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Cluster Munitions & Submunitions in Syria:
A Technical Appraisal

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Remember, all arms and munitions are dangerous. Treat all firearms as if they are loaded, and all munitions as if they are live, until you have personally confirmed otherwise. If you do not have specialist knowledge, never assume that arms or munitions are safe to handle until they have been inspected by a subject matter specialist. You should not approach, handle, move, operate, or modify arms and munitions unless explicitly trained to do so. If you encounter any unexploded ordnance (UXO) or explosive remnants of war (ERW), always remember the 'ARMS' acronym:

AVOID the area
RECORD all relevant information
MARK the area to warn others
SEEK assistance from the relevant authorities

Cluster munitions and, in particular, unexploded submunitions can be very dangerous. Where possible, follow these rules if encountering them:

- First and foremost, avoid handling all munitions.
- Try to avoid approaching any munitions.
- If you observe submunitions or landmines, assume that there are more in the area around you.
- Remember that item that has been armed, fired, or damaged may be particularly hazardous.

Disclaimer

This report is presented for informational purposes only. It is not intended to provide instruction regarding the construction, handling, disposal, or modification of any weapons systems. Armament Research Services (ARES) strongly discourages non-qualified persons from handling arms and munitions. Arms or munitions of any variety should not be handled without the correct training, and then only in a manner consistent with such training. Subject matter experts, such as armourers, ATOs, and EOD specialists, should be consulted before interacting with arms and munitions. Make a full and informed appraisal of the local security situation before conducting any research related to arms or munitions.

Cover image: *Syrian social media via ARES CONMAT Database.*

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Abbreviations & Acronyms

AT	Anti-tank
ATO	Ammunition technical officer
AO	*Aviatsionnaya Oskolochnaya*; ('aviation fragmentation bomb') [Russian]
AOI	Arab Organisation for Industrialisation
ARCS	(ARES) Arms & Munitions Classification System
ARES	Armament Research Services
AXO	Abandoned explosive ordnance
BetAB	*Betonoboynaya Aviatsionnaya Bomba* ('concrete-piercing aircraft bomb') [Russian]
BKF	*Blok Konteynerndlya Frontovoy aviatsii* ('container blocks for frontline aviation') [Russian]
BW	Biological weapons
CCM	Convention on Cluster Munitions
CMC	Cluster Munition Coalition
CONMAT	(ARES) Conflict Materiel Database
CW	Chemical weapons
DPICM	Dual-purpose improved conventional munitions
EFP	Explosively formed penetrator
EOD	Explosive ordnance disposal
ERW	Explosive remnants of war
HE	High explosive
HE-FRAG	High explosive fragmentation
HEAT	High explosive anti-tank
HEDP	High explosive dual-purpose
IED	Improvised explosive device
IR	Infrared
IS	Islamic State
KMGU	*Konteyner Malogabaritnykh Gruzov Universalnyi* ('universal small-size cargo container') [Russian]
KO	*Kumulyativnaya Oskolochnaya* ('HEAT-FRAG')

MBRL	Multiple-barrel rocket launcher
NEQ	Net explosive quantity
PETN	Pentaerythritol tetranitrate
PID	Positive identification
PKM	*Peresnosnogo Komplekta Minirovaniya* ('portable mining kit') [Russian]
POM	*Protivopekhotnaya Oskolochnaya Mina* ('anti-personnel fragmentation mine') [Russian]
PTAB	*Protivo Tankovaya Avia Bomba* ('anti-tank aviation bomb') [Russian]
PTM	*Protivo Tankovaya Mina* ('anti-tank mine') [Russian]
RBK	*Razovaya Bombovaya Kasseta* ('single-use cassette bomb') [Russian]
RHAe	Rolled homogeneous armour equivalent
RDX	Research Department eXplosive
ShOAB	*Sharikovaya Oskolochnaya Aviatsionnaya Bomba* ('spherical fragmentation aircraft bomb') [Russian]
SPBE	*Samopritselivayushchiysya Boyevoy Element* ('self-guided submunition') [Russian]
TNT	Trinitrotoluene
UXO	Unexploded ordnance
UMZ	*Universal'nyy Minnyy Zagraditel'* ('universal minelayer') [Russian]
UZRGM	*Universal'nyi Zapal, Ruchnaya Granata, Modernizirovannyi* ('universal igniter, hand grenade, improved') [Russian]
WP	White phosphorous
ZAB	*Zazhigatel'naya Aviatsionnaya Bomba* ('incendiary aircraft bomb') [Russian]

Introduction

The use of cluster munitions in the ongoing Syrian Civil War (2011–present) has resulted in thousands of casualties. Between July 2012 and December 2020, the Cluster Munition Coalition documented at least 687 cluster munition attacks that resulted in at least 4,281 casualties in Syria (CMC, 2021). ARES assessments of these numbers indicate they are conservative estimates, and that the actual impact is likely to be significantly higher. The particular harms cluster munitions pose to civilians are twofold. Firstly, their submunitions are often dispersed relatively indiscriminately over a wide area, thus increasing the chance of affecting civilians or civilian objects. Secondly, submunitions that fail to detonate often remain in the area as unexploded ordnance (UXO).[1] If not handled properly, UXO poses a significant ongoing risk to civilians long after hostilities have concluded. In Laos, for example, millions of unexploded submunitions remain in the country after bombings that began over fifty years ago. These UXO have killed dozens of civilians annually for decades since they were employed, and 75% of the thousands of injuries caused by them involve children (Convery, 2018). The continuous impact of UXO can sometimes be as deadly—or more deadly—than the cluster munition attacks themselves. For example, in Syria in 2020, 142 casualties from cluster munition airstrikes were recorded; by comparison, 147 casualties were recorded as resulting from submunitions that had previously failed to detonate upon impact (CMC, 2021).

A wide range of cluster munitions and submunitions have been documented in Syria. These include types designed specifically to kill and injure people (e.g., munitions dispensing high-explosive fragmentation submunitions), those intended to target armoured vehicles (e.g., munitions dispensing high explosive anti-tank submunitions), and multipurpose types (e.g., munitions carrying dual-purpose improved conventional munitions, or DPICMs). More specialised submunitions, such as incendiary types, have also been documented. This report examines all of these, as well as 'scatterable' landmines. Whilst not always considered cluster munitions by technical specialists due to their differing roles, many munitions dispensing landmines can indeed be classified as cluster munitions under the definition contained within the Convention on Cluster Munitions (see pp. 11–12).

This report details the variety of cluster munitions and their submunitions identified in Syria, as well as providing key technical specifications. The report presents the following key findings:

- The ongoing use of cluster munitions has been a feature of the Syrian conflict from its earliest days until the time of writing, albeit at varying levels of intensity;
- A wide variety of cargo munitions and submunitions have been employed during the conflict (at least 19 different submunitions and at least 24 different delivery munitions);
- The submunitions and delivery munitions identified by ARES in Syria are almost entirely of Soviet or Russian design and manufacture, with limited numbers of munitions produced in China or Egypt are also recorded;
- Improper employment, the use of old munitions, and other factors have led to a substantial dud rate among all types of submunitions. The ubiquitous UXO problem this has created poses a serious, ongoing threat to Syrian civilians; and
- A variety of unexploded submunitions have been repurposed into other, craft-produced munitions and improvised explosive devices (IEDs). Some of these have been produced in sophisticated, purpose-built workshops.

An overview of the key technical characteristics of the submunitions identified in Syria—along with a list of probable delivery devices—is provided in ***Appendix 1***. A summary of the date and location of first recorded use for each submunition is presented in ***Appendix 2***.

1 Sometimes referred to by the broader term 'explosive remnants of war' (ERW), which includes both unexploded ordnance (UXO) and abandoned explosive ordnance (AXO). However, the term ERW does not include those explosives left behind intentionally (e.g., landmines) (Landmine & Cluster Munition Monitor, 2019).

Methodology

This report stems from ongoing monitoring of the armed conflict in Syria. In particular, it documents the use of cluster munitions and their submunitions used during the conflict from its outbreak to the present day. The majority of evidence in this report was derived from traditional media, social media, non-governmental organisations, and open-source reporting. Additional information was provided by journalists, demining/disarmament specialists, and confidential sources working on the ground in Syria.

The visual data provided in this report was recorded in the ARES *Conflict Materiel (CONMAT) Database* before being assessed and graded following established ARES verification procedures to ensure data quality and source reliability. A variety of criteria informed the initial assessment of the data: the nature and credentials of the material's source; the quality of any imagery; the source and content location; and any available meta-information. Following this process, formal identification (positive identification; PID) of munitions was made, based upon physical features and any visible markings in accordance with ARES standards. Munitions have also been assessed in line with the ARES *Arms & Munitions Classification System (ARCS)* (Jenzen-Jones, 2020). Any necessary caveats or limitations in the PID were noted. Items were then catalogued to include an assessment of the country of origin. Primary and secondary sources were used to ensure reliable and accurate identification of specific cluster munitions and submunitions. Finally, entries were cross-checked for errors and reviewed for accuracy by the authors and contributors in the course of preparing this report, before being subject to peer review by technical specialists, both internal and external to ARES.

A Brief Overview of Cluster Munitions & Submunitions

Sometimes referred to as 'bomblets'[2] (and less commonly as 'grenadelets', 'grenades', or 'minelets'), submunitions are individual munitions contained, delivered, and dispensed either from a cargo (also 'carrier' or 'cluster') munition—such as a fixed dispenser, or a rocket, mortar, or artillery projectile—or directly from an aircraft. There are definitive military advantages to the use of submunitions in warfare. The primary advantages of using cluster munitions as opposed to other munitions are the increased spread of the munitions' effect over a target area and a higher hit probability (Lee, 1982). As such, cluster munitions are typically employed as area-attack or area-denial weapons.[3] The ability to target a wider area with a single munition offers an efficiency benefit, which can allow for more targets to be engaged, increased sortie duration, and can reduce resupply and other logistical burdens. Cluster munitions were first employed by the German military during the Second World War, and their use by conventional military forces peaked during the 1965–75 conflicts in Southeast Asia.[4] Modern designs first entered service in the 1960s, while DPICMs were developed in the early 1970s, offering the ability to more effectively engage both personnel and armoured vehicles (Dullum, 2008). DPICMs disperse submunitions which combine a small shaped charge[5] with a fragmentation jacket or matrix. Efficient design allows for their overall size and weight to be reduced, with the explosive fill of these munitions sometimes weighing as little as 30 g (Halsey & Goad, 1982).

Cargo munitions are either dropped from an aircraft or fired from a ground or naval system towards the target area. At a pre-determined phase of the munition's flight—typically at a pre-determined height above ground—the carrier munition will disperse its submunitions (Jenzen-Jones, 2021). Submunitions include a wide range of munition types, including high explosive (HE), high explosive anti-tank (HEAT), high explosive fragmentation (HE-FRAG), high explosive dual-purpose (HEDP; often referred to as 'dual-purpose improved conventional munitions', or DPICMs,[6] when delivered by cargo munitions),[7] incendiary, and chemical weapons (CW) or biological weapons (BW). The descent of these submunitions is often slowed and/or stabilised using various methods, such as fins, ribbons, ballutes, or parachutes.

Most submunitions must be unarmed while within the delivery vehicle, arming themselves after ejection but before impact. The methods by which this is achieved vary. For example, some less sophisticated submunitions arm themselves by having an internal turbine reach a specific number of rotations per minute while falling through the air, or function by striking the ground with sufficient force. Hence, external factors—such as delivery height and the firmness of the ground at the impact site—can significantly interfere with the arming or functioning processes. Additionally, some submunitions' detonators use compounds that degrade over time, making their functioning less predictable. Unexploded submunitions are very often unsafe, as the arming or firing processes may have been interrupted while in progress, and because it is often challenging to determine the condition of these processes. As such, even the slightest disturbance—including those caused by environmental factors, such as wind, or even the simple passage of time—could cause an unexploded submunition to detonate.

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2 The 2008 Convention on Cluster Munitions (CCM) defines a bomblet as "specifically designed to be dispersed or released from dispensers affixed to aircraft". The term 'bomblet' is nonetheless often used synonymously with 'submunition' in military and humanitarian demining circles.

3 Specialised types may have different, or additional, uses. See, for example: Jenzen-Jones, 2021.

4 For more details, see, for example, the United States Air Force's Theatre History Operations Reports (THOR) database.

5 A shaped charge is an explosive charge shaped in such a way to focus the effect of the explosive's energy. These are often used in combination with thin, sheet-metal warhead 'liners' to create HEAT munitions for use against armoured or otherwise hardened targets (Walters, 2007).

6 The term 'DPICM' is now commonly applied to submunitions themselves, as well as the munitions which carry them.

7 Also called 'HEAT-FRAG' in some cases.

The high failure rates of submunitions—particularly early, less sophisticated submunition designs—and their incorrect employment have resulted in submunitions accounting for a disproportionately high percentage of UXO in several conflicts. For example, the American BLU-26—of which the Soviet ShOAB-0.5, documented in Syria, is a copy—reportedly had an accepted failure rate of 26% even under optimal conditions (Handicap International, 2006). Whilst this has been significantly improved in more modern munitions, a comparatively high dud rate remains a fundamental problem created by the employment of many cluster munitions to this day. Unexploded submunitions remain an ongoing humanitarian problem in several former conflict zones, most notably Laos, Vietnam, Cambodia, Lebanon, and Kosovo—despite all of these conflicts officially ending decades ago.

As of July 2021, 110 states have ratified the Convention on Cluster Munitions (CCM), which bans the stockpiling, use, and transfer of all typical cluster munitions (CCM, 2008). The CCM defines a cluster munition as:

> *"a conventional munition that is designed to disperse or release explosive submunitions each weighing less than 20 kilograms, and includes those explosive submunitions. It does **not** mean the following:*
>
> > *(a) A munition or submunition designed to dispense flares, smoke, pyrotechnics or chaff; or a munition designed exclusively for an air defence role;*
> >
> > *(b) A munition or submunition designed to produce electrical or electronic effects;*
> >
> > *(c) A munition that, in order to avoid indiscriminate area effects and the risks posed by unexploded submunitions, has all of the following characteristics:*
> >
> > > *(i) Each munition contains fewer than ten explosive submunitions;*
> > >
> > > *(ii) Each explosive submunition weighs more than four kilograms;*
> > >
> > > *(iii) Each explosive submunition is designed to detect and engage a single target object;*
> > >
> > > *(iv) Each explosive submunition is equipped with an electronic self-destruction mechanism;*
> > >
> > > *(v) Each explosive submunition is equipped with an electronic self-deactivating feature."*

The CCM further defines the term 'explosive submunition' as:

> *"a conventional munition that in order to perform its task is dispersed or released by a cluster munition and is designed to function by detonating an explosive charge prior to, on or after impact".*

Most of the carrier munitions and submunitions presented in this report fall within these CCM definitions.

Carrier Munitions & Dispensers in Syria

The vast majority of the carrier munitions and dispensers identified in Syria were produced in the former Soviet Union or the Russian Federation. Others, recorded in much smaller numbers, were of Egyptian or Chinese origin. Occasionally, unexploded submunitions were documented whilst still inside their carrier munition or dispenser (collectively 'delivery devices'). This is notable because the delivery device itself can remain a significant explosive hazard in addition to the submunitions themselves—many use explosive components to scatter their payloads. These delivery devices are also key pieces of evidence in conducting arms and munitions investigations, often bearing physical characteristics and markings that can be used to identify the delivery platform, method, contents, likely user, or other important information. The submunitions covered in this report were delivered by one or more of four methods: aerial bombs, dispensers, powered munitions, or projectiles. Submunition delivery devices identified in Syria are summarised in *Table 1.1*.

Table 1.1 — Submunition Delivery Devices Identified in Syria by Model

Aerial Bombs	RBK-250 PTAB-2.5
	RBK-250-275 AO-1SCh
	RBK-500 AO-2.5RT/RTM
	RBK-500 PTAB-1M
	RBK-500 ShOAB-0.5
	RBK-500 ZAB-2.5SM
	RBK-500 SPBE
Fixed Dispensers	KMGU KMGU-2
	BKF AO-2.5RT [8] BKF PTAB-2.5-KO
Rockets	122 mm Sakr
	122 mm GBL212
	220 mm 9M27K1
	300 mm 9M55K
Guided Missiles	9M79K [9]
Mortar Projectiles	3O8
Artillery Gun Projectiles	122 C.P HE/HEAT

Note: *This table lists only those delivery devices confirmed (via PID) in Syria. There are others which have almost certainly been employed.*

8 The BKF AO-2.5RTM is suspected to have been used, but has not been confirmed.

9 Whilst the 9M79K has been confirmed, as has the later *Tochka-U* system, the presence of the updated 9M79-1K missile remains unconfirmed.

Aerial Bombs

One of the primary methods by which submunitions have been employed in the Syrian conflict is air-delivered carrier munitions. The most common of these is the *Razovaya Bombovaya Kasseta* (*Разовая бомбовая кассета*; RBK; 'single-use dispenser bomb') family of aerial bombs, which entered Soviet service in the 1980s (Shirokorad, 1999). The RBK dispenser is made of sheet steel and typically features stencilled markings in black paint across its light-grey body. The body of the dispenser is cylindrical, with suspension lugs following the standard Soviet (and subsequently Russian) spacing of 250 mm (Hewson, 2002). An additional single lug can be seen on the opposite side of some older RBK-series munitions. While all RBK cluster bombs were designed to withstand the substantial g-forces experienced when carried by fast-flying aircraft, they are less aerodynamic in their original configuration than many modern aerial munitions (Jane's Information Group, 2002).

All RBK models feature a threaded fuze well located in the front of the munition that typically accepts an electromechanical time fuze, often an ATK-series fuze. RBK carrier munitions in storage or transit will usually be found with a transit plug in their fuze well; fuzes are typically fitted to the munition by armourers prior to a sortie. The fuze well connects to a chamber containing a low explosive[10] expelling charge (this is also fitted by armourers prior to flight). Once the munition is released from an aircraft, the pre-set time delay of the fuze begins to elapse. Once the delay has elapsed, the fuze functions the expelling charge. The pressure generated by this charge overcomes the safety features within the munition and drives its obturator and central rod assembly rearward. This, in turn, drives a baseplate which causes the RBK's tail unit to release. Much of the pressure is then expelled into the conical nose unit, putting pressure on the bulkhead and pushing the payload and tail assembly rearward. The tail is finally expelled by the airstream. Once the tail assembly—which is connected to the body of the dispenser by a central hollow steel rod—has separated, the submunitions disperse in an uncontrolled pattern. This mechanism is a known cause of failure for RBK-series munitions within Syria, with tail assemblies sometimes failing to properly separate.[11] It should be assumed that complete RBK dispensers found on the ground with a tail-retaining nut in the centre of the tail still contain a cargo of submunitions, as well as the low explosive expelling charge inside the nose section. Some footage of employed, but unexploded, RBK-250 munitions in Syria show the munition's conical nose, its connecting rod, and its bulkhead intact. In some cases, the coupling with the tail unit is still in place (ARES, n.d.(a); HRW, 2012a; HRW, 2012b).

RBK-series munitions are divided into 250 kg and 500 kg nominal weight classes, as indicated by a munition's designation. For example, the RBK-500 series of aerial bomb models have a nominal weight of 500 kg; although, in practice, this varies slightly from model to model. The RBK-500 PTAB-1M, for example, has an actual weight of 427 kg (Spasskiy, 2006). Where the actual weight deviates significantly from the nominal weight class, a second figure is sometimes given. The RBK-250-275 AO-1SCh, for example, weighs 273 kg (ARES, n.d.(b)). To accommodate different submunitions, individual RBK cluster bombs differ slightly in their external and internal dimensions as well as in their interior configuration. This is referenced in the name of the cluster bomb by adding the name of the carried submunitions after the munition's weight designation. For example, the RBK-250 series munition which carries the AO-2.5RT submunition is designated the 'RBK 250-275 AO-2.5RT', indicating the munition's nominal weight class (250 kg), actual weight class (approximately 275 kg), and the fact that it is loaded with AO-2.5RT submunitions (Shirokorad, 1999; ARES, n.d.(b)).

