ADVANCED MATERIAL ENGINEERING PTE LTD
40MM LOW VELOCITY HIGH EXPLOSIVE DUAL PURPOSE CARTRIDGE
FOR: 40mm Grenade Launchers

TM/086C/C/00

Edition Apr 2023

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1 INTRODUCTION

The 40mm Low Velocity HEDP cartridge described in this manual is a high explosive dual purpose round designed to defeat 2.5 inches light armour as well as to give anti-personnel effects.

It can be fired from the STK40GL, HK69A1, M203, M79, AG36, FN40GL and M320A1 or other approved launchers at a range up to 400 meters. The cartridges are packed in a M2A1 metal box with 18 rounds per box.

2 GENERAL DESCRIPTION

The 40mm Low Velocity HEDP Cartridge is a fixed round ammunition consisting of a point-detonating fuze, an aluminum projectile body and a cartridge case assembly. The fuze is made up of two main groups, namely, the striker unit and the safety and arming device. The fuze is secured onto the front opening of the shell body to form the projectile. The projectile is assembled with HE shaped charge that is initiated by a spitback charge at the base of the fuze. The cartridge case contains the propellant charge and the primer cap. The deep drawn aluminium case is protected from corrosion with anodising and sealed with varnish.

The projectile body is assembled onto the cartridge case assembly, which has an insert that contains the propellant. The primer is fitted in the center of the base plug that is crimped onto the base of the cartridge case. The insert forms the high-pressure chamber and the hollow cavity in the cartridge case acts as a low-pressure chamber.

3 FUNCTIONING

Upon firing, the firing pin strikes the primer, igniting the propelling charge in the high pressure chamber. The burning gas escapes through the vent holes into the low pressure chamber. The built-up pressure propels the projectile forward with an average velocity of approximately 76 m/s, and a spin rate of approximately 3,750 rpm.

Upon hitting the target, the safe and arm mechanism in the fuze would move forward and strike the PD firing pin.

This in turn detonates the explosive charge causing a blast and fragmentation of the projectile body and a penetrating jet of metal particles from the liner with armour piercing properties.

4 CARTRIDGE EFFECTIVENESS

The effectiveness of the projectile against personnel targets is ensured by consistent high order detonation of the explosive charge and fragmentation of the shell body. The inner surface of the steel shell body is embossed with hexagonal patterns, which form fracture lines during an explosion. This results in a regular dispersion of fragments, with a lethal radius of 5m. The shaped-charge explosive effect will defeat most of current armoured personnel carriers. Accurate delivery of the rounds onto targets is ensured by consistent muzzle velocities and aerodynamically stable projectiles. These result in uniform trajectories, which contribute to predictable target engagement.

5 TECHNICAL DESCRIPTION (Figure 1)

Fuze (1) The nose fuze is a point initiating base detonating (PIBD) fuze. Its design ensures muzzle and detonation safety.

Projectile Body (2) The shell body is made of drawn steel and the internal surface is embossed with hexagonal patterns that break up and form uniform fragments upon detonation of the explosive.

Liner (3) The shaped-charge liner is made of copper and it can defeat 2.5 inches of light armour and that covers most of the current armoured personnel carriers.

Explosive Charge (4) The explosive charge consists of approximately 45 gm of Comp A5 pressed into the steel shell body.

Driving Band (5) The driving band is fabricated within the aluminium skirt. When the round is fired, the driving band engages the barrel rifling and at the same time provides a good gas sealant. Thus, the projectile is constrained to rotate about its longitudinal axis (spin). This ensures that the projectile muzzle velocity remains constant so long as the barrel is still within its serviceable life.

