative research and development efforts, the supply has yet to catch up with domestic demand. As a stopgap measure, India has resorted to several foreign sources, including South Africa, to address its large demand for 155mm artillery ammunition.

Despite the shortcomings in the field of 155mm ammunition production, India still hopes to become a major player on the international market. Since 1999, the production of artillery ammunition in India has been running at a significantly increased pace in response to the perceived threat from Pakistan in the Kashmir region. Upon some sort of resolution of the Kashmir question, India may indeed be able to focus its considerable production resources on the international market.

Artillery Ammunition

Pakistan

Pakistan Ordnance Factories. As a component of the Pakistan Ministry of Defense, the state-owned Pakistan Ordnance Factories employed about 45,000 people in 2000, making it the largest single industrial organization in Pakistan. This organization satisfies nearly all of Pakistan's requirements for munitions up to 155mm, producing a cross-section of NATO- and Chinese-pattern ammunition. With 14 facilities in the Wah complex and the potential to expand, Pakistan Ordnance Factories has the capability to increase its export market share.

Significant Production Capacity

The Pakistan Ordnance Factories Heavy Artillery Factory in Sanjwal reportedly maintains a maximum annual production capacity of about 800,000 projectiles. In the late 1990s, annual production averaged around 70,000 rounds; since 1999, production has reportedly ramped up substantially in response to the ongoing Kashmir crisis.

The large Pakistan Ordnance Factories propellants factory at Havelian, which has been in operation since 1983, is a product of extensive collaboration with the People's Republic of China. Its two continuous-process production plants manufacture solvent-free, single- and double-base propellants for mortar, tank, and artillery rounds.

Pakistan has provided the benefits of its acquired experience to Malaysia, another Asian nation seeking autonomy in defense production.

People's Republic of China

China North Industries Corp (NORINCO). Prior to the 1980s, the People's Republic of China produced only Soviet-pattern artillery ammunition. This changed as the PRC embraced Western technology in general and military technology in particular. The PRC was one of the first nations to appreciate the potential of the late Dr. Gerald Bull's revolutionary Extended-Range, Full-Bore technology. By the mid-1990s, the PRC was offering a full line of both standard and base bleed ERFB projectiles. The PRC has also adopted the NATO-standard 155mm and 203mm rounds.

Foot in the Door?

In 1995-1996, the People's Republic of China began a major effort to sell its artillery systems and ammunition on the international market through the China North Industries Corporation (NORINCO). This effort paid off with the 1998 sale of its PLZ45 self-propelled artillery system to Kuwait. Although the PRC has not reported any associated ammunition sales, there is evidence that NORINCO has indeed sold some ammunition.

Republic of China (Taiwan)

Hsing Hua Electric Innovative Corp. In addition to producing U.S.-pattern ammunition, the Hsing Hua Arsenal also conducts research and development in the field of extended-range ammunition. Like the PRC, the ROC has embraced Extended-Range, Full-Bore technology. The Hsing Hua effort in the ERFB field supports the contractor's development of new 155mm towed and self-propelled howitzers. Hsing Hua has exported ammunition to at least two nations in the Far East; it hopes to build on that success with its new long-range products.

Republic of Korea

Daewoo Ammunition Corp. This firm (along with Poongsan Metal Corp and Korea Explosives Corp) produces U.S.-pattern 105mm and 155mm ammunition under license for the Korean armed forces and export. The ROK is also developing new 105mm ammunition (especially a new cargo round) as part of the country's fielding of modern 105mm artillery (the KH 178).

Historically, the ROK has sold its ammunition products to Indonesia, Malaysia, Pakistan, Peru, the Philippines, Thailand, and Venezuela. There are unconfirmed reports of sales to Latin American nations in addition to Peru.

Republic of Singapore

Singapore Technologies Kinetics Ltd. Known as Chartered Industries of Singapore until 2000, this firm has managed to make significant strides in the international market. Recent customers of ST-K include Australia, Brunei, New Zealand, three unidentified Arabian Gulf nations, Thailand, Zimbabwe, and unidentified countries in Central America.

ST-K has been expanding its artillery product lines. The associated Ordnance Development and Engineering firm has developed and placed into production the 155mm FH-88 towed howitzer, as well as its 52-caliber follow-on, the FH-2000. The development and production of several different projectiles incorporating Extended-Range, Full-Bore technology (including base bleed types) proceed in parallel with the development of the howitzer. A new wheeled self-propelled artillery system and a tracked self-propelled artillery system are in development; ST-K will offer these weapons systems as packages, including ammunition.