10 Low explosives burn very rapidly, but the resultant gas expansion is subsonic (as opposed to supersonic, as in high explosives) (McDonough, 2017). Low explosives are used in many types of carrier munitions to expel submunitions.

11 One plausible cause for this could be the degradation of the low explosive black powder charges, possibly as a result of prolonged and/or improper storage in hot climates.

Figure 1.1 *An RBK-250 PTAB 2.5M on a Lybian Mig-23. Date 2015 (source: aerohisto.blogspot.com).*

The RBK-250 ZAB-2.5 differs from other RBK-250 series dispensers not only in the munitions it loads but also in its outer dimensions. The *Zazhigatel'naya Aviatsionnaya Bomba* (Зажигательная авиационная бомба; ZAB; 'incendiary aircraft bomb') series of weapons includes both cluster munitions as well as a range of unitary incendiary bombs. The RBK-250 ZAB-2.5 contains three different variations of ZAB-2.5 submunitions (Jenzen-Jones, 2012c). The dispersion of these submunitions is achieved by the fuze igniting a central burster tube containing low explosives. Visually, the dispenser is distinguished from other RBK-250-series munitions by its relatively flat nose and fixed tail. The bomb casing typically bears a single red line marking, indicating an incendiary payload. Additionally, the RBK-250 ZAB 2.5 is the shortest of the RBK-series aerial bombs at just 1,490 mm in length (Jenzen-Jones, 2012c; Hewson, 2002).

Figure 1.2 *An RBK-250 ZAB-2.5 in Peru (source: Colin King/Fenix Insight).*

The larger cousin of the RBK-250, the RBK-500 is approximately 1,950 mm long (1,500 mm without nose cone), with a body diameter of 450 mm, a wingspan diameter of 570 mm, and an unloaded weight of 334 kg (Babkin et al., 2008). Like its smaller counterpart, the RBK-500's internal configuration varies in order to accommodate different payloads, again indicated by the submunition designation being included after the bomb's nominal weight (e.g., 'RBK-500 SPBE' would indicate that the payload is the SPBE sensor-fuzed anti-tank submunition). A modernised variant of the RBK-500, the RBK-500U, has also been employed in Syria (Fulmer, 2015b). The RBK-500U is a modernised base-ejection, parachute-retarded cluster munition, capable of delivering a variety of submunitions, including the AO-2.5RT and AO-2.5RTM.

Figure 1.3 *An RBK-500 AO-2.5RT aerial bomb fitted to a Russian aircraft (source: Russian social media via ARES CONMAT Database).*

Dispensers

The Soviet/Russian *Konteyner Malogabaritnykh Gruzov Universalnyi* (контейнер малогабаритных грузов универсальный; KMGU*;* ‘universal small-size cargo container’) series of dispensers has also been used to deliver submunitions in Syria. KMGU dispensers, whilst also carried by aircraft, utilise a different dispersion method than that of RBK-series aerial bombs—the KMGU is a dispenser that remains with the aircraft, whereas aerial bombs such as the RBK are released from it. Outwardly, the conical nose of the KMGU is sharper in profile than that of the RBK-series munitions, and the fins on the tail unit, while also rectangular, are smaller. KMGU-series dispensers are noticeably longer than those of the RBK aerial bombs, at 3.7 m in length (KMGU-2)—compared to less than 2 m for the RBK-500. The KMGU casing is made of aluminium and is therefore relatively light, at 170 kg when unloaded (Kulyasov, 2010). As with RBK-series munitions, the suspension lugs have the standard Soviet spacing of 250 mm (Hewson, 2002).

Figure 1.4 *An improved KMGU dispenser in front of a Mil Mi-24 attack helicopter (source: Karl-Heinz Feller).*

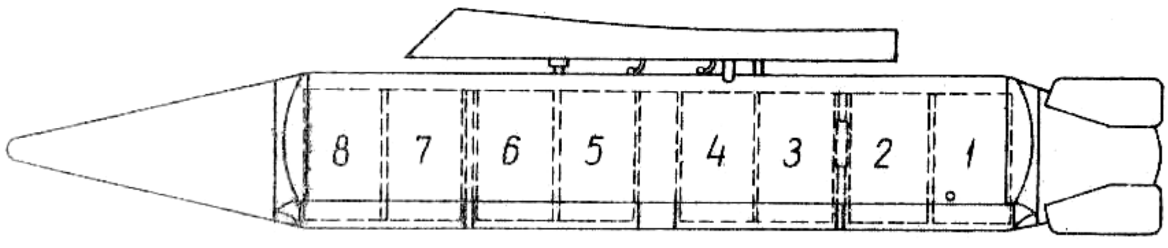


Figure 1.5 *A diagram indicating the order in which cassettes are activated and their position (source:USSR Ministry of Defence).*

KMGU series munitions contain eight cargo compartments, each fitted with a rotating door controlled by a pneumatic actuator.[12] A compressed air cylinder is used to eject the payload. Submunitions used with the KMGU, such as the AO-2.5RT and PTAB-2.5KO, are stacked in expendable *Blokakh Konteynernykh dlya Frontovoy aviatsii* (блоках контейнерных для фронтовой авиации; BKF; 'container blocks for frontline aviation') cassettes. On deployment, the pilot initiates the pneumatic actuator, which opens the doors of the KMGU dispenser. An air cylinder then inflates airbags which expand to eject the cargo. An automated system allows for release intervals between each cassette of 0.05, 0.2, 1.0, or 1.5 seconds. If intact BKF cassettes containing submunitions are found, they likely contain a small low explosive expulsion charge below the cable connecting the prominent connector unit on the side of the casing (Kulyasov, 2010).

Powered Munitions

Powered munitions—that is, rockets and missiles—have also been used to deliver submunitions in Syria. Rockets employed to dispense submunitions in Syria have ranged in size from 122 mm 'Grad' types to much larger 220 mm and 300 mm examples, as well as the *Tochka* ballistic missile. One example of the 122 mm variety is the Egyptian Sakr family of rockets, which have been used to deliver Egyptian Sakr Type B submunitions. This family of 122 mm rockets is designed for use with the Russian BM-21 multiple rocket launcher and other 122 mm systems such as the Chinese Type 81 SPRL or Egyptian RL-21 and RC-21 launch vehicles. These surface-to-surface multiple-barrel rocket launchers (MBRLs) are not designed for precise fires, instead targeting wide areas; this effect is, of course, even more pronounced when these systems fire submunition-dispensing rockets. Sakr 122 mm rockets contain HE, leaflet, or submunition payloads and come in four different lengths: Sakr-10, Sakr-18, Sakr-36, and Sakr-45. However, Sakr 122 mm cargo rockets only come in -18, -36, and -45 varieties, with effective ranges of 17, 31, and 42 kilometres, respectively. Sakr-18 and Sakr-45 rockets each contain 72 Sakr Type B submunitions, while Sakr-36 rockets contain 98. A mechanical time fuze ejects the submunitions from the carrier rocket (believed to occur at approximately 700 m above ground) (Jenzen-Jones, 2013b). Open-source footage, along with verified images from within Syria, supports the assertion that these rockets were manufactured in Egypt. One example shows rocket remnants bearing Egyptian Arab Organization for Industrialisation (AOI) markings found alongside a Sakr Type B submunitions (تنسيقية اللطامنة, 2013).

Figure 1.6 *9M218 cargo rocket with anti-tank submunitions. Representative of the general layout of 122mm cargo rockets (source: missilery.info).*

Additionally, the Chinese GBL212 122 mm rocket (export versions have been marked as the '122-15 ATML') was documented deploying Type 84 scatterable anti-tank mine systems in 2014. The 122 mm rockets can also be fired from BM-21 'Grad' multiple-barrel rocket launcher (MBRL) and its copies and variants. Each rocket has a length of 2.86 mm, weighs 63.26 kg, and can carry six Type 84 anti-tank mines (each weighing 3.13 kg) (Jenzen-Jones & Lyamin, 2014b).[13] After the launch of the rocket, a time fuze is triggered at a predetermined distance and the rocket's warhead bursts to expel the mines, which make a controlled descent using drogue parachutes.

12 A pneumatic actuator is a device that converts the energy of compressed air into mechanical motion.

13 Some sources state that GBL212 rockets carry eight mines, instead of the six as documented by ARES.

Larger rockets have also been documented delivering submunitions in Syria. One example is the 300 mm 9M55K cargo rocket, fired by the 9K58 *Smerch* (Смерч; 'Tornado') MBRL. The 9K58 MBRL system was originally designed in the USSR and can fire several different rockets, including cargo rockets deploying submunitions. The 9M55K cargo rocket with 9N235 fragmentation submunitions is designed to engage concentrations of infantry and light vehicles in open terrain or light cover by dispersing submunitions over an area of 40 hectares (Jenzen-Jones, 2014; Dullum, 2010). This model is identifiable by its distinct nose cone and bursting charge components (Jenzen-Jones, 2014a). When carrying 9N235 fragmentation submunitions, the rocket has a range of 20 to 70 km and can deliver 72 submunitions. The rocket weighs 800 kg (243 kg of which is the warhead) and measures 7,600 mm in length (2049 mm of which is the warhead) (Jenzen-Jones & Lyamin, 2014a).

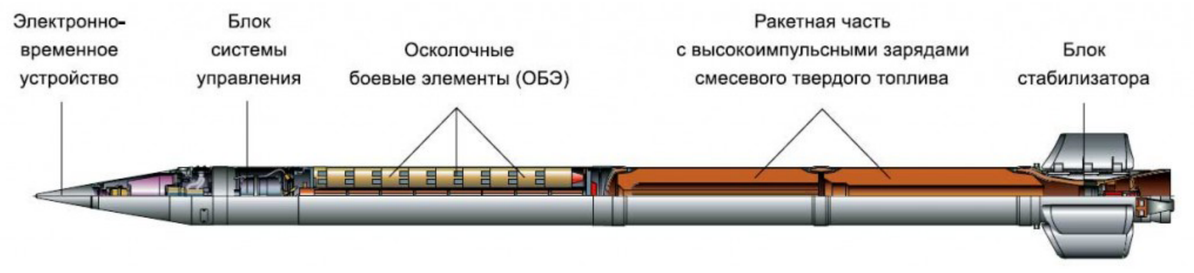


Figure 1.7 *9M55K cargo rocket with 9N235 fragmentation submunitions (source: missilery.info).*

The 220 mm 9M27K1 cargo rocket for the 9K57 *Uragan* (Ураган; 'Hurricane') MBRL has also been documented. When the cargo rocket carries 9N210 fragmentation submunitions (which are outwardly identical to 9N235), it has a range of between 10 to 35 km and can deliver 30 submunitions (Jenzen-Jones & Senft, 2022a). The rocket weighs 270 kg (90 kg of which is the warhead) and measures 5178 mm in length (Smallwood & Lyamin, 2014). Like the larger 300 mm 9M55K cargo rocket, the 9M27K1 cargo rocket is designed to engage concentrations of infantry and light armoured vehicles in open terrain or light cover.

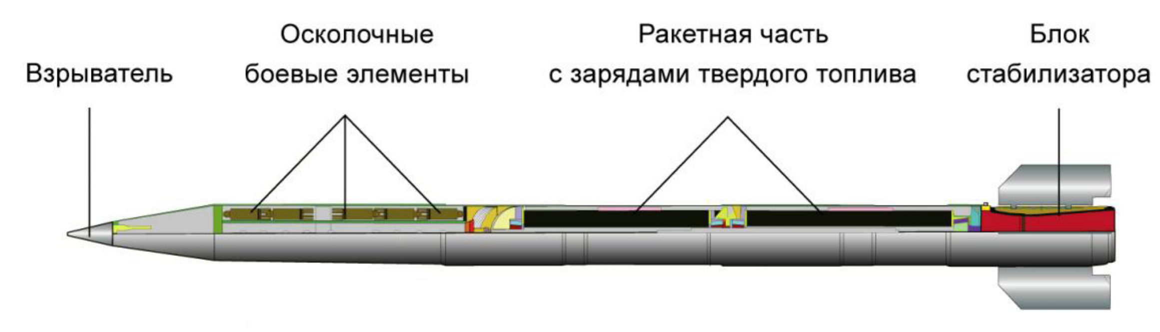


Figure 1.8 *9M27K cargo rocket with 9N210 fragmentation submunitions (source: missilery.info).*

Missiles fired by the 9K79 *Tochka* (Точка; 'point') tactical ballistic missile launcher have also been identified as a delivery munition for submunitions in Syria. The 9K79 Tochka is also referred to as the OTR-21 (OTR: оперативно-тактический ракетный комплекс, or 'Tactical-operational Missile Complex'), or by its NATO reporting name, the SS-21 Scarab. This Soviet-produced system has a maximum range of 70 km or 120 km in its updated version, the 9K79-1 Tochka-U (Scarab-B), introduced in the 1980s. Syria is thought to possess both iterations, having received its first deliveries of the earlier 9K79 (Scarab-A) systems from the USSR in

1983 (Jenzen-Jones, 2013a). Each iteration of the 9K79 Tochka has two missile variants: the 9M79F series with a 9N123F high explosive conventional warhead, and the 9M79K series, with a 9N123K cargo warhead. The 9N123K cargo warhead is designed to function at an altitude of 2,250 m, using a low explosive burster charge to scatter 50 9N24 HE-FRAG submunitions over the target area. The delivery of 9N24 submunitions via the 9N123K cargo warhead was first widely publicised in May 2018 (Jenzen-Jones & Lyamin, 2018).

Figure 1.9 *9K79-1 "Tochka-U" tactical ballistic missile and mockup of its cluster warhead with 9N24 submunitions (source: Sputnik; missilery.info).*

Projectiles

In addition to powered munitions, both mortar projectiles and artillery gun projectiles have been used to deliver submunitions in the course of the Syrian conflict. Cargo projectiles typically have relatively small payload capacity compared to other delivery mechanisms, although this is offset somewhat by the use of large-calibre munitions. Since late October 2015, for example, remnants of 240 mm 3O8 *Nerpa* ('cargo') rocket-assisted cargo projectiles delivering O-10 submunitions have been documented in Syria. The 3O8 cargo projectile was designed in the Soviet Union in the late 1970s and introduced into Soviet military service in 1983. It can deliver 14 O-10 submunitions and can be fired from the self-propelled 2S4 *Tyulpan* heavy mortar system and the towed M-240 mortar system. In the case of Syria, 3O8 cargo projectiles were highly likely to have been fired from the latter system. Syrian government forces have used towed 240 mm M-240 mortars in the civil war since 2012; however, until late 2015, only 53-F-864 HE projectiles were documented as having been fired from them. In some pictures showing 3O8 cargo projectiles, their remnants display the markings '3-O-9'. It is believed this designation refers specifically to the cargo warhead of the munition, while the 3O8 designation refers to the entire munition, including rocket motor and loaded submunitions (Lyamin & Jenzen-Jones, 2015). When the 3O8 projectile is fitted with a V-120E fuze, 4BN56 propellant charge, and 3Ch20 braking device (if desired), the complete round is designated the 3VO11. The distinctive 3Ch20 braking device ('brake ring') used with 240 mm rocket-assisted projectiles can be seen on the tip of the round lying in the foreground in *Figure 1.10*. The 3Ch20 is used to reduce the overall range of the projectile (Jenzen-Jones & Lyamin, 2015a).

Figure 1.10 *A 3-O-8 Nerpa mortar projectile being loaded into a 2S4 Tyulpan self-propelled mortar (source: Russian social media via ARES CONMAT Database).*

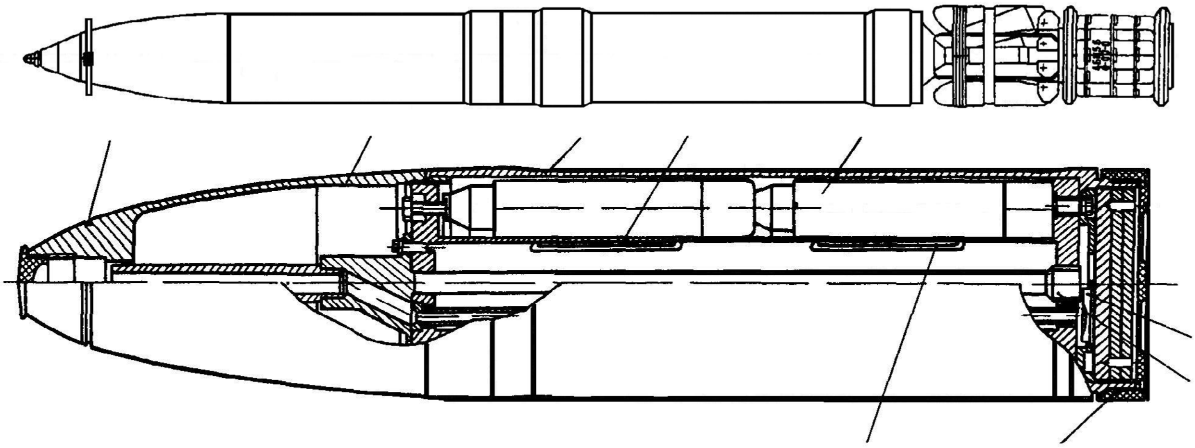


Figure 1.11 *Top: Technical diagram of the entire 3VO11 round; Bottom: Technical diagram of the 3-O-9 cluster warhead of the mortar projectile, loaded with o-10 submunitions. Note that the warhead is part of the entire 3VO11 round (Source: Soviet-Ammo.ru and USSR Ministry of Defence).*

Submunitions in Syria have also been delivered by artillery projectiles. Specifically, the employment of Chinese ZP39A submunitions has been connected to fired 122 mm cargo projectiles on several occasions. These projectiles are almost certainly of Chinese manufacture and are marked "122 C.P HE/HEAT", indicating a DPICM-type loading (ARES,n.d.(a); Ansar Alhaq, 2013). Based on an assessment of known Chinese cargo projectiles, it is estimated that the 122 C.P HE/HEAT projectile likely carries 33 submunitions of 39.2 mm diameter.

Figure 1.12 *122 mm carrier artillery projectiles loaded with ZP39A submunitons (source: ARES CONMAT).*

Submunitions Identified in Syria

AO-1SCh

The AO-1SCh (*Aviatsionnaya Oskolochnaya*; 'aviation fragmentation bomb'; sometimes stylised as *AO-1CЧ* or *AO-1STsh*) is a Russian-designed, anti-personnel HE-FRAG submunition. The first documented use of AO-1SCh submunitions in Syria occurred in July 2012, in a mountainous region outside of Hama city (HRW, 2012a). After a reported aerial bombardment in the area, two videos uploaded to YouTube displayed numerous unexploded AO-1SCh submunitions and the remnants of its delivery munition, which was identified as an RBK-250 series cluster bomb (ARES, n.d.(a)).