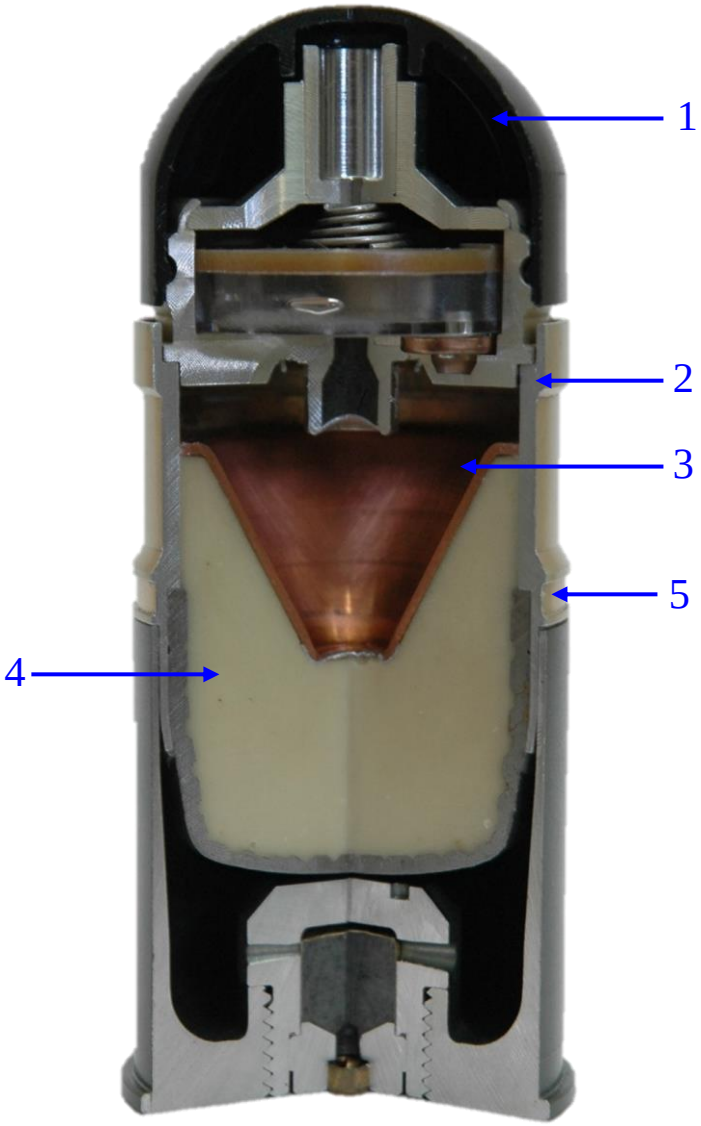


Figure 1

6 Technical Data

6.1 Complete Round

1.	Type	HEDP
2.	Weight	220 g
3.	Length	103.8 mm
4.	Used with weapons	STK40GL, FN40GL, M79, M203, M320A1, HK69A1, HK AG36 launchers
5.	Total NEQ per round	45.9 g

6.2 Projectile

1.	Body material	Aluminum skirt with embossed steel cup and plastic fuze ogive
2.	Colour	Chromated with black marking
3.	Explosive filling	Comp A5 (NEQ per round: 45.1 g)
4.	Explosive density	1.6 g/cc
5.	Weight	approx. 167 g
6.	Fuze	PIBD Fuze

6.3 Fuze

1.	S&A	Mechanical
2.	Arming	a) spin b) setback
3.	Arming Distance	14 to 28m
4.	Spitback	CH6 (NEQ per round: 0.35 g)
5.	Detonator	M55 (NEQ per round: 0.085 g)

6.4 Propulsion Unit

1.	Cartridge Case	Bi-chamber, aluminium
2.	Propellant	Double base (NEQ per round: 0.33 g)
3.	Primer	Percussion (NEQ per round: 0.052 g)

6.5 Performance

1.	Muzzle velocity	76 m/s
2.	Maximum range	400 m
3.	Lethal radius	5 m
4.	Penetration	2.5" thick mild steel plate

6.6 Ballistic Data

FIRING TABLE
FOR
40MM LOW VELOCITY GRENADE

RANGE METERS	SUPER-ELEV MILS	DX/DSE METERS/MIL	DH/DX METERS/100M	DRIFT MILS	TIME OF FLIGHT SEC	10 KM/HR CROSS-WIND DEFLECTION MILS	MAXIMUM ORDINATE METERS	RANGE TO MAXIMUM ORDINATE METERS	ANGLE OF FALL MILS	REMAINING VELOCITY METERS/SEC
0	0	1	0	0	0	0	0	0	0	76
20	**17.5**	**1**	**1.7**	**0.7**	**0.3**	**0.3**	**0.1**	**10**	**18**	**75**
40	35.4	1	3.6	1.4	0.5	0.7	0.4	20	36	73
60	53.8	1	5.5	2.1	0.8	1.0	0.8	30	56	72
80	72.8	1	7.1	2.9	1.1	1.4	1.5	40	76	71
100	**92.3**	**1**	**9.6**	**3.6**	**1.4**	**1.7**	**2.3**	**51**	**98**	**70**
120	112.4	1	11.9	4.5	1.7	2.1	3.4	61	121	68
140	133.2	1	14.3	5.3	2.0	2.4	4.8	71	145	67
160	154.8	1	16.8	6.2	2.3	2.8	6.4	82	170	66
180	177.2	1	19.6	7.1	2.6	3.2	8.3	92	197	65
200	**200.6**	**1**	**22.5**	**8.1**	**2.9**	**3.6**	**10.6**	**103**	**225**	**64**
220	225.0	1	25.6	9.2	3.3	4.0	13.2	114	255	63
240	250.7	1	29.0	10.3	3.6	4.4	16.2	124	287	62
260	277.9	1	32.7	11.6	4.0	4.9	19.7	135	322	61
280	306.8	1	36.7	12.6	4.4	5.4	23.6	146	358	60
300	**337.8**	**1**	**41.2**	**14.4**	**4.8**	**5.9**	**28.3**	**157**	**398**	**59**
320	371.4	1	46.3	16.0	5.2	6.4	33.6	168	441	58
340	408.3	1	52.0	17.9	5.7	7.0	39.9	179	489	58
360	450.0	0	58.8	20.1	6.2	7.6	47.5	190	542	57
380	498.5	0	67.2	22.9	6.8	8.4	56.8	201	603	57
400	**558.9**	**0**	**78.2**	**26.6**	**7.5**	**9.3**	**69.1**	**212**	**676**	**56**
420	**650.4**	**0**	**96.7**	**33.0**	**8.5**	**10.8**	**88.9**	**223**	**783**	**56**