AUSTRALIA/NEW ZEALAND

Australia

Thales Australia. The Australian Department of Defence coordinates the functions of several major facilities as well as smaller units in the production of all types of ammunition. The formerly government-owned Australian Defence Industries (ADI) Ltd, which has operated as a component of the Transfield and

Artillery Ammunition

Thomson-CSF (now Thales) joint venture team since August 1999, runs a number of these facilities.

In October 2006, the Thales Group (Neuilly-sur-Seine, France) acquired ADI Ltd. The Australian contractor now operates as Thales Australia.

On July 10, 1998, a new 17-year renewable munitions supply agreement between (then) ADI Ltd and the Australian Department of Defence increased the contractor's munitions revenue to about AUD100 million a year. The total value of the contract for the initial 17-year period was more than AUD1.7 billion. The contractor had previously (after securing a 1995 agreement with the Australian DoD) invested more than AUD160 million in the development of a modern munitions production facility on a site at Benalla in northern Victoria. This facility replaced three older munitions plants in Sydney and Melbourne.

New Opportunities?

In the area of artillery ammunition, Thales Australia has long produced NATO-standard 105mm ammunition for the M101 and M56 howitzers. More recently, the firm has concentrated on the production of British-pattern 105mm ammunition for the Hamel gun (the 105mm Light Gun). Production of 155mm ammunition has been dormant for some years. As Australia is looking to procure a new 155mm artillery piece, production could resume during the next 10 years.

Thales Australia hopes to be able to compete in the profitable but very competitive Southeast Asian market. However, other than for some small sales to New Zealand, Thales Australia has yet to score any major export sales.

MIDDLE EAST

Israel

Israel Military Industries Ltd (IMI). This firm serves as the prime Israel Defense Forces (IDF) contractor for artillery ammunition of all types. Further, IMI has emerged as a major player in the international market.

A Major International Player

Since 1985, Israel has exported artillery ammunition to at least 10 nations, including Germany, Iran, South Africa, and the United Kingdom. Previous customers include Chile, El Salvador, Ethiopia, Guatemala, Haiti, Mexico, and Nicaragua. Since 2001, the U.S. Army has shown an increased interest in Israeli artillery ammunition.

Following extensive trials, the German Bundeswehr selected IMI's 155mm projectile as the DM602 in February 1986. According to the terms of the DEM221 million procurement contract, IMI initially supplied

88,000 projectiles, with options (subsequently taken up) on an additional 12,000 rounds. Due to domestic political pressures, the Bundeswehr also signed an identical contract with Rheinmetall for its 155mm ammunition. In a subsequent (October 1987) contract, IMI supplied the Bundeswehr with DEM300 million worth of artillery ammunition, including IMI's 155mm cargo (submunition-dispensing) round.

In 1995, IMI beat out Rheinmetall, (then) Giat Industries, and (then) Royal Ordnance to supply 155mm cargo rounds to the British Army. This \$79.2 million sale was the first to the U.K. by IMI. Though data on the exact type of round remain unavailable, our research indicates that it was one of the CL 3013 projectiles.

In June 1996, IMI and Rheinmetall entered into an agreement for the cooperative development of new artillery ammunition.

Expanding Customer Base

India's Ordnance Factory Board has been negotiating a coproduction agreement for IMI projectiles. This agreement and its resulting Indian Army procurement could generate tens of millions of dollars for IMI; potential export sales could double that revenue.

Development continues. IMI has revealed a new 152mm cargo round: the CL 3162 (also known as the DP-ICM M350/351). This projectile is available in standard and extended-range (base bleed) versions. The CL 3162 may be a joint development program between IMI and Arsenalul Armatei of Romania. A 155mm version, the M395, is also available.

United States

Background. The U.S. Army's ammunition production base includes 20 government-owned ammunition plants (many of which are inactive) located throughout the country. Appendix VI ("U.S. Army Operations Support Command") of *Ordnance & Munitions Forecast* provides a complete listing of U.S. ammunition plants. The U.S. Army usually awards five-year contracts to various firms in the private sector to operate and maintain these ammunition plants.

Focus on 105mm and 155mm

The U.S. Army currently employs field artillery systems in two calibers, 105mm and 155mm. The Army also continues to procure 75mm M337A1 blank rounds for ceremonial purposes.

Although procurement of artillery ammunition by the U.S. Marine Corps is a component of the overall U.S. Navy budget, the Marines are generally dependent on U.S. Army artillery ammunition development programs.

Artillery Ammunition

In this report, we address only field artillery pattern ammunition. We do not cover naval pattern ammunition of any type.