Figure 2.1 *An AO-1SCh submunition (source: Russian Social Media via ARES CONMAT Database).*

The AO-1SCh submunition is cylindrical in shape with four tail fins and a strengthening ring aerofoil at the rear. With a total weight of 1.2 kg, each submunition contains 38 g of A-IX-2 explosive compound (73% RDX, 23% aluminium powder, 4% wax) and is fitted with an AM-A B/V direct impact fuze. A metal-foil closure disc covers the AM-A B/V fuze, while a membrane holds the firing pin in place. Upon impact, the closure disc and firing pin retainer are crushed, and the firing pin is driven into the detonator. There is no creep/compression spring or detent to act as a holding device, only a firing pin retainer and a firing pin guide. For this reason, the AO-1SCh is sometimes described as armed prior to deployment. Due to the nature of its fuzing, which causes the submunitions to detonate on impact regardless of delivery height, it is unlikely that the high failure rate evident with the AO-1SCh in Syria is the result of deployment errors or inadequate fuze-setting. Rather, failure more likely results from the degradation of the mercury fulminate within the submunition's detonator (Jenzen-Jones, 2012b). Mercury fulminate is known to degrade over time, leading to AO-1SCh submunitions becoming "more insensitive to impact" and decreasing its "chance of successful detonation" (RRMA, 2012). As most AO-1SCh examples documented in Syria bear markings indicating they were manufactured in the 1970s, it is very possible that the inevitable degradation within the submunition over four decades has increased AO-1SCh dud rates.

Figure 2.2 *Unexploded AO-1SCh submunitions identified in Maarrat al-Numan, Idlib, with a pen for scale. The markings on the left-hand submunition indicate factory number, lot number, and year of production. Markings on the right-hand submunition read "A-IX-2", designating the explosive fill (source: Syrian social media via ARES CONMAT Database).*

AO-1SCh submunitions are delivered by the RBK family of dispensers, with the assembled RBK-250-series munition designated the 'RBK-250-275 AO-1SCh'. This aerial bomb measures 2,135 mm in length, 325 mm in body diameter, and has a tail fin diameter of 407 mm. It carries 140 submunitions and when fully assembled weighs 265 kg (Morozova & Kharitonov, 1975). As with most finned submunitions, if deployed correctly, the strike pattern (i.e., the density of impacts) is likely to be relatively tight. Notably, footage from Syria suggests these bomblets have been routinely harvested for their explosive content to produce crude improvised hand grenades (see ***Repurposed Submunitions***, p. 78).

AO-1SCh Technical Characteristics

Length: 153–158mm
Diameter: 49 mm (body); 60 mm (tail fins)
Weight: 1.2 kg
Explosive weight: 38 g
Explosive composition: A-IX-2 (73% RDX, 23% aluminium powder, 4% wax)
Fuze: AM-A B/V direct impact

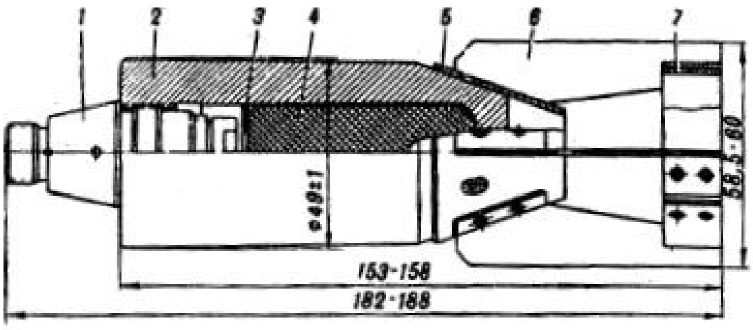


Figure 2.3 *Technical diagram of an AO-1Sch submunition (source: USSR Ministry of Defence).*

RBK-250-275 AO-1SCh Technical Characteristics

Length: 2,135 mm
Diameter: 325 mm
Weight: 265 kg
Number of submunitions: 140

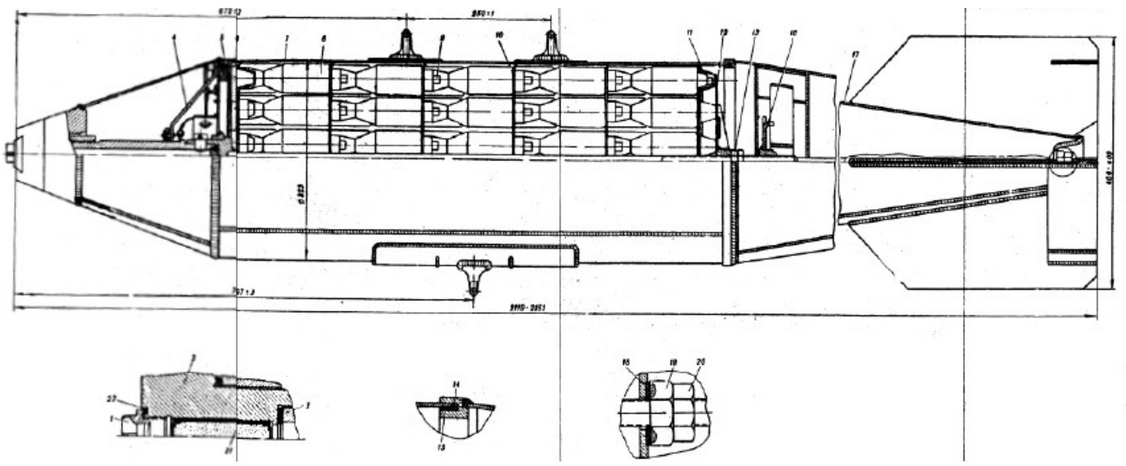


Figure 2.4 *Technical diagram of an RBK-250-275 AO-1SCh (source: USSR Ministry of Defence).*

9N235

The Russian-made 9N235 (9H235) HE-FRAG submunition was first documented in Syria in mid-February 2014. Videos shot near the town of Kafr Zita in the north of Syria's Hama Governorate show both the unexploded submunition and remnants of its 9M55K carrier munition (Monkeeth Alkhabour, 2014; ARES, n.d. (a)). Each submunition consists of a 263 mm long cylinder with six spring open fins, with a body 65 mm in diameter which contains two sizes of preformed fragments of chopped steel rod (Jenzen-Jones & Lyamin, 2014a). It is designed to engage both personnel and unarmoured vehicles in open terrain or light cover. The submunition's explosive charge contains 312 g of what is believed to be A-IX-10 (95% RDX and 5% paraffin wax) (Tsonev, et al., 2018; Jenzen-Jones & Senft, 2022a). The 9N235 utilises a 9E272 impact fuze, which is paired with a self-destruct mechanism that should initiate detonation between 110 seconds and 120 seconds after ejection from its cargo rocket delivery munition (SPLAV, n.d.; Spassky, 1997).

Figure 2.5 *A 9N235 submunition (source: UNDP).*

The munition pictured in *Figure 2.6* relates to an incident in which 9N235 submunitions were delivered via the 300 mm 9M55K cargo rocket, fired by the 9K58 *Smerch* (Смерч*;* 'Tornado') MBRL (Jenzen-Jones & Lyamin, 2014a). The 220 mm 9M27K1 cargo rocket for the 9K57 *Uragan* (Ураган; 'Hurricane') MBRL can carry the 9N235 submunition as well. As with many other cluster munition systems, incorrect employment (such as insufficient ejection height) can increase the dud rate of the munition. Incorrect deployment by inexperienced artillery units was a primary cause of the high failure rates of these munitions witnessed in Georgia in 2008, and it is possible that the same is true in Syria today.[14]

Figure 2.6 *An unexploded 9N235 submunition recovered near Kafr Zita, Hama Governorate, in February 2014 (source: Syrian social media via ARES CONMAT Database).*

14 Author interview with clearance staff deployed to Georgia in 2008.

Figure 2.7 *A composite picture showing remains of the 9M55K cargo rocket which delivered 9N235 submunitions near Kafr Zita, Hama Governorate, in February 2014 (source: Eliot Higgins).*

9N235 Technical Characteristics

Length: 263 mm
Diameter: 65 mm
Weight: 1.75 kg
Explosive weight: 312 g
Explosive composition: A-IX-10
Pre-formed fragments: 96 × 4.5 g; 360 × 0.75 g
Fuze: 9E272 (impact)

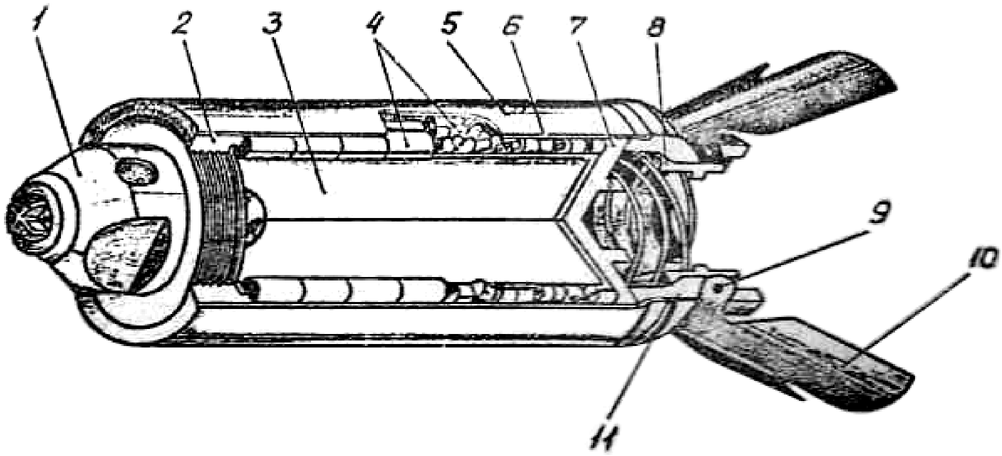


Figure 2.8 *Technical diagram of an 9N235 submunition. Note the different sized pre-formed fragments in the rear of the munition (source: USSR Ministry of Defence).*

9N210

The 9N210 (9H210), like the 9N235, is a HE-FRAG submunition, first documented in the Daraa Governorate in 2014. YouTube videos show the remnants of a 220 mm 9M27K-series cargo rocket within the southern Syrian governorate of Daraa, which, depending on its model (9M27K1 or 9M27K) could have been carrying either 9N235 or 9N210 submunitions (Jenzen-Jones, 2014; ARES, 2020). The 9N210 submunition is designed to engage personnel and unarmoured vehicles in open terrain or light cover. While externally identical, the 9N210 differs from the 9N235 primarily in that it contains 370 to 400 preformed fragments of chopped steel rod of 2 g each, instead of two different sizes of fragments (Lyamin & Smallwood, 2014). Outwardly, the two can only be differentiated by the markings on the submunition's body (Jenzen-Jones & Senft, 2022c). The 9N210 is fitted with either the 9E246 or 9E246M fuze. The 9E246M fuze features a self-destruct mechanism that is designed to function 60 seconds after the submunition's ejection from the cargo rocket (Jenzen-Jones & Senft, 2022c). Conversely, the 9E246 does not feature a self-destruct mechanism (Baranovsky, 1996).

Figure 2.9 *A 9N210 submunition (source: Wikimedia Commons).*

9N210 Technical Characteristics[15]

Length: 263 mm
Diameter: 65 mm
Weight: 1.80 kg
Explosive weight: 300 g
Explosive composition: A-IX-10
Pre-formed fragments: 370–400 x 2 g.
Fuze: 9E246 or 9E246M

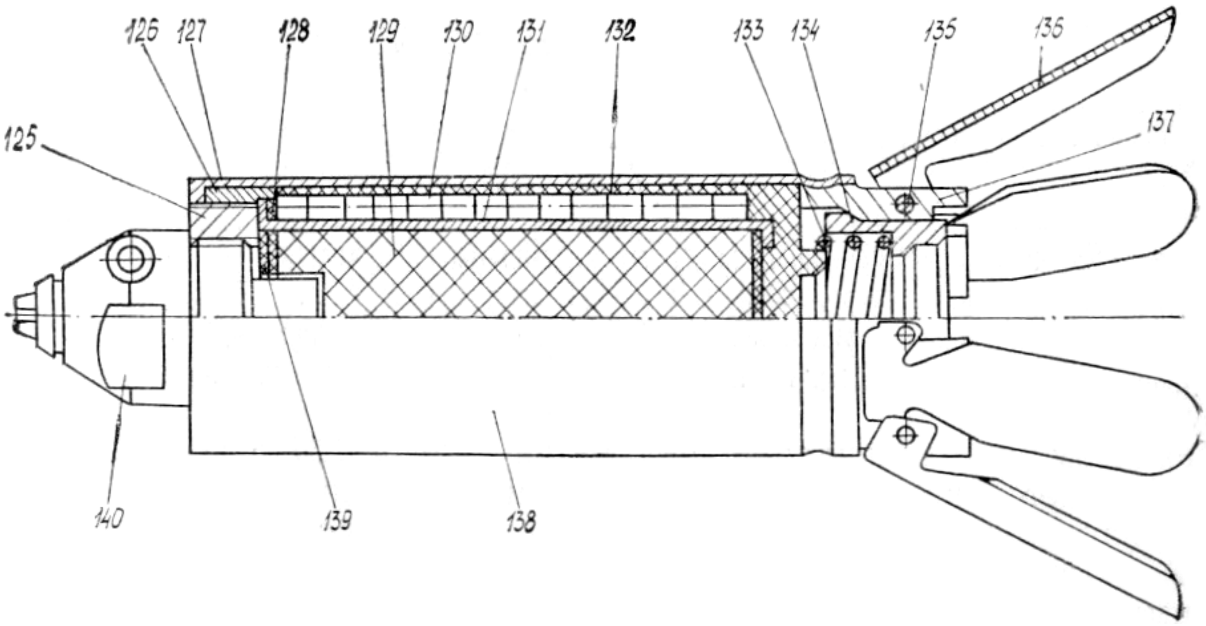


Figure 2.10 *Technical diagram of an 9N210 submunition. Note the uniform pre-formed fragments in the munition (source: USSR Ministry of Defence).*

15 Information from Jenzen-Jones & Senft, 2022c.

9M27 Rocket with 9N128K Warhead Technical Characteristics

Length: 4,832 mm
Weight: 280 kg
Calibre: 220 mm
Fired by: 9K57 Urgan MBRL
Number of submunitions: 30

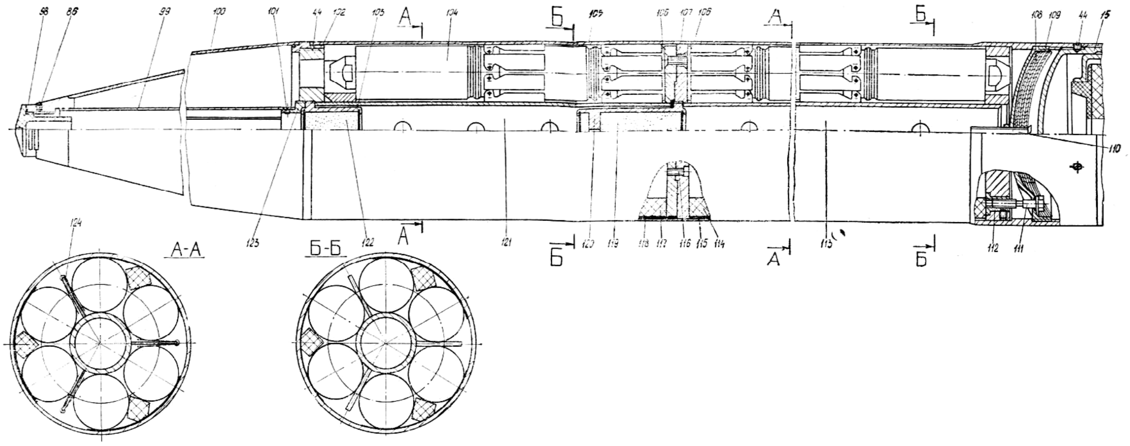


Figure 2.11 *Technical diagram of a 9N128K warhead containing 9N210 submunitions (source: USSR Ministry of Defence).*

9N24

The Soviet-designed 9N24 (9H24) submunition is a 7.45 kg HE-FRAG submunition encased in a pre-fragmented ring, generating approximately 316 fragments (of 7 g each) by way of a 1.45 kg explosive payload. This submunition was first identified during the Syrian conflict in the As-Suwayda Governorate in May 2018 (Jenzen-Jones & Lyamin, 2018). The 9N24 appears to have been delivered in Syria via a 9K79 Tochka tactical missile (using a 9N123K cargo warhead). This submunition utilises the 9E237 impact fuze, which arms as the submunitions are expelled from the warhead. The fuze is designed to function on impact with the ground or other obstacles, at any angle between 25 to 90 degrees (Jenzen-Jones, Lyamin, 2018). This fuze also features a self-destruct function, which should ensure the submunition explodes 32–60 seconds after it is deployed from the cargo warhead. In the example from As-Suwayda, the missile and/or the cargo warhead appear to have suffered a failure, causing the 9N24 submunitions to be dispersed without arming or triggering their self-destruct mechanisms. According to the markings visible on recovered examples (see *Figure 2.12*), these submunitions were produced in 1988.

Figure 2.12 *A 9N24 submunition (source: Ukraine Ministry of Defence).*

Figure 2.13 *Remnants of multiple 9N24 submunitions in As-Suwayda governorate, in May 2018 (source: Syrian social media via ARES CONMAT Database).*

9N24 Technical Characteristics

Weight: 7.45 kg
Explosive weight: 1.45 kg
Explosive composition: A-IX-2
Approximate number of fragments: 316
Average fragment weight: 7 g

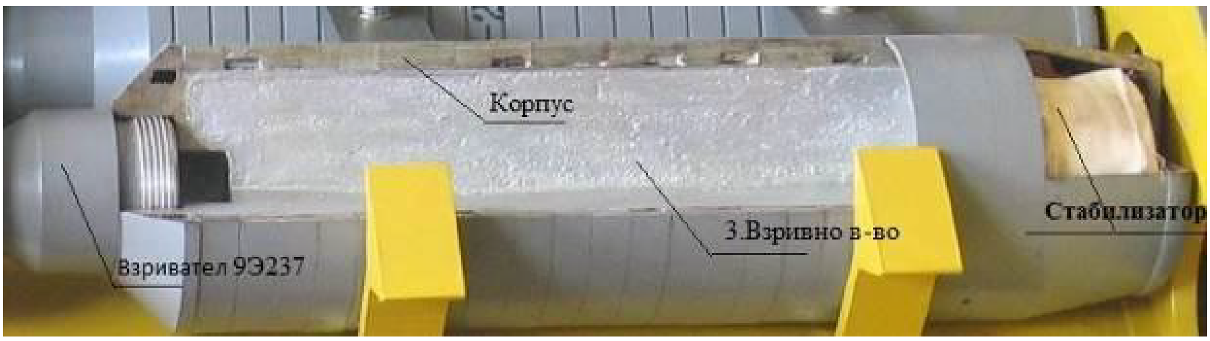


Figure 2.14 *A cutaway model of an 9N24 submunition (source: Convention on Cluster Munitions).*

O-10

The Soviet developed O-10 is an HE-FRAG submunition, first documented in Syria in October 2015, near Damascus. Relatively little is known about this submunition, but it appears to be designed to target personnel and unarmoured, or lightly, armoured vehicles. O-10 submunitions weigh 3.9 kg and contain 640 g of A-IX-2, an explosive composition consisting of 73% RDX, 23% aluminium powder, and 4% wax as a phlegmatiser. The submunitions are fitted with one of four PS-69 series parachute systems, which are employed by various Soviet and Russian munitions.