ELEVATION – DEGREES	5	10	15	30	42
RANGE – METERS	97	180	252	392	428
MAXIMUM ORDINATE - METERS	2	8	18	64	112

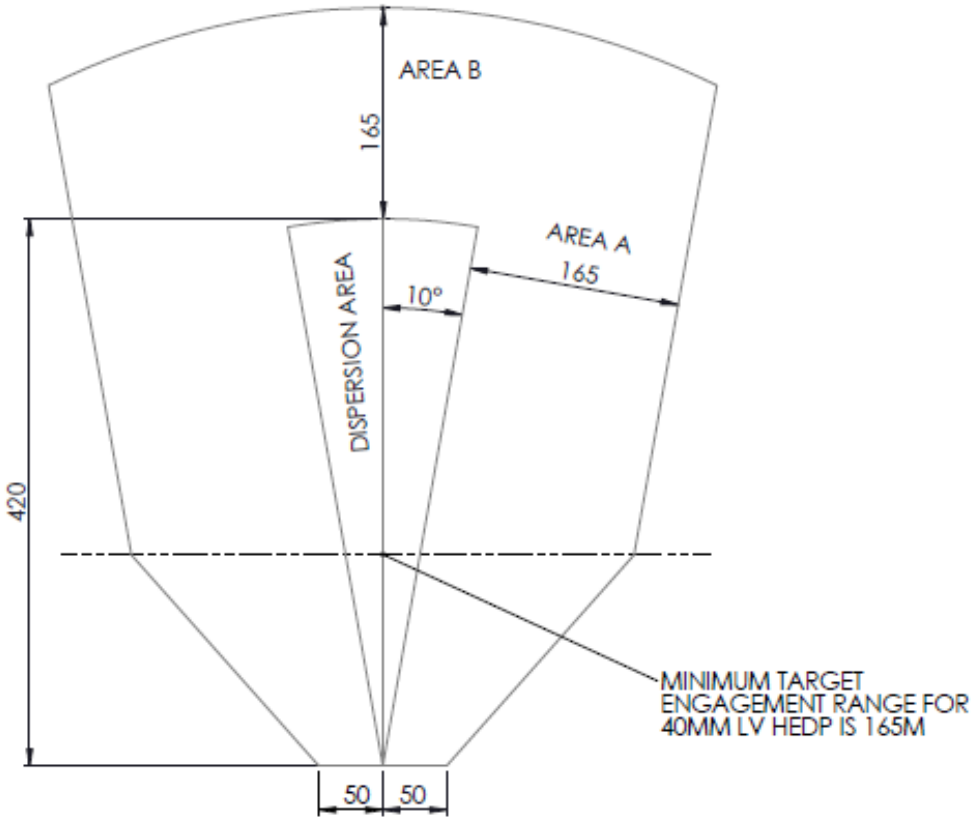
DH=Change in Height

DX=Change in Range — Source: 40mm

DSE=Change in Superelevation — Limit cycle in drag curve

6.7 Safety Template

Reference ammunition, HEDP cartridge shall not be fired against targets that are closer that 165m.