U.S. Industrial Base Issues

In the mid-1990s, concerns within both Congress and the Pentagon over the status of the U.S. industrial base for artillery ammunition production led to two reports by the Government Accountability Office (GAO):

- *NSIAD-96-133* found that since 1978, the annual production capacity of the industrial base had decreased by 84 percent – from 11,436,000 projectiles in FY92 to 1,812,000 projectiles by FY00.
- *NSIAD-96-129* found that the U.S. Department of Defense held over 5 million tons of ammunition, worth \$80 billion, as of September 30, 1994. GAO investigators reported much of the stockpiled artillery ammunition to be in excess of stated requirements, obsolete, or outright unusable.

While the GAO reports led to a significant streamlining of artillery ammunition production and procurement procedures under the auspices of the U.S. Army as lead agency, the fact remains that the worldview underpinning the GAO reports has proven to be fundamentally flawed in that it foresaw no significant threat after the end of the Cold War.

Limitations & Opportunities

By the time the global war on terror emerged in 2001, the U.S. Department of Defense was primarily dependent upon the Milan Army Ammunition Plant and Iowa Army Ammunition Plant for artillery ammunition. The prime contractor for these plants, American Ordnance (a joint venture of General Dynamics and Mason & Hanger), has been hard-pressed to meet the combat requirements of the U.S. Army and U.S. Marine Corps.

As a result of this depleted production capacity, the U.S. Army looked to the private sector and the international market to quickly make up for existing shortfalls. Among the international players that bid for U.S. Army artillery ammunition contracts were:

- BAE Systems, in collaboration with Alliant Techsystems (ATK)
- Denel SOC Ltd, in collaboration with General Dynamics Armament and Technical Products (GDATP) to offer Denel's 155mm Assegai munitions
- Diehl Munitionssysteme, in collaboration with Denel to offer Joint Ballistics artillery ammunition for the lucrative NATO Advanced Future Artillery Ammunition Systems (AFAAS) requirement
- Israel Military Industries (IMI)
- Rheinmetall Defence, also in collaboration with ATK

Development Programs. In the field of 105mm artillery ammunition, the extended-range M927 High Explosive round is a rocket-assisted projectile derived from the M913 round for the M119 Light Gun. The XM915 and XM916 are both Dual-Purpose Improved Conventional Munition (DPICM) rounds that dispense XM80 submunition.

Enter the Excalibur

The most significant new 155mm round is the M982 Excalibur extended-range precision-guided projectile. Designed to provide a range increase of 44 kilometers (48,118.4 yd) over the M483 series, the M982 features advanced airfoil technology and a refined projectile design to achieve the desired range of 57,000 meters (62,335 yd).

The guidance component of the M982 Excalibur features a GPS receiver and an inertial measurement unit (IMU). A portable inductive artillery fuze setter

loads target data prior to firing. After the projectile exits the tube, it sheds a slip obturator band, allowing four aft-mounted fins to deploy. At the maximum ordinate, four canard fins deploy to adjust for in-flight commands and execute terminal guidance. The production Excalibur round reportedly features an accuracy of 10 meters (10.94 yd) from a range of 40 kilometers (24.85 stat mi).

Beyond its precision-guidance capability, the ability of the Excalibur to strike targets from a near-vertical angle allows the projectile to attack targets that would otherwise be screened from the ballistic trajectory of conventional artillery munitions by intervening structures or terrain features.

The original plans called for the XM982 Excalibur to be available in the following warhead configurations:

- Fragmenting Unitary warhead, with proximity, point-detonating, and delay fuze modes

Artillery Ammunition

- DPICM, with 72 M42 or M46 submunitions
- DPICM, with 85 XM80 submunitions
- Sensor-fuzed munition (SFM), with seven M718 or M741 Remote Anti-Armor Mine submunitions

In February 1998, the U.S. Army selected Raytheon as the prime contractor and systems integrator for the M982 Excalibur program. On August 1, 2002, Raytheon and Bofors Defense AB signed a Cooperative Program Agreement to merge Excalibur with Bofors' Trajectory Correctable Munition program.

From Test Range to Battlefield

Live-fire tests began in November 2004. The U.S. Army began fielding the M982 Excalibur in Iraq during 2007; the munition made its debut in Afghanistan in 2008.

The M982 Excalibur is compatible with the M109A6 Paladin self-propelled howitzer and the M777-series Joint Lightweight Howitzer.

U.S. Army budget request documentation indicates that funding for Excalibur production commenced in FY05. The U.S. Army procurement objective for the M982 Excalibur unitary projectile remains at 30,000 rounds. This represents a drastic reduction from the original procurement objective of 200,000 rounds.