Figure 2.15 *An O-10 submunition (source: Syrian Media via ARES CONMAT Database).*

The O-10 submunition is delivered by the 3O8 *Nerpa* (Нерпа; 'Seal') cargo projectile, a rocket-assisted 240 mm mortar projectile which contains 14 O-10 submunitions. Such projectiles can be fired from self-propelled 2S4 Tyulpan systems and towed M-240 mortar systems. Syrian government forces have used 240 mm towed M-240 mortars in war since 2012, suggesting that these weapons are the most likely delivery system for the O-10 in Syria. Between late October and mid-December 2015, remnants of 240 mm 3O8 Nerpa rocket-assisted cargo projectiles and O-10 submunitions were documented in the militant-controlled suburbs of Damascus. This was the first confirmed use of the O-10 submunition in any combat zone, despite persistent rumours of their use in Chechnya in 2000. 240 mm mortars are relatively rare and have been used in comparatively few conflicts since the 3O8 cargo rocket with O-10 submunitions entered Soviet military service in 1983. Markings indicate that, in at least one instance in Syria, both the rocket motor and the submunitions were produced in 1989.

Figure 2.16 *An unexploded O-10 submunition reportedly photographed in Douma, Rif Dimashq Governorate, in January 2016 (source: Syrian social media via ARES CONMAT Database).*

Figure 2.17 *3VO11 with 3Ch20 braking device, reportedly photographed in Damascus, Damascus Governorate, in November 2015 (source: Syrian social media via ARES CONMAT Database).*

O-10 Technical Characteristics

Total weight: 3.9 kg
Explosive weight: 640 g
Explosive composition: A-IX-2

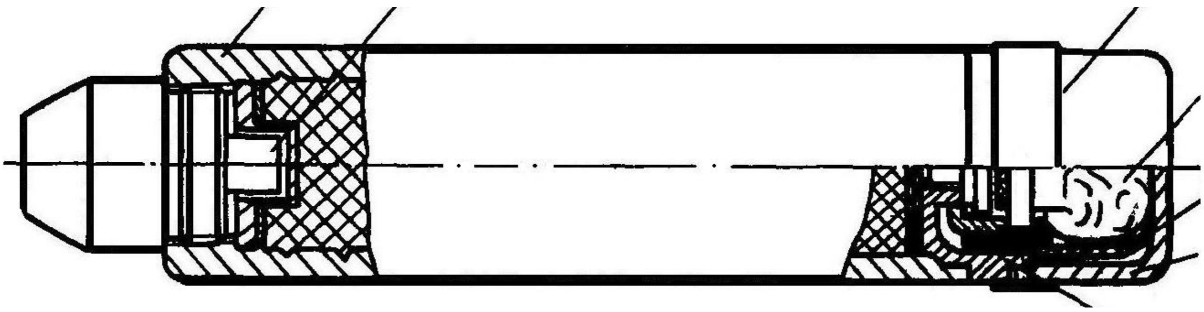


Figure 2.18 *Technical diagram of an O-10 submunition (source: USSR Ministry of Defence).*

308 Nerpa Technical Characteristics

Total weight: 280 kg
Calibre: 240 mm
Fired by: 2S4 Tyulpan systems and towed M-240 mortar systems
Number of submunitions: 14

ShOAB-0.5

The ShOAB-0.5 (ШОАБ-0,5; *Sharikovaya Oskolochnaya Aviatsionnaya Bomba*; 'spherical fragmentation aircraft bomb') is a Russian-made, anti-personnel HE-FRAG submunition. Its remnants were first documented and identified in Syria in early March 2013 (Brown Moses, 2013a). The ShOAB-0.5 is believed to be a direct copy of the American BLU-26, which the Soviets would have been able to acquire from their allies in Southeast Asia during the 1960s and 1970s. Its spherical aluminium casing, 64 mm in diameter, contains approximately 304 steel balls for fragmentation (USSR, 1973). A core of 85 grams of TG-30 explosive compound (30% TNT, 70% RDX) encases a fuze which is likely a direct copy of the US M219 or M219E1. This is an 'all-ways acting' fuze, meaning it should detonate regardless of the impact angle. Each submunition weighs approximately 417 grams (Jenzen-Jones, 2013a). Since the fuze is encased in the centre of the munition, it is better protected from corrosion than external fuzes on other submunitions, meaning it often remains a viable UXO for longer. For example, BLU-26s, dropped in large numbers during the Vietnam War in the 1960s, remain a real threat today in places like Vietnam, Laos, and parts of Cambodia (Jenzen-Jones, 2012a; Reuters, 2016). Between 1969 and 1973, it is estimated that the U.S. Air Force dropped 10.4 million BLU-26 submunitions on Cambodia alone. Due to difficulties penetrating Cambodia's thick tree canopy, as well as user error, it is now assumed that around 30% of BLU-26s failed to detonate (Handicap International, 2006). Similar issues have also been documented in Laos (Reuters, 2016). In the case of Syria, freshly irrigated fields may also limit detonation.

Figure 2.19 *A ShOAB-0.5 submunition (source: reibert.info).*

The ShOAB-0.5 is dispensed from the RBK-500 ShOAB-0.5. Each full cluster bomb contains around 565 submunitions (+/- five pieces). Assembled, these cluster bombs are 1,950 mm long (1,500 mm without nose cone), have a body diameter of 450 mm and wingspan diameter of 570 mm, and weigh 334 kg (Babkin et al., 2008). The bomb contains a central bursting charge for dispersing its payload and is designed to scatter submunitions over a wide area. The strike footprint of the RBK-500 ShOAB-0.5 can be approximated by examining date for the CBU-24[16] strike footprint, which indicates areas of around one hectare. This is significantly less than some official estimates indicating an exclusion area to provide a margin of safety for ground troops. When employed at sufficient altitude, it is likely that some of the submunitions dispersed by the RBK-500 ShOAB-0.5 migrate away from the point of aim and form a doughnut pattern on the ground. This phenomenon was widely noted by pilots deploying CBU-24 cluster munitions during both the conflict in Southeast Asia in the 1960s–70s and the 1973 Yom Kippur War (Evans, 2014).

16 The CBU-24 is the U.S. cluster bomb that dispensed BLU-26 submunitions, making it a good reference point for the ShoAB-0.5.

Figure 2.20 *Unexploded ShOAB-0.5 submunitions in Heish, Idlib Governorate , in May 2013. If found intact, these munitions should still be considered armed and are extremely dangerous to handle (source: Syrian social media via ARES CONMAT Database).*

Figure 2.21 *A Syrian displays remnants from the body of a ShOAB-0.5 submunition in March 2013, with steel balls used as fragmentation visible (source: Syrian social media via ARES CONMAT Database).*

Figure 2.22 *The remains of a cluster bomb in Homs, Homs Governorate, in April 2013. The markings on the side are translated as "RBK-500 ShOAB-0.5" and underneath "TG-30", indicating the explosive compound within the submunitions (source: Syrian social media via ARES CONMAT Database).*

ShOAB-0.5 Technical Characteristics

Diameter: 64 mm
Weight: 454 g
Explosive weight: 85 g
Explosive composition: TG-30 (30% TNT, 70% RDX)
Fuze: AV-281

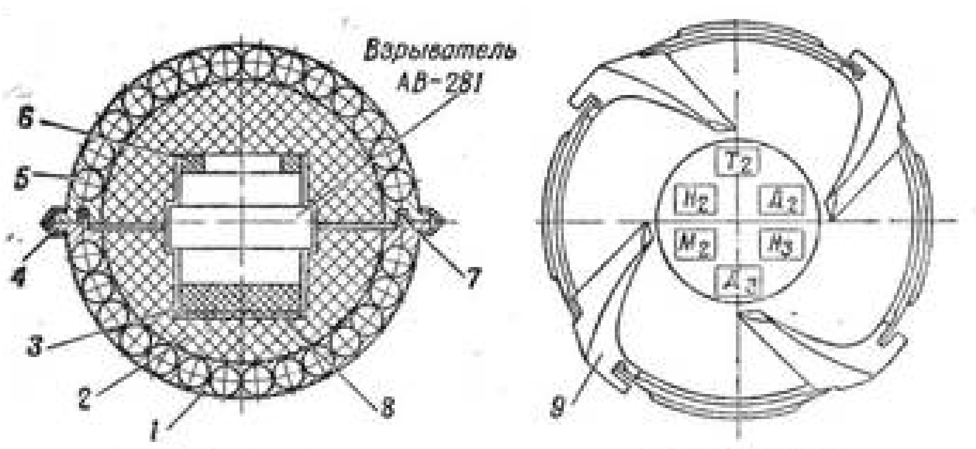


Figure 2.23 *A technical diagram, with a cutaway, of the ShOAB-0.5 submunition (source: USSR Ministry of Defence).*

RBK-500 ShOAB-0.5 Technical Characteristics

Length: 1,950 mm
Diameter: 450 mm
Weight: 334 kg
Number of submunitions: 565 (+/-5)

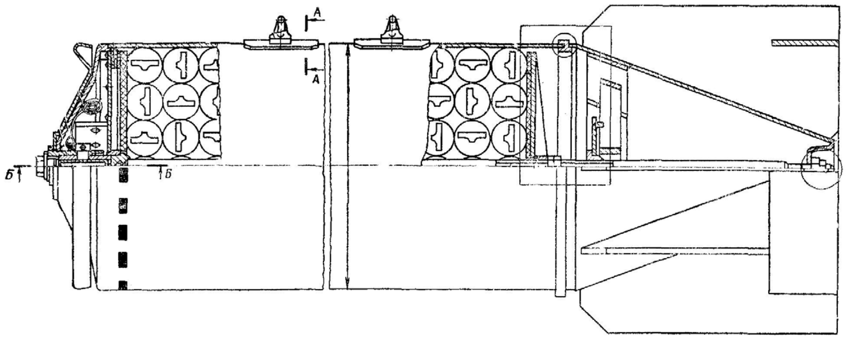


Figure 2.24 *A technical diagram of the RBK-500 ShOAB-0.5 cluster bomb (source: USSR Ministry of Defence).*

AO-2.5RT

The Russian AO-2.5RT (AO-2,5PT; *Aviatsionnaya Oskolochnaya*; 'aviation fragmentation bomb') HE-FRAG anti-personnel submunition was first documented in June 2013, with photos from the Syrian city of Hama depicting unexploded munitions of this model (Higgins, 2013a). Each AO-2.5RT is made up of a cylinder with a 90 mm diameter (115 mm with stabilisers) with rounded ends. The submunition is 150 mm long and contains 300 grams of TG-40 (60% RDX, 40% TNT).

Figure 2.25 *An AO-2.5RT submunition (source: Gavrilo Milentijević).*

The AO-2.5RT is fitted with the I-352V fuze, located in the centre of the submunition. Once released from its cargo munition, the centrifugal force exerted by the submunition's rotation through the airstream causes the safety mechanism pantograph arms to lock open, freeing the central inertia striker. A rotation speed of 1,300–2,300 RPM is required for the fuze to arm. On impact with a solid surface, the inertia strikers overcome creep springs and activate the two pyrotechnic delays while splitting the submunition in half. The resulting halves jump back up to approximately 1.5 m before detonating. (Gruszczyński, 1993). The lethal radius of the AO-2.5RT is believed to be 30 m against materiel, 20 m against unsheltered personnel, and 10 m against entrenched personnel (CAT-UXO, n.d. (a)).

Figure 2.26 *An unexploded AO-2.5RT submunition, found in Harbnafeh, Hama Governorate, in June 2013 (source: Syrian social media via ARES CONMAT Database).*

Figure 2.27 *One half of an AO-2.5RT submunition pictured in Hama Governorate, in June 2013 (source: Syrian social media via ARES CONMAT Database).*

The AO-2.5RT can be deployed from the RBK-500 AO-2.5RT cluster bomb or the BKF AO-2.5RT expendable unit (cassette). The RBK-500 AO-2.5RT carries 60 submunitions and is 1,950 mm long, with a body diameter of 450 mm and tail fin diameter of 570 mm. Fully assembled, it weighs 325 kg (Fulmer, 2015a). In some cases, the RBK will be fitted with a drogue parachute, indicating that the munition was likely dropped at low altitude and low speed from a helicopter. The BKF AO-2.5RT expendable unit holds 12 submunitions and is carried in a KMGU series universal dispenser. KMGU series dispensers hold 8 BKF AO-2.5RT units, for a total of 96 submunitions (NAVEODTECHDIV, 2004). One weakness of this submunition design is its high dud rate upon impacting wet or soft surfaces. Such surfaces dampen the submunition's impact, sometimes resulting in a fuze that remains armed despite the munition failing to detonate. The consequences of this design flaw have been documented on numerous occasions in Syria, especially in irrigated or tilled farm fields. In several cases, farmers and workers have been forced to clear these munitions by hand or risk striking them with farm implements—which could cause the device to detonate.

In January 2015, a significant amount of AO-2.5RT submunitions stored in BKF dispensers were unearthed from a buried cache by Islamic State (IS) fighters in Iraq (Hiznay, 2015).

AO-2.5RT Technical Characteristics

Length: 150 mm
Diameter: 90 mm around body, 115 mm with stabilisers
Weight: 2.8 kg
Explosive weight: Approximately 300 g[17]
Explosive composition: TG-40 (40% TNT/60% RDX)
Fuze: I-352V

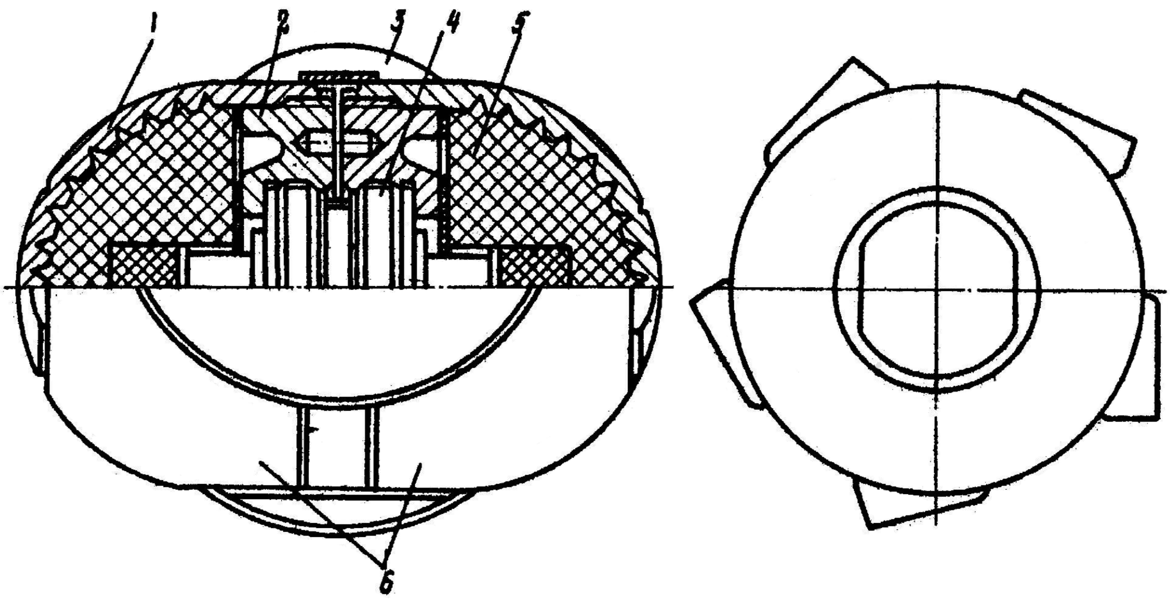


Figure 2.28 *A technical diagram of the AO-2.5RT submunition (source: USSR Ministry of Defence).*

17 There are contradictory sources indicating that the AO-2.5RT may have an explosive weight of 550 g.

BKF AO-2.5RT Unit Technical Characteristics

Total weight: 46kg
Dimensions: 346 mm x 256 mm x 373 mm
Number of submunitions: 12
Altitude to be used: 30m - 1,000m
Speed to be used: 700 km/h - 1,100 km/h

Figure 2.29 *BKF AO-2.5RT expendable cassette on Syrian airbase Shayrat, Homs Governorate, in April 2017 (source: Evgeny Poddubny).*

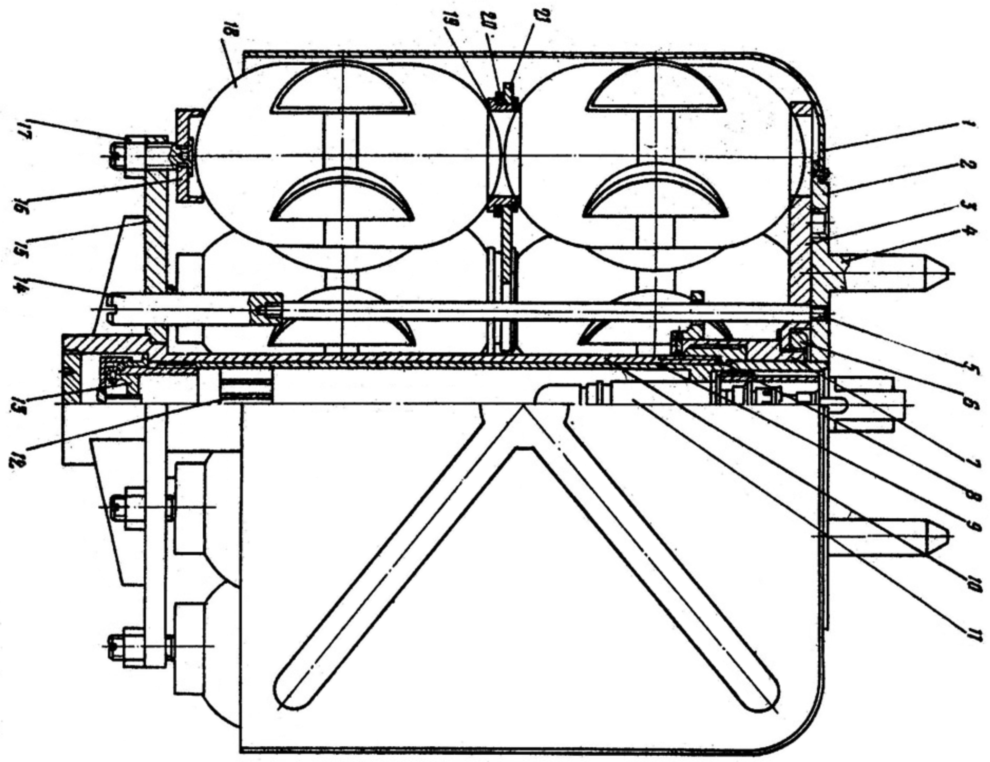


Figure 2.30 *Technical diagram of a BKF AO-2.5RT unit (source: USSR Ministry of Defence).*

AO-2.5 RTM

The Russian AO-2.5RTM (AO-2,5PTM) submunition is a modified version of the AO-2.5RT, which is also designed for use against infantry, unarmoured vehicles, and other light targets. The first documented evidence of their use in Syria appeared in October 2015 in video with a detailed teardown of unexploded AO-2.5RTM submunitions. The AO-2.5RTM is very similar to the AO-2.5RT, both externally and in its functionality. It is equipped with the same I-352V fuse and, like AO-2.5RT, it separates into two halves that bounce upon impacting the ground, detonating at a height of approximately 1.5 metres with a delay of 0.1–0.35 seconds. As with the AO-2.5RT, the fuzing mechanism significantly increases the risk of unexploded ordnance if the munition is deployed in marshland, wet soil, or other soft areas.

The main differences between the AO-2.5RTM and AO-2.5RT relate to their weight and means of delivery. Firstly, the AO-2.5RTM submunition is lighter, at 2.5 kg compared with the 2.8 kg of the AO-2.5RT. Secondly, the RBK-500 AO-2.5RTM cluster bomb holds 108 submunitions, compared with the RBK-500 AO-2.5RT which carries 126. Both the BKF AO-2.5RT and BKF AO-2.5RTM contain 96 submunitions total (Jane's Information Group, 2002). Whilst the AO-2.5RTM can be dispensed by both the RBK-500 AO-2.5RTM cluster bomb or BKF AO-2.5RTM expendable cassette, only the use of RBK-500 AO-2.5RTM has been conclusively documented in Syria.