Reference to Range Safety Document DA PAM 385-63. 10 APRIL 2014

7 Fuze

7.1 PIBD Fuze

7.1.1 Fuze components (Figure 2)

1 Ogive
2 Actuator
3 Cover
4 Firing Pin
5 Conical Spring
6 Pin, Setback
7 Spring, Setback
8 Verge Assembly
9 Spring, Detent
10 Detent
11 Sector Gear
12 Detonator, Stab, M55
13 Escapement Assembly
14 Pinion Assembly
15 Rotor

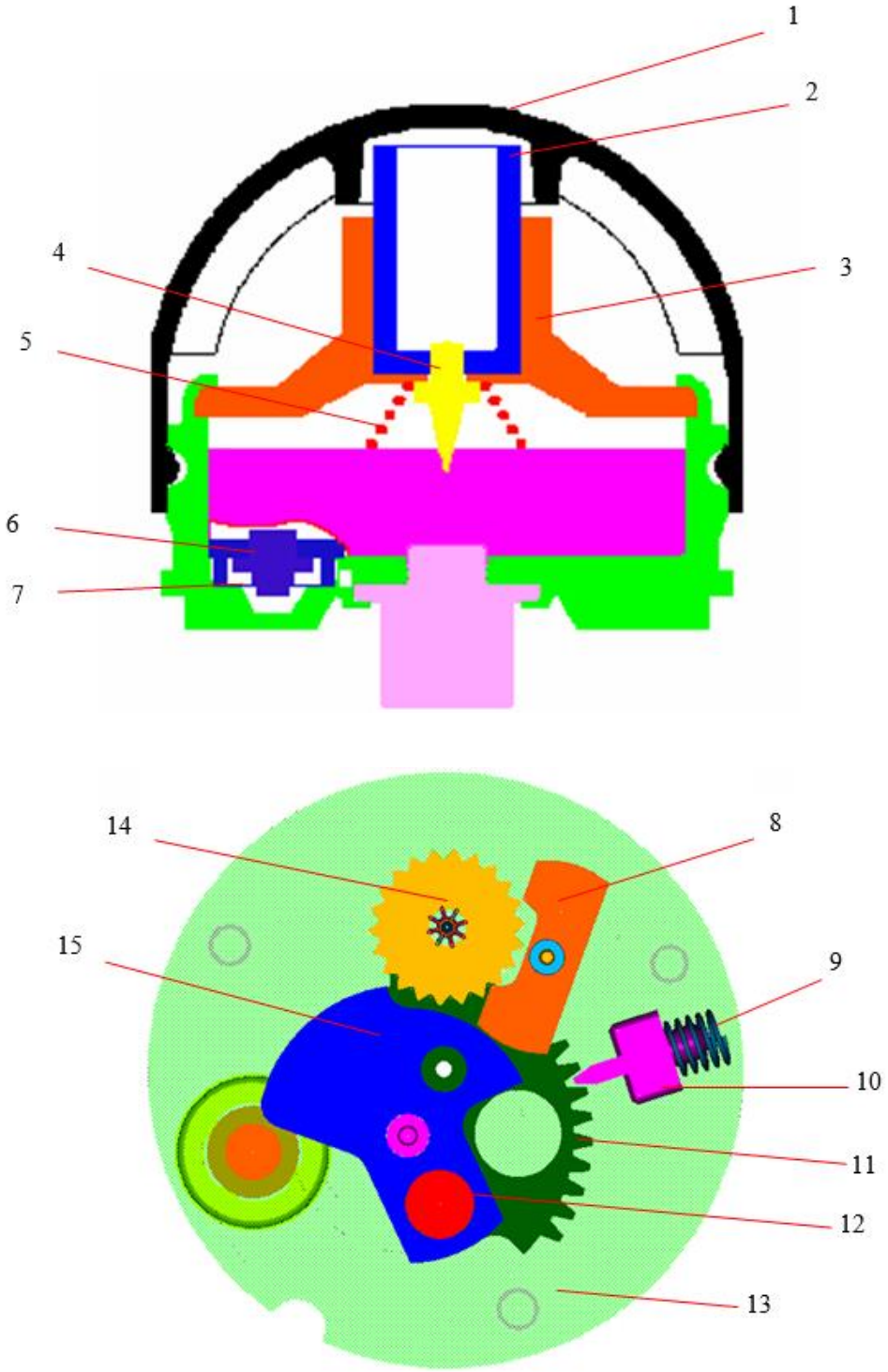


Figure 2: Fuze Components

7.1.2 Fuze functions

7.1.2.1 Fuze Safe (Figure 3)

The Detent and the Setback Pin lock the Rotor Assembly in an unaligned 'SAFE' position. The Setback Pin can only be released when a setback force is exerted on the projectile i.e. when projectile is propelled through the muzzle.