Other Cargo Projectile Programs

In addition to the Excalibur, a number of other 155mm submunition-dispensing projectiles are in development, including:

- XM867 expendable jamming projectile, essentially an M483-series cargo round that dispenses five electronic countermeasures device submunitions
- M692/M731 Area Denial Artillery Munition. The M692 dispenses 36 M67 long-delay anti-personnel mines; the M731 dispenses 36 M72 short-delay anti-personnel mines
- M718/M741 Remote Anti-Armor Mine System. The M718 dispenses nine M73 long-delay anti-personnel mines; the M741 dispenses nine M70 short-delay anti-personnel mines
- Remote Area Denial Artillery Munition (RADAM), integrating the M692/M731 and M718/M741 munitions into a single dispensing system. At least 337,000 RADAMs are currently in production

Although the current U.S. Army interest in submunition-dispensing projectiles remains a severe bone of contention with adherents to the 1998 Ottawa Treaty banning anti-personnel land mines (which is precisely what the M67 and M72 are), the U.S. Army has repeatedly stated that until viable options are developed, it needs this type of area denial capability in certain areas of the world, such as the Korean Peninsula.



M982 Excalibur Precision-Guided 155mm Projectile

Source: Raytheon Co

Funding

Individual contractors and various governments fund the development of ammunition programs.

Selected Acquisition Reports (SARs)

The Department of Defense (DoD) periodically releases Selected Acquisition Reports (SARs) that summarize the latest estimates of cost, schedule, and performance status for Major Defense Acquisition Programs (MDAP). These reports are prepared annually in conjunction with submission of the president's budget. (Subsequent quarterly exception reports are required only for those programs experiencing unit cost increases of at least 15 percent or schedule delays of at least six months.)

Artillery Ammunition

The total program cost estimates provided in the SARs include research and development, procurement, military construction, and acquisition-related operations and maintenance. Total program costs reflect actual costs to date as well as future anticipated costs.

See below for instructions on how to view the annual SAR related to this particular report.

Online and DVD Clients – Click link below.

Hard-Copy Clients – Insert the CD located in the sleeve at the front of the binder. (Electronic version updated quarterly.)

P:\SAR\Current\SAR31_342_Artillery Ammunition.pdf

Timetable

Several European players will likely soon field enhanced guided projectiles using improved forms of guidance such as advanced infrared or millimeter wave. These technologies may also be incorporated in submunition-dispensing rounds.

The non-U.S. and non-European players have made significant technological progress in the past decade. We expect that at least one of these contractors will offer an advanced "smart" projectile on the international market within the next 10 years.

The U.S. Army commenced low-rate initial production of the M982 Excalibur extended-range precision-guided munition in April 2007. During the forecast period, the U.S. Army should also introduce into service some sort of successor to the M712 Copperhead guided artillery projectile. The U.S. Army may also adopt the Extended-Range, Full-Bore concept in some form.



155mm M777A1 Joint Lightweight Howitzer

Source: U.S. Army

Worldwide Distribution/Inventories

European- and U.S.-pattern artillery ammunition is widely available with nations using U.S.- or NATO-standard artillery. Likewise, Russian-pattern artillery ammunition is widely available worldwide.

Artillery Ammunition

Forecast Rationale

With the current war in Ukraine and that being a conflict with heavy emphasis on artillery, artillery production has soared and has likely soared in countries either directly or indirectly involved with the war.

With that being said, numbers are currently difficult to ascertain as to production figures of non-NATO nations.

Recent reports from Russia indicate that nation is producing about 3 million rounds per year.

The forecast represents the major calibers of munitions produced today, namely 155mm and 152mm. The war has driven production and will numbers will likely remains steady as long as the war in Ukraine drags on.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			Total
	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
MFR Varies												
152mm RUSSIAN Rounds <> 152mm Artillery <> Russian Federation												
	11,500,000	3,000,000	3,500,000	3,500,000	3,500,000	2,000,000	1,500,000	1,000,000	1,000,000	1,000,000	1,000,000	21,000,000
155mm CHINESE Rounds <> 155mm Artillery <> China												
	1,930,000	250,000	270,000	270,000	300,000	300,000	300,000	320,000	320,000	320,000	320,000	2,970,000
155mm NATO Rounds <> 155mm Artillery												
Note: Namely United States; France; Germany and the United Kingdom												
	2,286,000	1,300,000	1,850,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	1,500,000	1,000,000	500,000	16,150,000
155mm WORLDWIDE Rounds <> 155mm Artillery												
Note: Namely Japan; South Korea; Turkey and Israel												
	2,750,000	400,000	500,000	600,000	500,000	500,000	500,000	500,000	400,000	300,000	300,000	4,500,000
Total	18,466,000	4,950,000	6,120,000	6,370,000	6,300,000	4,800,000	4,300,000	3,820,000	3,220,000	2,620,000	2,120,000	44,620,000