Figure 2.31 *Upper and lower halves of an AO-2.5RTM submunition in Douma, Rif Dimashq Governorate, in October 2015 (source:* Almarra Today*).*

AO-2.5 RTM Technical Specifications

Length: 150mm
Diameter: 90mm
Weight: 2.5 kg
Explosive weight: Approximately 300 g[18]
Explosive composition: TG-40 (40% TNT/60% RDX)
Fuze: I-352V

18 There are contradictory sources indicating that the AO-2.5RTM may have an explosive weight of 550 g.

RBK-500 AO-2.5RTM Technical Characteristics

Total weight: 504kg
Overall length: 2,500 mm
Diameter: 450mm
Number of submunitions: 108

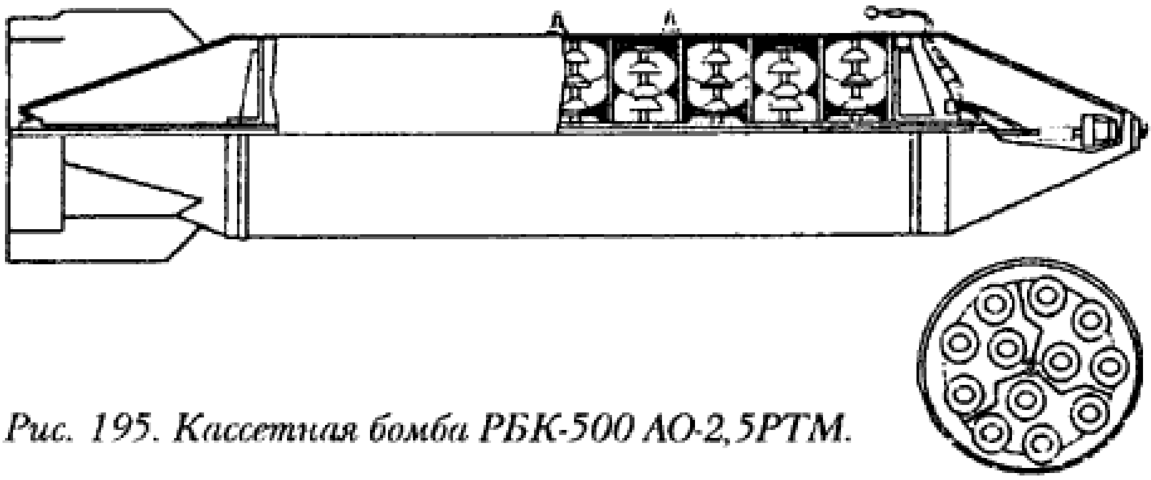


Figure 2.32 *Technical diagram of a RBK-500 AO-2.5RTM (source: USSR Ministry of Defence).*

PTAB-2.5M

The Soviet-designed PTAB-2.5M (ПТАБ-2,5М; *Protivo Tankovaya Avia Bomba Modernizirovanii*; 'anti-tank aviation bomb, modernised') was first documented in Syria in August 2012. It is one of the more prolific submunitions in the Syrian conflict, and had been documented in over 45 different locations by mid-2014 (HRW, 2014). The PTAB-2.5M measures 332–339 mm long unfuzed, with a cylindrical body 68 mm in diameter, four tail fins, and circular strengthening aerofoil 87–90 mm in diameter. It features an AV-524M point-initiating, base-detonating (PIBD) impact fuze with a protective cap and is intended as a HEAT munition, containing 450 grams of TG-50 explosive (RDX/TNT) capable of penetrating 120 mm of rolled homogeneous armour equivalent (RHAe) (Morozova & Kharitonov, 1975).

Figure 2.33 *A PTAB-2.5M submuniton (source: Ukrainian social media via ARES CONMAT Database).*

Figure 2.34 *An unexploded PTAB-2.5M submunition in Al-Bukamal city, Deir ez-Zor Governorate, August 2012 (source: Syrian social media via ARES CONMAT Database).*

When the PTAB-2M is dispersed into the air, a small turbine head is set in rotation by the airflow. At approximately 5,000 rpm, the turbine head engages the impeller, which winds forward in flight, arming the fuze. On impact, the aluminium impeller guard breaks, and the impeller shaft is driven into the fuze body. A magnet is then driven through a generator coil housing, which induces a voltage that ignites the detonator and detonates the main charge (SKB, 2018). Sources that claim the AV-524M contains a piezo crystal[19] are incorrect. The AV-524M fuze is mechanically very similar to the German El.A.Z 66 fuze and the Hungarian Modell 38M (U.S. War Office, 1953; SKB, 2019).

Footage suggests that, when striking a hard surface at an angle, AV-524M fuzes frequently shear from the main body of the submunition. Additionally, impeller shields are frequently found damaged. Impact on soft ground can possibly also lead to high failure rates, when the force of impact is insufficient to collapse the impeller guard. These submunitions have been found not only with relatively intact impeller guards but also with the impeller clogged by mud. Additional failures may be caused by the detonator shutter malfunctioning due to rusted or degraded shutter springs.[20] Analysis of video evidence suggests that these submunitions have been routinely harvested and repurposed to act as payloads for improvised mortar projectiles, rockets, and other munitions (see the section on ***Repurposed Submunitions,*** p. 78).[21]

19 A piezo crystal accumulates electric charge when under mechanical stress.

20 Private explosive ordnance disposal (EOD) technical source.

21 Author analysis of images and video footage from Syria. For additional analysis, see this report's section on ***Repurposed Submunitions***, p. 78.

Figure 2.35 *PTAB-2.5M submunitions recovered in Syria. Translated, the markings on these munitions read "PTAB-2.5M" and, below, "TG-50" (the explosive fill). The reverse side, as seen on the submunition second from the left, displays factory code (80), lot number (27), and year of production (1975) (source: Syrian social media via ARES CONMAT Database).*

The PTAB-2.5M, like the AO-1SCh, is delivered by the RBK series of cluster munitions, specifically the RBK-250 PTAB-2.5M. The bomb is 2,300 mm in length, 325 mm in diameter across the body, and has a 410 mm tail fin diameter. It carries 42 submunitions and weighs 248 kg when fully loaded. The RBK-250 PTAB-2.5M contains several wooden spacers (often dark maroon in colour). If these are seen on munitions or found on the ground, they may indicate a relatively recent strike, depending on seasonal/weather conditions within the country.

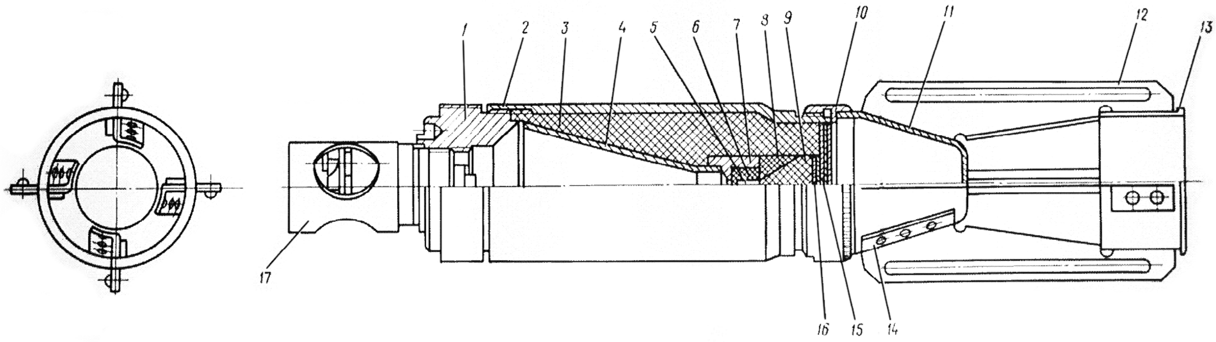


Figure 2.36 *A technical drawing of a PTAB-2.5M submunition, with a cutaway (source: USSR Ministry of Defence).*

PTAB-2.5M Technical Characteristics

Length: 332–339 mm without fuze
Diameter: 68 mm (body); 87–90 mm (tail fins)
Weight: 2.8 kg
Explosive weight: 450 g
Explosive composition: TG-50 (50% TNT/50% RDX)
Fuze: AV-524M

RBK-250 PTAB-2.5M Technical Characteristics

Total weight: 248kg
Overall length: 2,300 mm
Diameter: 325 mm
Number of submunitions: 42

PTAB-2.5KO

The Russian PTAB-2.5KO (ПТАБ-2,5КО; *Protivo Tankovaya Avia Bomba, Kumulyativnaya Oskolochnaya;* 'anti-tank aviation bomb, HEAT-FRAG') is designed for both anti-tank and anti-personnel purposes. Videos showing unexploded PTAB-2.5KO submunitions were uploaded to YouTube in late May 2013 (Brown Moses, 2013b). These submunitions were developed to replace the earlier PTAB-2.5M in Soviet service. While older anti-armour fin-stabilised submunitions tend to have fixed fins, later developments changed to a folding fin design, reflected in the PTAB-2.5KO. Though the PTAB-2.5KO submunitions documented in Syria were likely produced more recently than the observed PTAB-2.5M submunitions, it is unknown whether the failure rate for this more modern munition is significantly lower. The PTAB-2.5KO measures 307 mm in length with a diameter of 60 mm. An estimated 184-gram charge of Gekfol-5[22] (95% RDX/5% phlegmatiser oxazine) is detonated by the impact inertia I-350AM fuze (Gruszczyński, 1993). As the submunition is ejected and begins to descend, an impeller of six spring-loaded fins arms it. On impact, an inertia weight drives the firing pin. To do so, the weight must overcome a strong creep spring (distinct from the externally visible spring used to deploy the six fin arms). A pyrotechnic delay is also initiated by an inertia pellet, causing the submunition to (in theory) self-destruct within 7–10 seconds.[23] The PTAB-2.5KO is carried in the BKF PTAB-2.5 expendable unit. Each unit holds 12 submunitions, and 8 BKF units are loaded within the KMGU series universal dispenser, for a total of 96 submunitions (Babkin et al., 2008). Alternatively, 75 PTAB-2.5KO submunitions can be carried by the RBK-500 PTAB-2.5KO aerial bomb.

Figure 2.37 *A PTAB-2.5KO submunition (source: Wikimedia Commons).*

22 Gekfol-5 is also known as A-IX-10.

23 Interview with confidential EOD source.

Figure 2.38 *An anti-government combatant displays a PTAB-2.5KO submunition in Basqala, Idlib Governorate, in May 2013 (source: Syrian social media via ARES CONMAT Database).*

PTAB-2.5KO Technical Characteristics

Length: 307 mm
Diameter: 60 mm (body)
Weight: 1.82 kg
Explosive weight: 184g
Explosive composition: Gekfol-5 (A-IX-10; 95% RDX, 5% oxazine as phlegmatiser)
Fuze: I-350AM

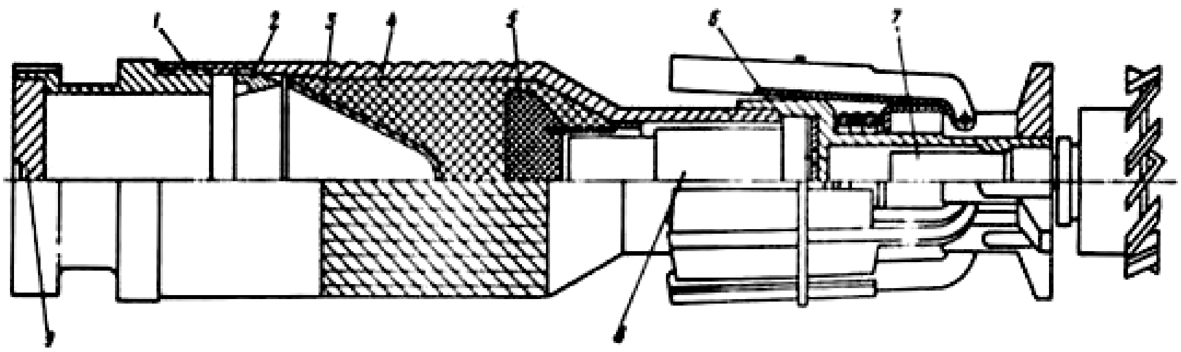
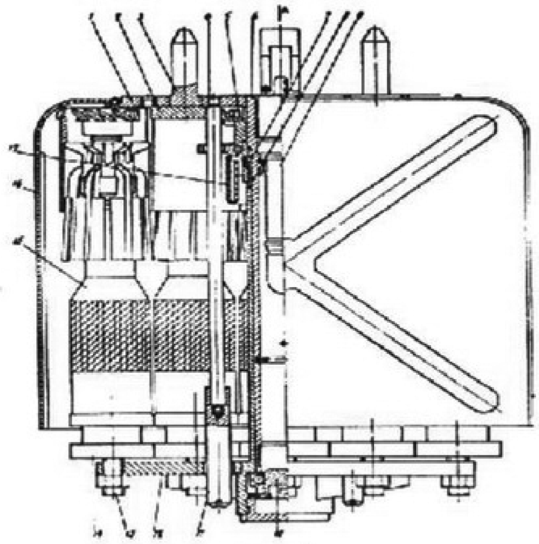


Figure 2.39 *Technical diagram of a PTAB-2.5KO submunition (source: USSR Ministry of Defence).*

A BKF PTAB-2.5KO Unit Technical Characteristics

Total weight: 41kg
Dimensions: 346 mm x 256 mm x 373 mm
Number of submunitions: 12
Altitude to be used: 30m - 1,000m
Speed to be used: 700 km/h - 1,100 km/h

Figure 2.40 (right) *Technical diagram of a BKF PTAB-2.5KO Unit (source: USSR Ministry of Defence).*



PTAB-1M

The PTAB-1M (ПТАБ-1M) submunition is a HEAT, fin-stabilised, aerially dispersed submunition. It was first documented in Syria around mid-to-late February 2016. Images posted to Facebook and Twitter show the presence of PTAB-1M anti-tank submunitions and the RBK-500 PTAB-1M air-delivered cargo munition in the al-Ghanto area of the Homs governorate.

Figure 2.41 *A PTAB-1M submunition (source: Syrian Social Media via ARES CONMAT Database).*

Each RBK-500 PTAB-1M contains 268 submunitions, arranged in three 'forward' layers of 80 submunitions each and one rear layer of 28 submunitions towards the tail end of the munition. An electromechanical time delay fuze functions the cargo munition, triggering an ejection charge that disperses the submunitions. After ejection, the PTAB-1M submunitions are dispersed by centrifugal force and fall to the ground. Additionally, the interlocking sections of the tail unit spring open, which disengages the safety devices within the fuze (CAT-UXO, n.d. (c)). The submunitions are unguided and intended to strike the top armour of armoured fighting vehicles—which is often thinner than frontal or side armour—and are capable of penetrating 200 mm of RHAe (Jenzen-Jones & Randall, 2022). PTAM-1M submunitions employ a shaped charge that is initiated by a piezoelectric PIBD fuze and are equipped with a self-destruct mechanism, which U.S. EOD sources believe function after 20 to 40 seconds (Lyamin & Jenzen-Jones, 2016, NAVEODTECHDIV, 2004b). The RBK-500 PTAB-1M cargo munition documented in Syria (and elsewhere; see Jenzen-Jones & Randall, 2022) have often failed to function as intended, both in its point-impact detonation and self-destruct mechanism, producing high quantities of UXO. Markings on the submunitions in Syria indicate that they were produced in 1988, which may have contributed to their high dud rate. Besides this RBK-500 variant, PTAB-1M submunitions can also be dispersed from the BKF PTAB-1M expendable cassette, which holds 31 submunitions. BKF cassettes are carried in KMGU series dispensers, with one dispenser holding 8 BKF PTAB-1M units (with 248 PTAB-1M bomblets in total) (NAVEODTECHDIV, 2004b). However, there has been no documented evidence of the use of these cassettes in Syria.

Figure 2.42 *An array of unexploded PTAB-1M submunitions pictured in al-Ghanto, Homs Governorate, in February 2016 (source: Syrian social media via ARES CONMAT Database).*

PTAB-1M Technical Characteristics

Length: 260 mm
Diameter: 42 mm
Weight: 944 g
Fuze: PIBD with self-destruct feature (suspected to be 20-40 seconds)
Armour penetration: 200 mm RHAe or greater

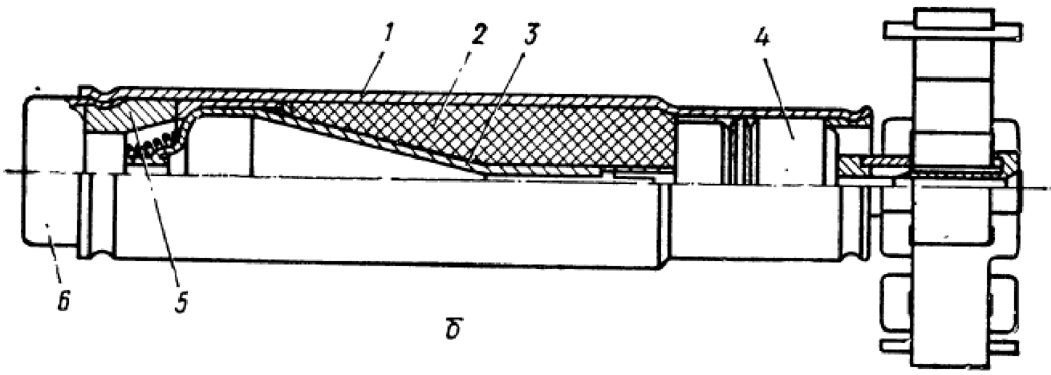


Figure 2.43 *Technical diagram of a PTAB-1M submunition (source: USSR Ministry of Defence).*

RBK-500 PTAB-1M Technical Characteristics

Total weight: 427kg
Overall length: 1,954-1,955 mm
Diameter: 450 mm
Number of submunitions: 265

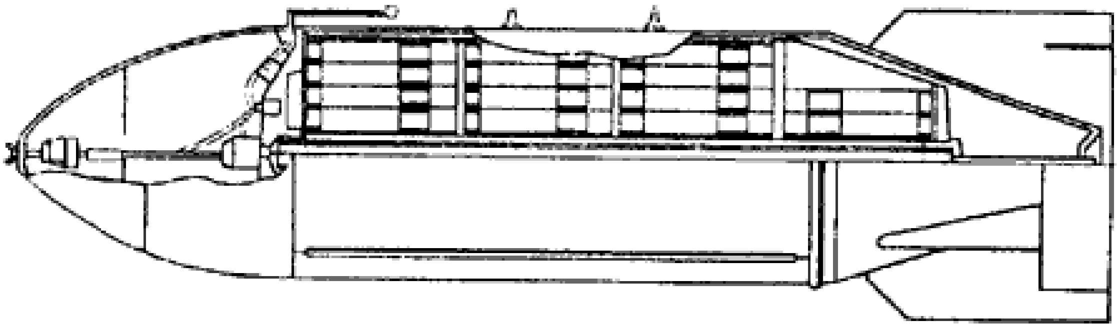


Figure 2.44 *Technical diagram of a RBK-500 PTAB-1M (Source: USSR Ministry of Defence).*

Sakr Type B

The Sakr Type B submunition is believed to be a copy or derivative of the American M77 DPICM submunition.[24] The first images of this submunition in Syria originated in Jabal al-Zaweya in December 2012; further examples were later identified in reviewing a YouTube video recorded in the Hama region in early January 2013. The video shows submunition remnants and unexploded submunitions, as well as the 122 mm Sakr cargo rocket that carried them (ARES, n.d. (a)). The Sakr Type B carries a high explosive dual-purpose charge and is cylindrical, featuring a ribbon attached to an inertia weight/striker assembly. The firing pin acts as a holding device for the detonator slider, which in turn acts as a masking device. Once ejected from the carrier, the Type B's ribbon unfurls in the airstream, causing its threaded firing pin to unscrew. This allows release of a spring-loaded detonator slide safety, leaving the firing pin assembly positioned directly above the detonator. Inertia from the impact then drives the weighted pin assembly into the detonator (Jenzen-Jones, 2013b). If the slider protrudes from one side of the fuze assembly, it should be assumed that the submunition is armed.