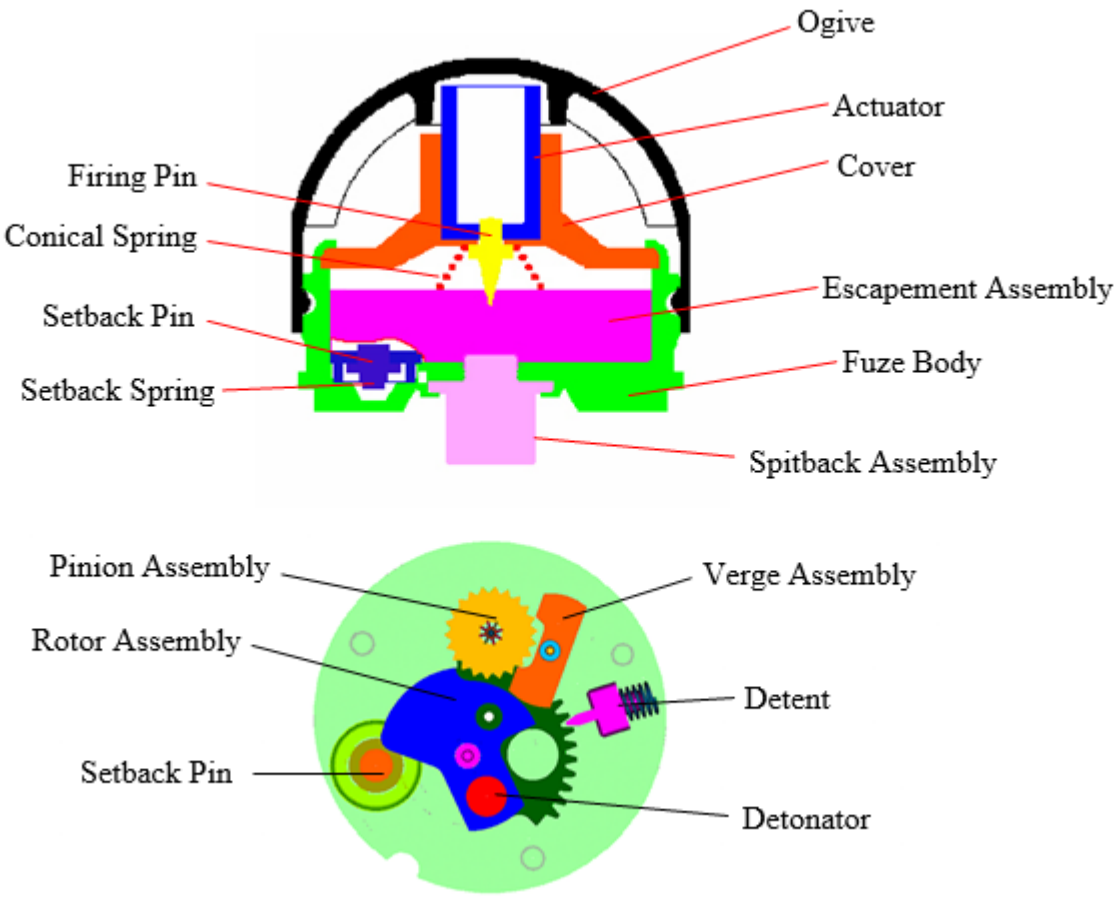


Figure 3: Fuze Safe

7.1.2.2 Muzzle Safety (Figure 4)

When the projectile is fired, the Setback Pin is retracted as the projectile experiences a setback force during launch. As the projectile is accelerated up the barrel and driven into rotation, and due to the axially acting acceleration forces and the friction resistance arising, the rest of the fuze components cannot change their position. The fuze remains secured and barrel safety is guaranteed.

After leaving the barrel muzzle, the projectile has reached the full speed of rotation at muzzle (spin). Acceleration has fallen to zero. Under the influence of the radially acting centrifugal forces, the Detent is retracted thus allowing the Rotor Assembly to rotate towards the armed position. However, due to the Verge Assembly and the Starwheel which act as the time regulator, the Fuze shall not arm itself until it has reached its arming distance.

The timing of these fuze functions guarantees a minimum muzzle safety of 14m.