Figure 2.45 *A Sakr Type B submunition (source: Mizokami, 2016).*

24 Some sources have referred to the Sakr Type B as "M42D", though it is unclear where this designation originates from. This may be an allusion to the US M42 submunition, though the Sakr Type B appears to be a copy of the M77, not the M42.

Submunitions of this design often fail to fully arm, especially if the dispersion height is too low. In some examples from Syria, the ribbons have been observed in the stowed position. Additionally, the arming mechanism generally can be unreliable and dangerous. If the submunition impacts at an angle—or has its velocity significantly reduced, (e.g., by impacting or catching on foliage)—it may fail to detonate even if armed. This may leave the striker critically close to the stab detonator in the resulting UXO. Submunitions found in such a state are highly dangerous. Any pressure on the submunition could be enough to move the firing pin assembly. If stepped on, an armed submunition can act—if orientated correctly—as a crude pressure-initiated landmine (Jenzen-Jones, 2013b). It should be noted that, since 2007, DPICM have been 'no touch' items in South Lebanon due to a number of accidents. As recently as 2014, clearance organisations have experienced accidents with this submunition.[25]

Figure 2.46 *An unexploded Sakr Type B submunition in Jabal al-Zaweya, Idlib Governorate, December 2012 (source: Nicole Tung).*

Figure 2.47 *A piece of Sakr Type B submunition body showing its fragmentation sleeve. Jabal al-Zaweya, December 2012 (source: Nicole Tung).*

25 Author interviews with confidential sources.

Figure 2.48 *Remnants from the 122mm Sakr cargo rocket found with the Sakr Type B submunitions in Hama, January 2013. The markings on the rocket clearly identify it as having been produced by the Egyptian AOI (source: Syrian social media via ARES CONMAT Database).*

The Sakr Type B submunitions used in Syria were most likely made in Egypt, as the 122 mm Sakr cargo rocket found with them in January 2013 (see *Figure 2.48*, above) clearly bears markings which indicate it was produced by the Egyptian AOI (Jenzen-Jones, 2013b). The Type B can be loaded into the Sakr-18, Sakr-36, and Sakr-45 cargo rockets. These different variants designate maximum ranges of 17, 31, and 42 km, respectively. Sakr-18 and Sakr-45 variants carry 72 Type B submunitions each, while the Sakr-36 carries 98. The 122 mm Sakr rocket family can be used with the Russian 122 mm *Grad* (Град; 'Hail') MBRL, as well as other 122 mm systems like the Chinese Type 81 SPRL and Egyptian RL-21 (Jenzen-Jones, 2013b).

Sakr Type B Technical Characteristics[26]

Length: 77 mm
Diameter: 38.5 mm
Weight: 187 g
Explosive weight: 31 g
Explosive composition: 94% RDX; 6% oxazine as phlegmatiser
Fuze: Impact-inertia fuze[27]

ZP39A

Although widely thought to have been first observed in April 2014, unexploded ZP39A submunitions (and associated remnants) were identified by ARES in a YouTube video dating to May 2013 (ARES, n.d.(a)). Relatively little is known about the ZP39A submunition, and it may not have been encountered by Western EOD organisations prior to the conflict in Syria.[28] There has been speculation that AOI Factory 333, in Heliopolis,

26 Most data taken from a confidential French-language EOD manual.

27 Likely to be a copy of the M233 impact-inertia fuze.

28 Author interviews with confidential EOD sources.

Egypt, which manufactures the Sakr 122 mm cluster rocket, produced the ZP39A, perhaps in cooperation with Chinese technical specialists. Some source claim that the ZP39A submunition in Syria has been used in conjunction with Sakr or similar 122 mm rockets. However, ARES assesses with high confidence that the ZP39A is of Chinese origin, and that it is delivered by a 122 mm cargo projectile (ARES, 2015(b); see *Figure 2.52*).

Figure 2.49 *A ZP39A (source: Syrian Media via ARES CONMAT Database).*

The ZP39A submunition also appears to be an adaptation of the standard American DPICM design. The submunition appears to use a simple mechanism whereby a ribbon unscrews the firing pin inertia pellet assembly, allowing a slider to move a small detonator in line. This is identical to the US design and thought to be very similar to the MZD-2 and Sakr Type B submunitions. The slider on the ZP39A appears thinner at one end, however. The position of the slider is normally an indicator of whether an American DPICM is armed, and it is likely that the ZP39A functions similarly.[29] The firing pin appears still screwed into the slider in most footage (ARES, n.d. (a)). This would suggest that these ZP39A submunitions were taken directly from the cargo munition or that their ribbon assembly failed to deploy correctly. The latter is a possible indicator of insufficient arming time due to a low-altitude release from the carrier munition.

The fill of the ZP39A submunition appears to be malleable and the build quality appears fragile. It is unlikely that the net explosive quantity (NEQ) would amount to more than 40–50 g of explosive.[30] The composition of the fragmentation casing is unknown, although the material is likely an alloy of some sort, possibly with embedded pre-formed fragmentation.

ZP39A Technical Characteristics

Length: 80 mm[31]
Diameter: 39.2 mm[32]
Fuze: Impact-inertia fuze

29 Authors' assessment.

30 Authors' assessment.

31 Estimated based on Norinco, 2011, pp. 35–36.

32 Estimated based on Norinco, 2011, pp. 35–36.

Figure 2.50 (top) *A ZP39A submunition held by an anti-government combatant in Aleppo Governorate, in May 2013 (source: Syrian social media via ARES CONMAT Database).*

Figure 2.51 (right) *The body of a ZP39A submunition pictured in Al Mleha,Damascus Governorate), in April 2014 (source: Syrian social media via ARES CONMAT Database).*

Figure 2.52 (bottom) *The Chinese 122 mm projectile which is the most likely carrier munition for ZP39A submunitions (source: Syrian social media via ARES CONMAT Database).*

MZD-2

Another derivative of an American DPICM design, the Chinese MZD-2 submunition (also known as the Type 90) functions very similarly to the Sakr Type B, and is similarly designed to target both personnel and armour. The first documented usage of MZD-2 submunitions in Syria was in August 2016, when they were employed by Hezbollah against Syrian rebel groups near Aleppo (Wright & Jenzen-Jones, 2018). Though principally designed to be contained within a 122 mm Type 81 rocket, in this instance Hezbollah used an unidentified "rotary-wing COTS UAV [commercial-off-the-shelf unmanned aerial vehicle] to deploy the submunitions" (Wright & Jenzen-Jones, 2018; CAT-UXO, n.d.(d); see *Figure 2.54*). While Hezbollah used Type 81 rockets containing 39 MZD-2 submunitions in the 2006 Lebanon conflict, it is unclear whether these munitions have been employed in Syria, or if the MZD-2 has only been delivered by UAVs in the Syrian conflict.

Figure 2.53 *A MZD-2 submunition (source: Jawad Metni/DanChurchAid).*

Figure 2.54 *Chinese MZD-2 submunitions being employed by Hezbollah near Aleppo, in August 2016 (source: Central Military Media via ARES CONMAT).*

Figure 2.55 *Size comparison between an MZD-2 (left) and a Sakr Type B (right). Note the spherical pre-formed fragmentation visible in the clear polymer matrix of the MZD-2, as well as its larger, distinctive shape (source: Mizokami, 2016).*

MZD-2 submunitions feature a fuze equipped with a safety slider which protrudes outwards when the fuze is fully armed. As well as its dual-purpose design, the MZD-2 shares its general fuze design with munitions such as the ZP39A, the American M42, and the Yugoslav KB-1. The MZD-2 and KB-1 also both feature an external fragmentation sleeve consisting of spherical pre-formed fragments encased in a polymer matrix. In the MZD-2 the metal spheres have a diameter of 3 mm (HRW, 2007). These spheres, combined with the shaped charge inside the submunition, provide the MZD-2 with its DPICM function. Despite the similar design and appearance, the MZD-2 is not identical to the KB-1. However, in light of the unknown technical characteristics of the MZD-2, the KB-1 may serve as a reasonable stand-in for assessing the MZD-2's capabilities in general terms. Further estimates can be found in ***Appendix 1*** (p. 84).

KB-1 Technical Characteristics
Length: 87 mm
Diameter: 40 mm
Weight: 0.245 kg
Explosive weight: ~30 g
Explosive composition: PETN
Fuze: Impact inertia fuze

3B30

The Russian 3B30 (3Б30; sometimes rendered '3-B-30') is a DPICM submunition, combining anti-personnel and anti-armour effects by employing both a HEAT shaped charge and fragmentation effect. It was documented comparatively recently in Syria, with pictures of the submunition first emerging in early April 2019. Sources indicate this submunition can be loaded into both 9M218 122 mm rockets, fired from the BM-21 *Grad* (Град; 'Hail') MBRL, and 9M55K5 300 mm rockets, fired from the 9K58 *Smerch* (Смерч; 'Tornado') MBRL. The 300 mm 9M55K5 cargo rocket caries 588 3B30 submunitions, whereas the 122 mm 9M218 rocket carries 45 3B30 submunitions. As no cargo munition remains were found among the 3B30 submunitions in Syria, it is unknown which carrier munition deployed the submunitions (Jenzen-Jones & Senft, 2022b).

Figure 2.56 *A 3B30 submunition (source: Reibert.info).*

Figure 2.57 *A 3B30 submunition found in Syria in early April 2019. Note the 'ADP' marking on the body of the submunition (source: Syrian social media via ARES CONMAT Database).*

Figure 2.58 *A collection of 3B30 submunitions documented in Syria in early April 2019 (source: Syrian social media via ARES CONMAT Database).*

It appears that at least one, and possibly two, later developments have modified the capabilities of the 3B30. In Figure 2.36, the 3B30 is marked with—among other things—'ADP77'. This marking has also been found on 3B30 submunitions more recently documented in Ukraine (Jenzen-Jones & Senft, 2022b). Some sources, including a Russian patent document, also describe the development of an 'ADP77-1' variant (Mikhailov et al., 2013). A confidential Russian source has told ARES that the ADP77 and ADP77-1 are enhanced bodies for the 3B30 submunition, offering greater RHAe penetration and better behind-armour effects (Jenzen-Jones & Senft, 2022b). It is not clear whether that means there are three variants of the 3B30 ('standard', ADP77, and ADP77-1), or just two (i.e., the ADP77 variant is the standard type). At least some of these submunitions have been referred to by the term '3Б30 КОБЭ' ('3B30 KOBE'), referring to the Russian term кумулятивно-осколочный боевой элемент—essentially 'HEAT-FRAG warhead'. Information on the 3B30—and particularly on the ADP77-series bodies—remains limited.

3B30 Technical Characteristics (version not specified)[33]

Diameter: 43 mm
Length: 128 mm
Total weight: 240 g
Explosive weight: 46 g
Self-destruct after: 200 s

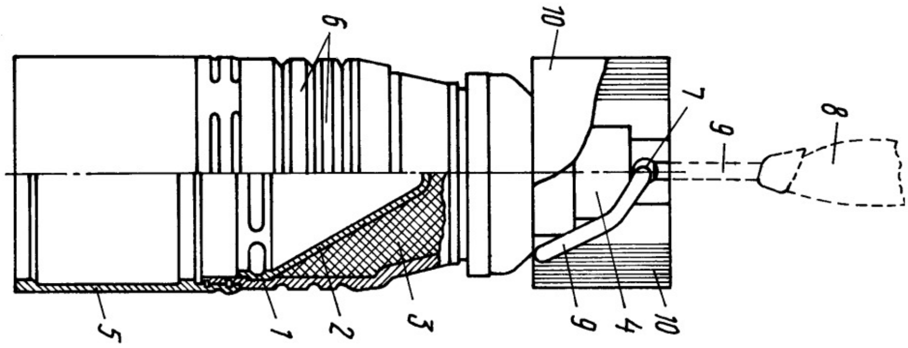


Figure 2.59 *A diagram from the patent for the 3B30 submunition, showing its typical DPICM arrangement (source: Russian patent no. 2277692).*

33 Information taken from Ivagkin, 2019.

SPBE

*The Russian SPBE (*СПБЭ; СамоПрицеливающийся Боевой Элемент; 'self-guided submunition') series of weapons consist of several HEAT submunitions. The SPBE submunitions use infrared (IR) seekers to target armoured fighting vehicles and engage them using an explosively-formed penetrator (EFP). This type of submunition was first observed in Syria in October 2015, when they failed to function in the countryside west of Aleppo. Numerous reports of that incident identified the submunition as the newer SPBE-D model. However, markings on these submunitions contradict this notion, indicating both the munition's designation (SPBE) and year of manufacture (1991). The SPBE submunitions were most likely deployed via the RBK-500 SPBE delivery vehicle. The RBK-500 SPBE was developed by the Russian weapons manufacturer NPO Bazalt in the 1980s, with the intent to produce a munition capable of engaging multiple armoured vehicles simultaneously. This work was awarded the State Prize of the USSR in 1991 (Jenzen-Jones, 2021).

Figure 2.60 *A SPBE submunition (source: Syrian social media via ARES CONMAT Database).*

Each RBK-500 SPBE contains 15 submunitions. The RBK-500 SPBE cargo munition functions after a pre-determined time delay, ejecting the parachute-equipped submunitions. These spin in a controlled fashion, sweeping the area below for targets. Upon detonation, the SPBE series submunitions fire an EFP,[34] which is believed to be capable of penetrating approximately 70 mm of RHAe at an angle of 30 degrees from a distance of 100 m (Jenzen-Jones, 2021). Some details on the submunition's guidance and control can be found in a Russian patent, lodged by Bazalt in 2006.

34 An EFP is a type of shaped charge intended to penetrate armour. Upon detonation the munition's explosive charge shapes a metal plate into a projectile, which is propelled to high velocities to defeat armoured targets.

SPBE submunitions can also be dispersed from 9M55K1 300mm rockets, which are fired from the 9K58 Smerch MBRL. While the Syrian government is known to possess the 9K58 Smerch system, they are not known to possess the specific munitions capable of delivering SPBE series submunitions. This, together with the contextual evidence surrounding the SPBE submunition use in October 2015, suggests that the RBK-500 SPBE was the most likely delivery method of deployment (Jenzen-Jones & Lyamin, 2015b).

Figure 2.61 *An unexploded SPBE reportedly photographed in the countryside west of Aleppo in October 2015 (source: Syrian social media via ARES CONMAT Database).*

The early SPBE model was succeeded by the later SPBE-D and SPBE-K models. The original SPBE submunitions use IR seekers to target armoured fighting vehicles. The later model SPBE-D submunition employs a dual-mode IR seeker, while the SPBE-K also includes a radio frequency sensor and millimetre wave radar. These later models can be operated in conjunction with an identification, friend or foe (IFF) system (Jenzen-Jones & Lyamin, 2015b). The RBK-500 SPBE is similar in design, function, and use to the American CBU-97 Sensor Fuzed Weapon with its BLU-108 submunitions. However, while the CBU-97 is available with Wind Corrected Munitions Dispenser (WCMD) series modification kits—converting the munition into the CBU-105 precision-guided munition (PGM)—the RBK-500 SPBE is an unguided munition (ARES, 2015(a)).[35]

SPBE Technical Characteristics

Total weight: 17.3 kg
Length: 384 mm
Diameter: 185 mm
Explosive weight: 5.8 kg

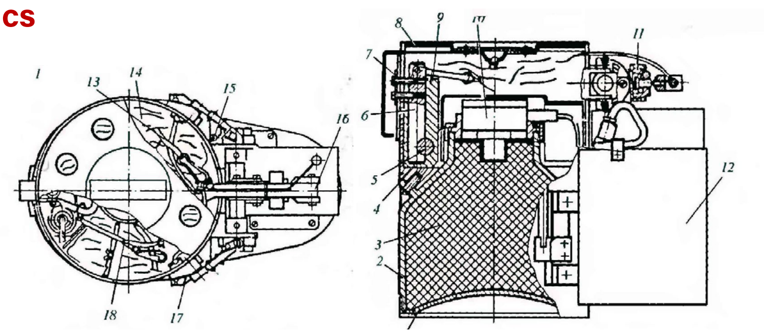


Figure 2.62 (right) *Technical diagram of a SBBE submunition (Source: USSR Ministry of Defence).*

35 A GLONASS-guided variant known as the RBK-500U SPBE series has been developed by Rostec Corporation's Tekhmash Concern in more recent years (Jenzen-Jones, 2021).

RBK-500 SPBE-D Technical Characteristics[36]

Total weight: 500 kg
Overall length: 2,485 mm
Diameter: 450 mm
Number of submunitions: 15
Delivery height: 400–5000 m
Delivery speed: 500–1,200 km/h

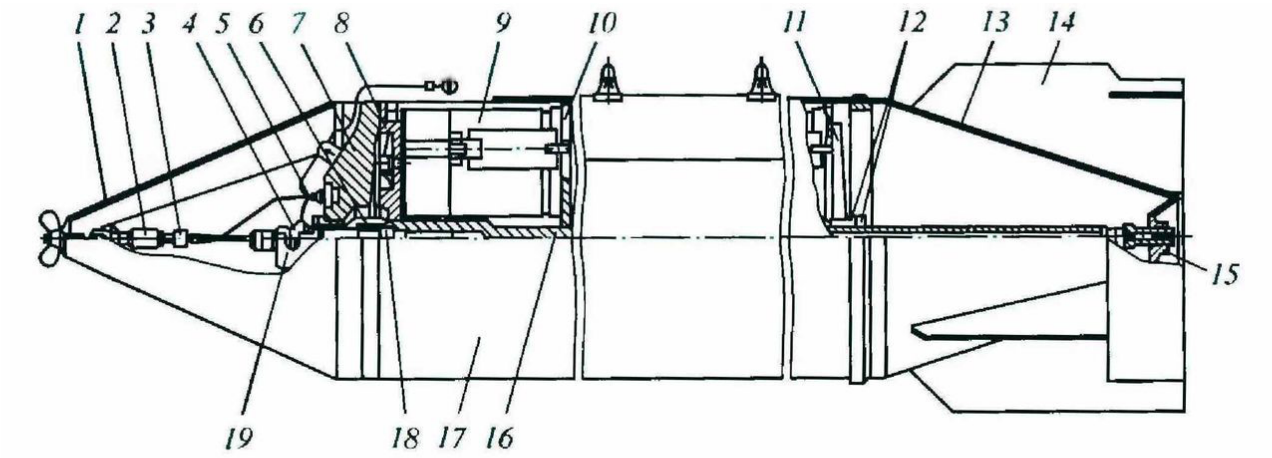


Figure 2.63 *Technical diagram of a RBK-500 SPBE (Source: USSR Ministry of Defence).*

ZAB-2.5

The Russian ZAB (*Zazhygatelnaya Aviatsionnaya Bomba*; 'incendiary aircraft bomb') series of weapons includes unitary incendiary bombs as well as incendiary cluster munitions like the RBK-250 ZAB-2.5. The first documented examples of ZAB-2.5 submunitions in Syria were recorded in 2012, with multiple videos showing both their deployment from fighter aircraft and the remnants of delivery munitions (ARES, n.d.(a)). Numerous observers and commentators initially misidentified the ZAB-2.5 submunitions as white phosphorous (WP) munitions (see, for example, *Al Jazeera*, 2012).