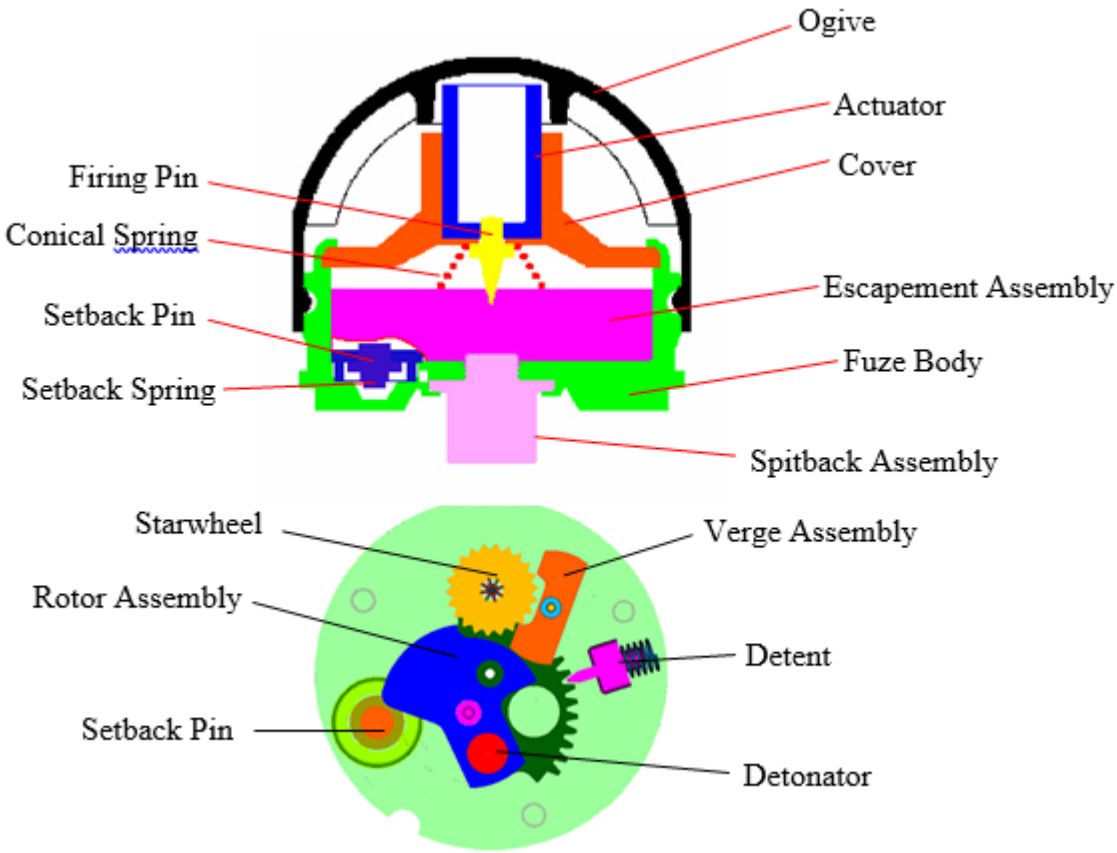


Figure 4: Muzzle Safe

7.1.2.3 Fuze Armed (Figure 5)

When the projectile has travelled a distance of between 14 to 28m, the Rotor Assembly will potentially be aligned in the 'ARMED' position. The Detonator is now in-line with the Firing Pin.

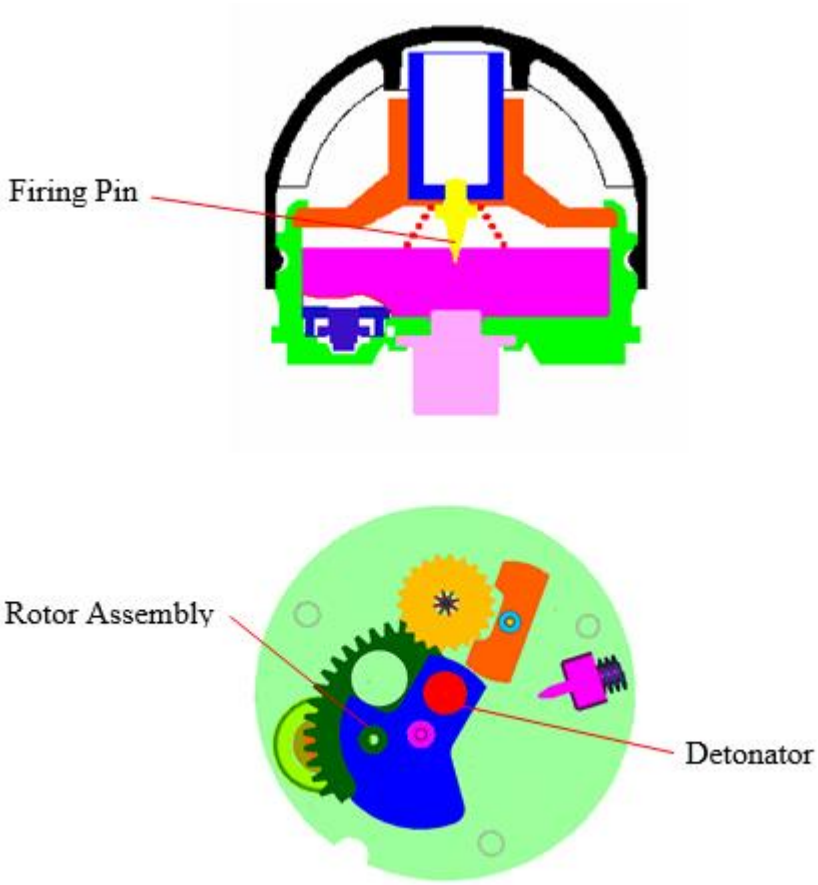


Figure 5: Fuze Armed

7.1.2.4 Fuze Impact (Figure 6)

Upon striking a target, the velocity of the shell decreases tremendously with a sharp retardation. At this time, the whole Escapement Assembly flies forwards due to the sudden reduction in velocity and causes the Detonator to hit the PD Firing Pin. Therefore, ignition of the Detonator propagates through the whole explosive train thus causing detonation of the projectile.