Figure 2.64 (right) *Variant 1, 2, and 3 of the ZAB-2.5 submunition. Nothe the I, II, and III marking on the munitions indicating their variant (source:* Basic Identification of Ammunition in Ukraine *V. 5.0 English Edition).*

36 Whilst details for the RBK-500 SPBE are not readily available, the RBK-500 SPBE-D is believed to be very similar.

Figure 2.65 *Fires burn across the city of Maraat al-Numan, Idlib Governorate, after an airstrike deploying suspected ZAB-2.5 submunitions in November 2012 (source: Syrian social media via ARES CONMAT Database).*

ZAB-2.5 submunition comes in three variants, all of which are found within each RBK-250 ZAB-2.5 cluster bomb. The RBK-250 ZAB-2.5 cluster bomb contains 48 submunitions in total, with 16 ZAB-2.5 Variant 1 submunitions, 16 ZAB-2.5 Variant 2 submunitions, and 16 ZAB-2.5 Variant 3 submunitions (Jenzen-Jones, 2013c). Each of the ZAB-2.5 submunitions is 244–249 mm long and 68 mm in diameter.[37] Technical specifications of the three variants are detailed in *Table 2.1*.

There is the ZAB-2.5 family of submunitions as well as the modernized ZAB-2.5SM family of submunitions (see below). Each family of ZAB-2.5 submunitons is made up of three variants - referred to as Variant 1, 2, and 3 in the case of the ZAB-2.5 and ZAB-2.5M1, ZAB-2.5M2, and ZAB-2.5S in the case of the ZAB-2.5SM. Both families of submunions are belived to have been developed by the NPO Bazalt after 1991.

Confusingly, there is also an older, soviet-manufactured incendiary submuniton referred to as ZAB-2.5. This submuniton differs visually from the ZAB-2.5 shown here, by featuring an aerodynamic body equipped with four fins in the back. It is generally believed that the aerodynamic ZAB-2.5 predates the canister-shaped ZAB-2.5 submunitions and is no longer in use today.[38]

Variants 2 and 3 also contain Pentaerythritol tetranitrate (PETN) bursting charges, which some sources claim are designed to discourage and impede attempts to extinguish the burning submunitions.[39] These charges are initiated by a pyrotechnic block delay after the submunitions have reached the ground and burned for some time. In the case of Variant 3 submunitions, PETN charges have the added effect of dispersing the napalm-like jellied fuel filler over a wider area after the thermite portion of the submunition has burned down. The thermite component of the submunitions is capable of penetrating 3–4 mm of steel, as well as igniting combustible materials (Jenzen-Jones, 2012c).

37 Specifications taken from Soviet technical diagram.

38 Author interview with confidential source

39 Author interview with confidential source.

Figure 2.66 *Burnt remains of ZAB-2.5 submunitions, believed to be pictured in Al Moadamyeh, on the outskirts of Damascus, in December 2012 (source: Syrian social media via ARES CONMAT Database).*

The RBK-250 ZAB-2.5 measures 1467–1492 mm in length, with a body diameter of 325 mm and tail fin diameter of 410 mm. Despite the '250' portion of its name indicating a nominal weight of 250 kg, the actual weight of the bomb is 194 kg. The explosive separation/ignition charge weighs 700 g. ZAB-2.5 submunitions are ignited upon ejection from the RBK-250 ZAB-2.5 and burn as they descend towards the ground. The submunitions are often mistaken for WP munitions as they behave similarly while descending (see p. 66 for information regarding the differential identification of WP and other incendiary munitions).

The ignition process of the ZAB-2.5 family of submunitions is reasonably reliable, unlike other munitions using ejection charge and fuze types which are more prone to deterioration over time. However, incorrect employment of the munitions, such as unsuitable ejection height or speed, can still increase the dud rate (Jenzen-Jones, 2012c).

Soviet manuals suggest that ZAB-2.5 submunitions are likely to be scattered across the following areas, based on their ejection height:

Ejection height of 500–750 m: 3,900–11,600 m^2
Ejection height of 1,500–1,700 m: 16,900–28,400 m^2

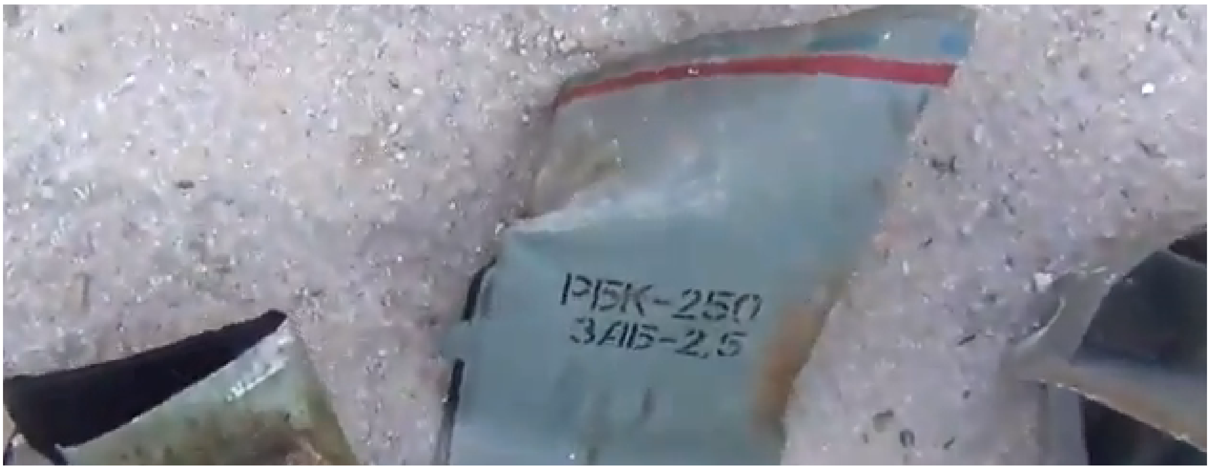
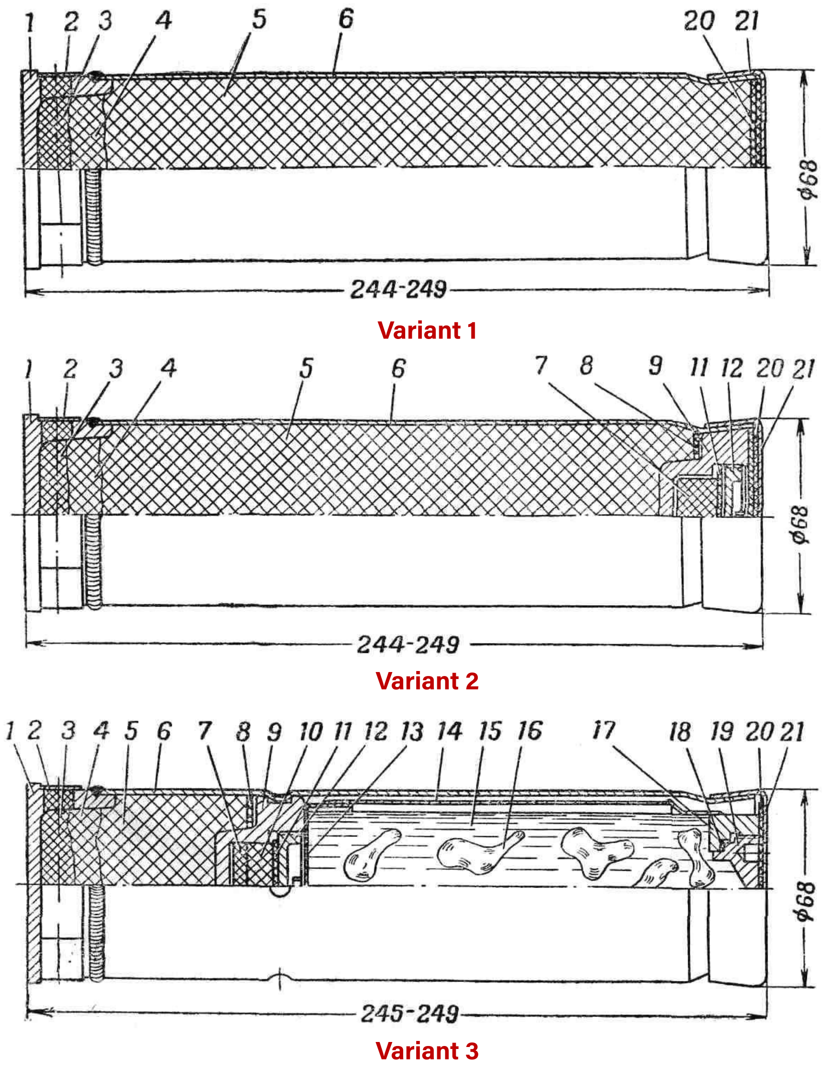


Figure 2.67 *The remains of a bomb found in the Aleppo Governorate in November 2012. The markings indicate this is an RBK-250 ZAB-2.5 (source: Syrian social media via ARES CONMAT Database).*



1) Case head
2) Glassine tape
3) Igniter compoition
4) Transitional composition
5) Primary composition (Thermite)
6) Munition casing
7) PETN charge
8, 11, 20) Cardboard spacers
9) Bursting charge container
10) Pyrotechnic charge
12) Stopper/plug
13) Cap of capsule
14) Capsule body
15) Thickened incendiary mixture
16) Cotton pieces
17) Head of capsule
18) Sealing ring
19) Plug for head piece
21) Cap

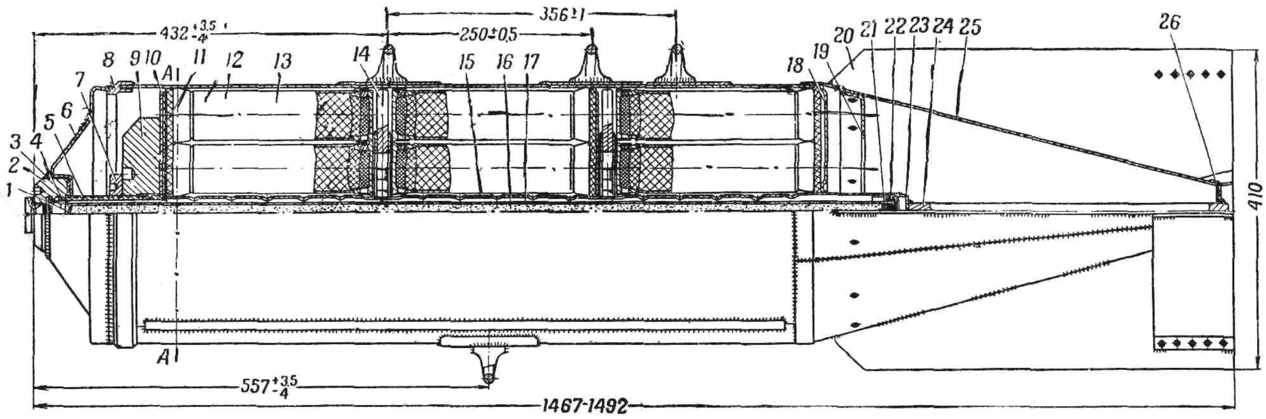
Figure 2.68 *A technical diagram of the three variants of ZAB-2.5 submunitions. English annotations have been added (source: USSR Ministry of Defence/ARES).*

ZAB-2.5 Technical Characteristics

Table 2.1 — ZAB-2.5 Submunition Variants

	Length	Diameter	Weight	Incendiary Composition	Explosive Composition	Approx. Burn Time
Variant 1	244–259 mm	68 mm	2.3 kg	Thermite[40]	None	150–180 seconds
Variant 2	244–259 mm	68 mm	2.5 kg	Thermite	PETN (bursting charge)	120–180 seconds
Variant 3	245–259 mm	68 mm	2.2 kg	Thermite + jellied fuel mixture	PETN (bursting charge)	3–9 minutes

Source: *Jenzen-Jones, 2012*



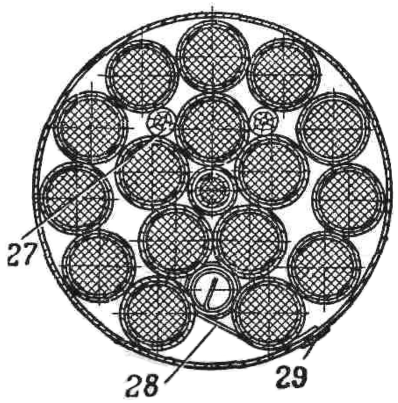


Figure 2.69 *A diagram showing a loaded RBK-250 ZAB-2.5 cluster munition (source: USSR Ministry of Defence).*

RBK-250 ZAB-2.5 Technical Characteristics

Total weight: 194 kg
Length: 1,467-1,497 mm
Diameter: 320 mm
Number of submunitions: 48

ZAB-2.5SM submunitions

Submunitions dispersed by the ZAB-2.5SM cluster bomb were first identified in November 2015 in the Syrian governorate of Idlib. Like its predecessor, the ZAB-2.5 series, the ZAB-2.5SM cluster munition carries three different models of submunition: the externally similar ZAB-2.5M1 and M2, as well as the smaller ZAB-2.5S. The different submunitions are sometimes erroneously identified by the term 'ZAB-2.5SM'; it should be noted that there is no submunition with this designation, which instead refers to the munition.

Both the ZAB-2.5M1 and ZAB-2.5M2 submunitions contain solid, thermite-type incendiary compositions that are designed to burn very hot, rapidly degrading metal. Specifically, the N-16 incendiary composition contained in the ZAB-2.5M1 can burn through up to 3 mm of steel; the N-17 incendiary composition contained in the ZAB-2.5M2 can burn through steel with a thickness of up to 5 mm. The ZAB-2.5S submunition contains the viscous incendiary composition OM-68-35. The ZAB-2.5SM cluster munition was designed for the destruction of unarmoured vehicles, trains, warehouses containing fuel, buildings with light ceilings, and other fire-vulnerable structures (Ivanova, 2006). Compared to the ZAB-2.5 submunitions, the new generation of incendiary submunitions provide a superior incendiary effect, burning hotter and for longer.

The ZAB-2.5SM-series submunitions have been employed via the RBK-500 ZAB-2.5SM cluster bomb, which holds 297 submunitions. The ZAB-2.5SM submunitions function like their predecessors; igniting upon ejection and falling through the air while burning. The submunitions can be released at an altitude from just 70 m up to 22,000 m and at speeds between 500 km/h and 1200 km/h (Bazalt, n.d).

Figure 2.70 (right) *Cutaway inert examples of the ZAB-2.5M1, ZAB-M2, and ZAB-2.5S submunitions (source: Russian social media via ARES CONMAT Database).*

Figure 2.71 *RBK-500 ZAB-2.5SM aerial bombs mounted under the wings of a plane stationed at the Russian Khmeimim airbase in Syria. Taken from a Russia Today report which aired on 18 June 2016. Note the markings on this RBK-500 ZAB-2.5SM indicating its contents:* H-16 *referring to the ZAB-2.5M1 containing N-16,* H-17 *referring to the ZAB-2.5M2 containing N-17, and* OM-68-35 *referring to the ZAB-2.5S containing OM-68-35 (source:* RT*).*

Figure 2.72 *Remnants of ZAB-2.5SM series submunitions photographed in Idlib, in November 2015 (source: Syrian social media via ARES CONMAT Database).*

Technical Specifications

Table 2.2 — ZAB-2.5SM Submunition Variants

Variants	Length	Diameter	Incendiary compound
ZAB-2.5M1	240 mm	60 mm	N-16
ZAB-2.5M2	240 mm	60 mm	N-17
ZAB-2.5S	140 mm	90 mm	OM-68-35

Differential Identification of ZAB Submunitions & White Phosphorous

The use of ZAB-2.5 submunitions often exhibits similar characteristics to that of cargo WP munitions, such as the M825A1.[41] The M825A1 155 mm WP projectile is designed to disperse smokescreen by ejecting 116 felt wedges, each measuring 19 mm, impregnated with WP over the target location. These wedges ignite upon contact with the air and fall to the ground burning. This produces the tell-tale 'snake-like' trails of smoke associated with M825A1. Like the felt wedges of the M825A1, ZAB-2.5 submunitions ignite upon ejection from their delivery munition, falling to the ground burning—making the two munitions visually similar to untrained observers, particularly at night. Some key indicators that can be used for accurate differential identification of these two munitions are:

1. ZAB-2.5 submunitions are much larger than the small elements (e.g., WP-impregnated felt wedges) used in most WP cargo munitions.

2. The number of ZAB-2.5 submunitions ejected from an RBK-250 ZAB-2.5 is fewer than the number of WP wedges ejected from munitions such as the M825A1. The RBK-250 ZAB-2.5 cluster bomb carries 48 ZAB-2.5 submunitions, whereas the M825A1 projectile carries 116 wedges of WP-impregnated felt.

3. ZAB-2.5 submunitions tend to be dispensed from a greater height than the WP cargo of munitions such as the M825A1 projectile.

4. Although both types of munitions emit smoke whilst descending and once on the ground, WP wedges will produce more smoke for their size, which is generally thicker and whiter in appearance (this does not take into account other materiel ignited by either type of munition).

5. Some ZAB-series submunitions contain bursting charges that explode after a given amount of time, something that is not generally associated with WP munitions.

6. ZAB-2.5 submunitions will often leave behind burnt-out remnants of their casing, whereas different forms of WP will leave varying residues. Felt-based WP elements, for example, typically leave brown coagulated lumps that can easily be mistaken for farm animal waste. If disturbed, this WP will start smoking immediately when the inner contents are exposed to oxygen.[42] Remnants of the carrier munitions will remain in both cases, and may assist with differential identification.

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41 This section is adapted from Jenzen-Jones, 2012c.

42 The smoke will have a distinctive garlic-like smell (Sciences International, 1997).

9N279

The Russian 9N279 (9H279) submunition is a parachute-retarded submunition, believed to carry a bursting incendiary payload. However, due to its relatively modern production and limited use history, only limited information about it is available. Images of one 9N279 submunition in Syria appeared online in 2022, but seem to have been taken in 2017 (ARES, n.d.). The 9N279 is a relatively large submunition, measuring around 280 mm in width and 530 mm in length. Based on the dimensions of the submunition, it is believed that is disseminated by a version of the 300 mm 9M55K missile—fired from the *Smerch* MBRL—or a cluster munition variant of the Iskander-M 9M723 ballistic missile. Alternatively, it is possible than an RBK-type cluster bomb could also deliver the 9N279 to its target.

Based on the available images of 9N279 submunitions from Syria and Ukraine, it appears that the 9N279 uses a parachute to slow its descent after ejection from its carrier munition. Further, the 9N279 is believed to carry a fuel-air or bursting incendiary payload, but this has not yet been confirmed (Leonidovych & Serhiyovych, 2023).

Figure 2.73 *Remnants of an unexploded 9N279 in Syria. Note the attached parachute and the submunition's large size relative to the artillery projectile on the right (source: @2EODMAN2).*

BetAB-20

The BetAB-20 (БетАБ-20; *Betonoboynaya Aviatsionnaya Bomba*; 'concrete-piercing aircraft bomb') is a concrete-piercing submunition designed to crater and disable both airfields and roads. Pictures showing unexploded BetAB-20 submunitions first surfaced in February 2017 in Al-Tamanah, Idlib governorate. In that incident, BetAB-20 submunitions were deployed by the RBK-500 BetAB cluster bomb, each of which holds 12 BetAB-20 submunitions (Human Rights Watch, 2009).