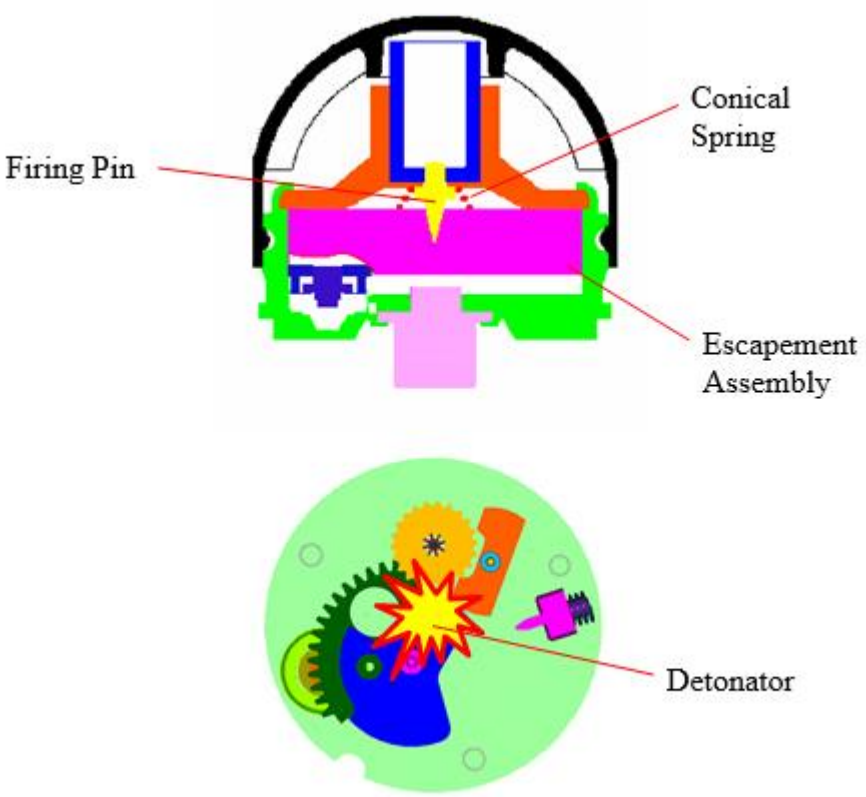


Figure 6: Fuze Impact

8 Packaging, Transportation, Storage, Surveillance and Handling of 40mm Ammunition

8.1 Packaging

- The 40mm ammunition is supplied ready for use in M2A1 metal ammunition boxes.
- Packages should only be opened with immediate use of ammunition.
- Ammunition from already opened packages should be used first.
- Empty ammunition boxes are to be used for packaging ammunition components for return to depot (cases, links, etc).

8.1.1 Metal Box

The metal cover is fastened to the metal box by one latch. A rubber seal provides hermetic sealing.

The cartridges are packed in vacuum enclosed barrier bag and separated by separators and fillers.

8.1.2 Unit Packing

18 rounds of Cartridge 40mm HEDP are placed in a M2A1 metal box. The quantity and calibre of the cartridges lot number, gross weight and volume are marked on the box.

Packaging Box

- Packaging box	18 rounds per M2A1 metal box
- Weight (Gross)	7.5 Kg
- Dimensions (mm)	299 x 154 x 184
- Volume (m^3)	0.008

8.1.3 Shipping and storage

- Hazard division 1.1
- Compatibility group E
- UN Serial No. 0006

8.1.4 Operating Temperature

The operational is enhanced within the temperature range of -46°C to +63°C.

8.2 Transportation

- Loading, unloading, and transportation of ammunition must be carried out carefully and all necessary precautions observed.
- Neither throw nor drop ammunition boxes.
- Dropped Ammunition: Ammunition which has been dropped from a height of ≤ 1.5m should be safe for handling and suitable for service provided that there is no obvious damage and the round can be chambered. Any round that is visibly damaged is to be disposed.
- The handling safety of the ammunition in the packaging box is however retained up to a falling height of 12m.
- UN Marking (design type of packaging approval) in accordance with UNRTDG.


4A/X8/S/**
SGP/AME010

** To be replaced by the last two digits of the year of manufacture.

8.3 General Storage Conditions

The manufacturer's guarantee is valid only for ammunition that has been stored under the following conditions.

8.3.1 Long Term Storage Temperature and Shelf Life

The recommended storage temperature for the rounds, in its original packaging is as follows: -
From temperature 0°C to +40°C and RH of up to 98% in well ventilated storehouses, the ballistic and chemical shelf life shall be five (5) years and ten (10) years respectively.

The round, once removed from its original packing, shall be expended as soon as possible and shall not be returned to storage.

It is recommended that the rounds should not be stored at temperature above 40°C to prevent degradation of the ballistic performance of the rounds.

8.3.2 Short Term Storage (One month) Temperature

The recommended storage for the rounds, in its original packaging is 0°C to +50°C and RH of up to 98% in well ventilated storehouses.

8.3.3 Special Storage Conditions

8.3.3.1 Depot storage conditions

- Ammunition should only be stored in well-ventilated dry rooms.
- The stability and loaded capacity of the flooring must be sufficient to support the weight of the ammunition quantity to be stored.
- The building must be of solid construction and securely locked.
- The storing of ammunition in light corrugated iron or wooden barrack buildings should be avoided.

- Good access, separate if possible, for incoming and departing vehicles must be available.
- The use of lights with exposed flame, such as kerosene lamps and candles, is prohibited.
- Ammunition depots must never be located under high voltage lines
- Ammunition crates must always be placed on wooden racks 40cm clear of walls and ceiling and 10cm clear of floor.
- Good ventilation of the ammunition stack is thus ensured.
- Store different types of ammunition separately.

8.3.3.2 Field storage conditions

The following guidelines are to be observed for the storage of ammunition near gun emplacements and under field conditions.

- Protect ammunition from direct sunlight.
- Erect tents to protect ammunition from moisture.
- Place ammunition crates on wooden flooring – never directly on the ground.
- Camouflage the ammunition dump by arranging ammunition stacks to merge with the surroundings.
- Entrench the ammunition for protection against bombardment and against pressure waves from atomic explosions.
- Never locate an ammunition dump in the vicinity of or directly beneath high voltage lines.
- Store different types of ammunition separately.

8.4 Reliability

The rounds shall have a functional reliability of at least 98% at 95% confidence level within the warranty period.

8.5 Surveillance

During long term or depot storage we recommend an inspection every 2–4 years.

The quantity can be determined by carrying out a complete acceptance in accordance with the acceptance conditions.

We would suggest that, as a minimum, the following should be checked:

- Muzzle velocity
- Hit pattern (accuracy)
- Self-destruction (appropriate types)

8.6 Ammunition treatment

8.6.1 Ammunition handling

Careful and correct handling of the ammunition is essential to ensure the faultless functioning of ammunition and gun when in action.

Transportability

With the original packaging, the round shall be safe and suitable for transportation by military trucks, rail, vessels and aircraft provided the round is well secured. After the transportation, the safety and performance of the round shall not be degraded.

1.5 metre Drop

Without packaging, the round shall be safe for handling and suitable for service after being dropped from a height of 1.5 metres onto a flat concrete floor, provided that there is no obvious damage and the round can be chambered. Any round that is visibly damaged is to be disposed.

4 metre Drop

With original M2A1 metal box packaging, the round shall be safe for handling and suitable for service after being dropped from a height of 4 metres onto a concrete floor, provided that there is no obvious damage and the round can be chambered.

Inspection before Use

The round should be inspected for visible damage and/or missing components that may impair the function of the round, e.g. missing primer, dented case, etc. Any round found with such damage or missing components should not be used and be disposed appropriately.

8.6.1.1 Rules for Handling Ammunition

- Make sure hands are clean before handling
- Lay ammunition only on a clean surface
- Use only clean metal box.

Before Firing:

- Remove the rounds from the ammunition box and feed into the 40GL chamber.
- The ammunition is supplied ready for use. It requires no further treatment and can be put into use immediately.
- Ammunition put ready for use must be protected from moisture and from direct sunlight.

During Firing:

- Additional ammunition must be held in readiness in a dry location shielded from the direct rays of the sun.

After Firing:

- Unfired ammunition shall be expended as soon as possible and shall not be returned to storage.
- Additional ammunition must be held in readiness in a dry location shielded from direct rays of the sun.

8.6.2 Ammunition malfunction

This practically never occurs.

- If a round fails to fire, the firing mechanism of the 40GL should be checked (firing pin missing, weak spring, or dirt in cartridge chamber)
- Cartridges that do not fire after correct manipulation of the triggering facility a second time should be unloaded, singled out, and returned to depot.
- Cartridges that have been deformed by external influences (jamming, compression, etc) should be singled out and returned to depot.