The submunition consists of a container tube that houses a penetrator and a parachute unit, weighing 25 kg in total (Dullum, 2008). Once the RBK-500 BetAB-20 carrier munition releases the container tubes, they fall to the ground; while falling, the submunitions tilt downwards. Once they reach an angle of around 60° to the ground, a parachute is ejected from the container tube which stabilises the submunition (Miropolsky et al., 1995). Once the submunition has built up sufficient momentum, a solid propellant rocket engine fires the penetrator from the container tube. The penetrator under these conditions can pierce up to 400 mm of concrete (*Russia's Arms and Technologies*, 2005). After the penetrator has entered the concrete, a delayed impact fuze detonates a charge of A-IX-2, creating a crater of around 4 m^2.

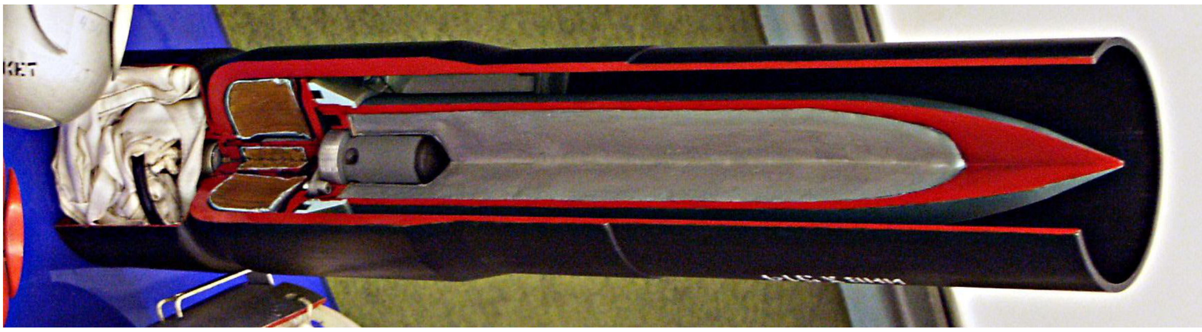

Figure 2.74 *A cutaway BetAB-20 submunition (source: Russian social media via ARES CONMAT Database).*

Figure 2.75 *Three BetAB-20 container tubes photographed in Al-Tamanah, Idlib Governorate, February 2017 (source: Syrian social media via ARES CONMAT Database).*

The RBK-500 BetAB-20 cluster munition measures 2500 mm in length, with a body diameter of 450 mm. When loaded, it weighs 525 kg and can be employed from an altitude of between 300 and 10,000 metres, reaching speeds between 500 to 1,000km/h (Hewson, 2002).

BetAB-20 Technical Characteristics

Length: 660 mm
Container tube diameter: 140 mm
Penetrator diameter: 76 mm
Weight: 25 kg
Explosive compound: A-IX-2

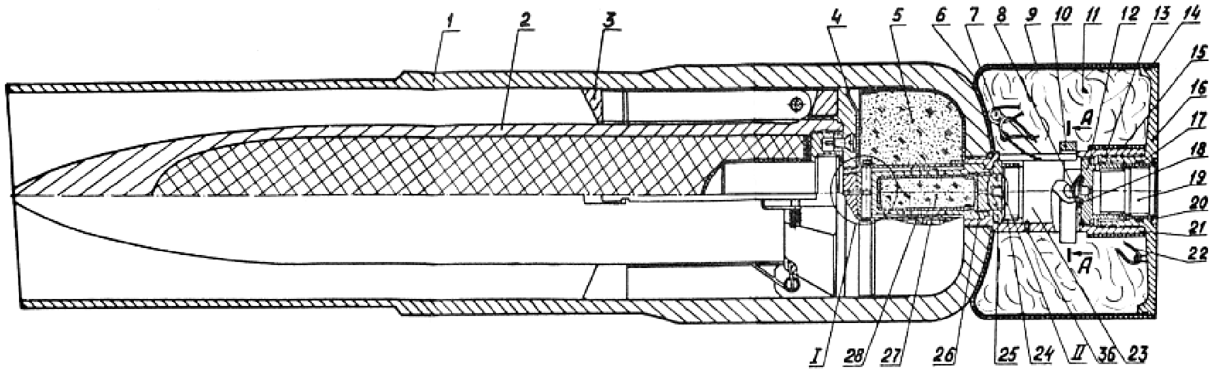

Figure 2.76 *Technical diagram of a BetAB-20 submunition (Source: USSR Ministry of Defence).*

RBK-500 BetAB-20 Technical Characteristics

Total weight: 525 kg
Overall length: 2,500 mm
Diameter: 450 mm
Number of submunitions: 12

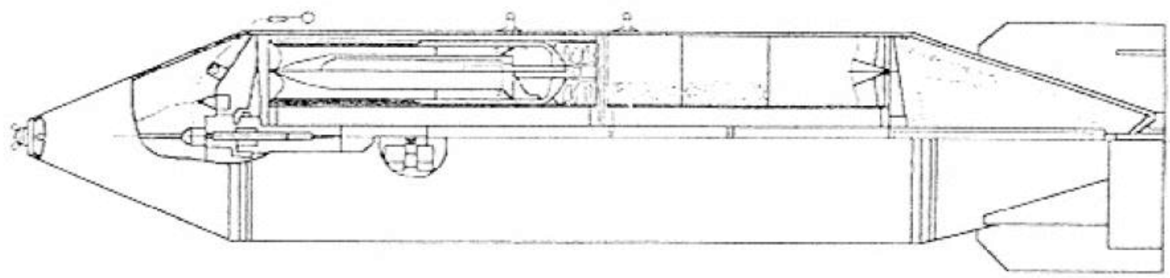

Figure 2.77 *Technical diagram of a RBK-500 BetAB-20 (Source: USSR Ministry of Defence).*

Area-denial Submunitions in Syria

Area-denial submunitions—sometimes referred to as scatterable mines—are submunitions that are deliberately designed to deny or limit the enemy's use of a target area. Such submunitions are employed in a similar fashion to the submunitions discussed above; that is, they are delivered by a cargo munition and dispersed over a wider area. As such, cargo munitions that can dispense conventional submunitions usually require only minimal modification to carry scatterable mines. However, unlike the submunitions discussed previously, area-denial submunitions are victim-initiated and not intended to detonate upon impact. Whereas most conventional submunitions feature a fuze that initiates when the submunition makes contact with a target, scatterable mines generally feature a fuze that initiates when a target makes contact with the submunition. Some scatterable mines can also be employed by combatants from the ground using simple remote mining systems to deny an area close to their position (Jenzen-Jones, 2020). Both conventional submunitions and scatterable mines present similar risks to combatants and civilians alike, hence the inclusion of munitions of the latter type in this report.

Type 84

In April 2014, near the town of Al-Sawaysa in the Syrian governorate of Quneitra, videos were uploaded of both Type 84 mines and remnants of the Chinese GBL212 122 mm rockets, which are used to deliver up to six individual mines (ARES, n.d.(a)). After the launch of a GBL212 rocket from, for example, the BM-21 'Grad' MBRL, a time fuze is triggered at a pre-determined distance and the rocket's warhead bursts to expel the mines, which make a controlled descent using drogue parachutes. During the descent, the three-prong legs at the bottom of the mines are released downwards and form a spike that pierces the ground (Jenzen-Jones & Lyamin, 2014b). The mine should be considered armed if these pronged legs are deployed.[43] Once embedded and armed, the warhead can penetrate up to 110 mm of RHAe by using the Misznay-Schardin effect[44] to project an EFP.

Figure 3.1 *A Type 84 scatterable mine (source: Libyan Mine Action Centre).*

43 Author interviews with a confidential source.

44 The Misznay-Schardin effect is the effect of the munition's explosive charge folding a sheet of metal into a penetrator to be used against armoured targets. It should not be confused with the Munroe effect, which directs an explosive effect using a cone-shaped cavity in the munition and is utilised in more common anti-tank munitions.

Figure 3.2 *A Type 84 scatterable AT mine near Al-Sawaysa, Quneitra Governorate, in April 2014. The drogue parachute is still attached, and it appears the mine has been shot with small arms in an effort to disable it, knocking it over and fracturing it in the process (source: Syrian social media via ARES CONMAT Database).*

Figure 3.3 *Another Type 84 mine near Sawaysa. Like in Figure 3.2, this mine appears to have been shot in an effort to disable it, with the body of the mine broken and explosive composition spilled out (source: Syrian social media via ARES CONMAT Database).*

Figure 3.4 *The remnants of the Chinese GBL212 122 mm rocket used to deliver the Type 84 mines, April 2014 (source: Syrian social media via ARES CONMAT Database).*

Three known variants of the Type 84 exist, each utilising a different fuze. The first variant, known as the GLD220, uses a magnetic influence fuze, disarming itself after approximately 72 hours once its internal battery has discharged. The second variant, known as the GLD220A, also features a magnetic influence fuze, though this variant uses a factory pre-set timer to self-destruct after 4.5, 13.6, 22.8, 36.4, or 72 hours. The final variant, known as the GLD221, uses a tilt-rod fuze (Jenzen-Jones & Lyamin, 2014b). It is unclear which variant or variants were employed within Syria from the review of images and videos. There have also been a number of recorded accidents involving the Type 84 mine in Libya.[45]

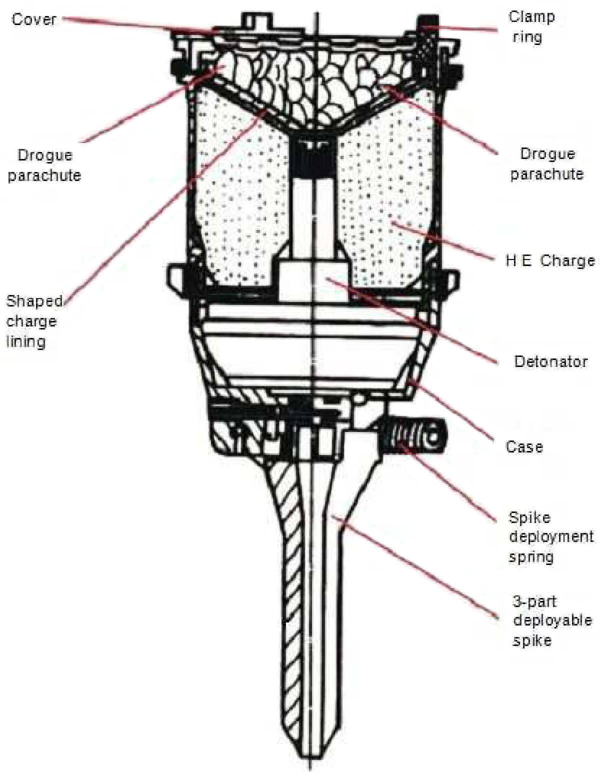

Figure 3.5 (right) *A technical diagram of the Type 84 mine with drogue parachute not deployed and spiked prongs in the downward position (source: Libyan Mine Action Centre).*

Type 84 GLD220 Technical Characteristics

Weight: 3.125 kg
Weight of explosive: 780 g RDX[46]
Diameter: 114 mm
Body Length: 160 mm
Overall Length: 270 mm

POM-2

The POM-2 (ПОМ-2; *Protivopekhotnaya Oskolochnaya Mina*; 'anti-personnel fragmentation mine') is a scatterable anti-personnel mine designed in the former Soviet Union. POM-2 mines were first documented in northern Syria in January 2019, though are rumoured to have been used as early as 2017 (ARES, n.d.(a); Ivagkin, 2020). The POM-2 mine can be deployed from the KMGU dispenser attached to fixed-wing aircraft. In addition, the mine can be deployed using a variety of remote mining systems. These systems include the helicopter-deployed VSM-1 or the land-based *Universal'nyy Minnyy Zagraditel'* (UMZ; 'Universal Minelayer') or *Perenosnoy Komplekt Minirovaniya* (PKM; 'Personal Mining Kit') (ARES, 2015). Irrespective of the delivery method, four POM-2 submunitions are placed into a KPOM-2 cassette to disperse the mine. Remnants of such cassettes were documented in Syria in March 2020, captured from Syrian government troops (ARES, n.d.(a)).

The KPOM-2 cassette is equipped with an ejection charge and an EKV-30M electrical primer (OCE MOD USSR, 1986). Four mines are housed in individual metal cylinders in each KPOM-2. When the cassette is placed into the delivery vehicle, it connects to a power source. Once an electrical current is applied, it triggers the charge, expelling the mines from the cassette. When employed with the PKM—an angled stand supporting the cassette—the four mines have a deployment range of about 30 m (*Arhub*, 2019).

45 Authors' correspondence with EOD teams in Libya.

46 It should be noted that the other variants of the Type 84 have marginally different figures for explosive weight.

Figure 3.6 *A POM-2 scatterable mine (source: Wikimedia Commons).*

Figure 3.7 *KPOM-2 cassettes captured from government troops in Jabal al-Zawiya, Idlib Governorate, in March 2020 (source: Syrian social media via ARES CONMAT Database).*

Figure 3.8 *A POM-2 mine that failed to deploy its tripwires, pictured in northern Syria in January 2019 (source: Syrian social media via ARES CONMAT Database).*

Between 0.2 and 0.6 seconds after launch, the KPOM-2 ejects all four POM-2 mines. Each mine deploys four stabilising ribbons to ensure it lands correctly. Shortly after ejection, a pyrotechnic delay element functions, ejecting the metal cylinders free from the mine. Next, a second expelling charge ensures the mine is standing upright, and six folding legs are released. Lastly, a block is expelled from the top of the mine, spreading four tripwires across the ground (OCE MOD USSR, 1986). Each wire is reportedly ten or five-metres long and is connected to fuze pins (NATO EOD Centre of Excellence, 2016). When a force of 300 g or more is applied to a wire, the pin shifts and detonates the mine.

The POM-2 mine features a fragmentation sleeve which provides a lethal radius of 6–8 m (with some reports suggesting up to 20 m) (NATO EOD Centre of Excellence, 2016; D'Aria & Grau, 1996). The mine comes in several variants, some featuring a self-destruct function or allowing for the device to be hand-emplaced. The POM-2 mine does not feature any electrical components, in order to increase shelf life and durability in the field; its self-destruct feature is initiated by a hydromechanical component of the VP-09C fuze (*Top War*, 2015).

POM-2 Technical Characteristics

Total weight: 1.6 kg
Weight of explosive: 140 g
Type of explosive: TNT or TNT/RDX
Diameter: 63 mm
Height (body): 105 mm
Height (with stabilisers extended): 180 mm
Fuze: VP 09S

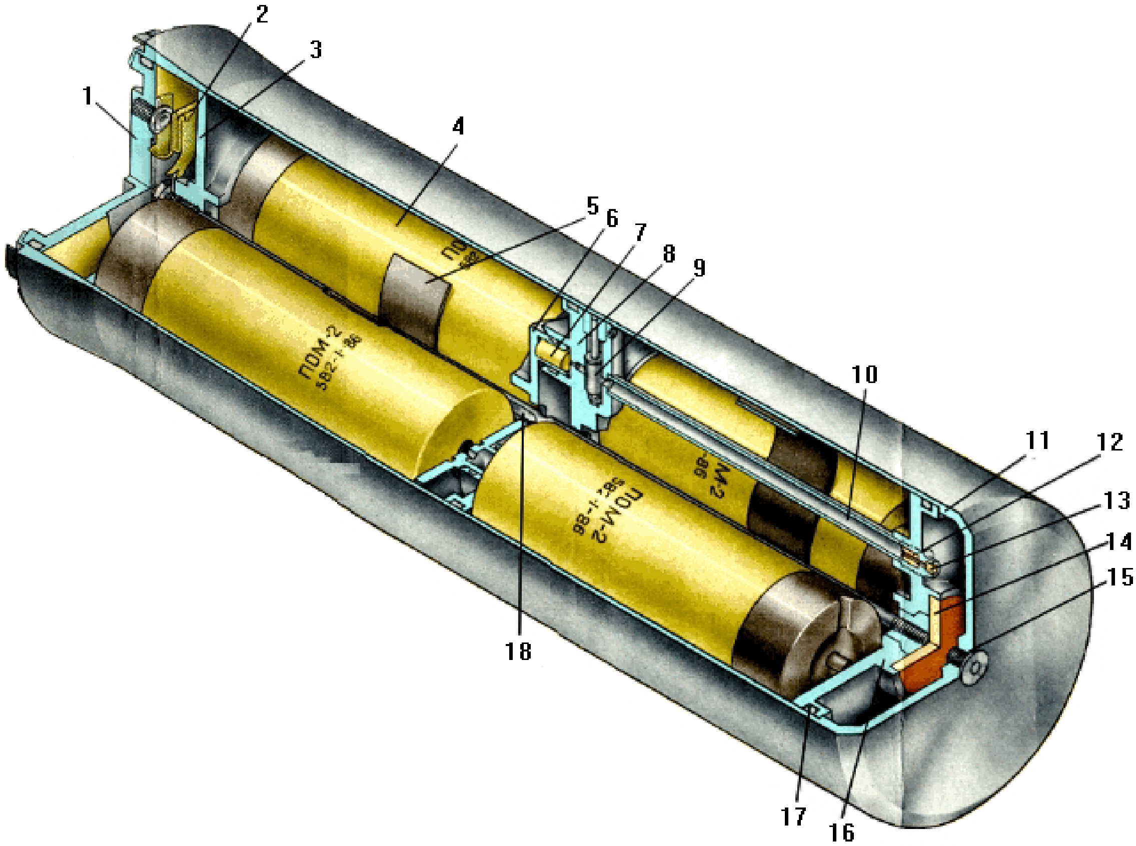

Figure 3.9 *Technical drawing of a KPOM-2 cassette (source: Russian social media via ARES CONMAT Database).*

PTM-4

The PTM-4 (ПТМ-4; *Protivo Tankovaya Mina*; 'anti-tank mine') is a Russian-designed scatterable anti-tank mine, first documented in Syria in 2018 near Homs and Hama. As with the POM-2, the PTM-4 can be deployed by any remote mining system that uses the standardised K-cassette—the KPTM-4 in this case. Thus, the mine can be deployed from ground vehicles, helicopters, aircraft, and rockets. The PTM-4 apparently does not reliably self-destruct (Ivagkin, 2018); as a result, it poses a lasting UXO threat.

Figure 3.10 *A PTM-4 scatterable mine (source: ArmedConflicts.com).*

Figure 3.11 *Two unexploded PTM-4 mines photographed near Homs in April 2018 (source: Syrian social media via ARES CONMAT Database).*

The PTM-4 is an improvement of the earlier the PTM-3 (Popov et al., n.d.). The PTM-3 is a rectangular landmine with a groove to focus the explosive energy present on all four sides. The mine's dispenser cassette—the KPTM-3—has a cylindrical shape, meaning only one rectangular PTM-3 mine can be deployed per cassette (D'Aria & Grau, 1996). Additionally, the PTM-3 does not feature an orientation device; therefore, when dispersed, any side of the mine could collide with the ground without decelerating. Hence, the PTM-3 must have a concave shaped-charge surface on all four sides and thick metal walls to prevent damage from impact. The PTM-4, on the other hand, has a semi-cylindrical body so that two mines can be placed into one cylindrical cassette. A groove runs lengthwise on the flat side of the mine to focus the explosive energy upwards. The mine is designed so that it lands with its flat side upwards by deploying a spring-loaded wire frame that holds a fabric cover. This frame and fabric cover function as a device-stabilising mechanism and a decelerator, respectively (Popov et al., n.d.).

As a scatterable anti-tank mine, the PTM-4 is deployed from the KPTM-4 cassette. Each cassette holds two mines and can be deployed from helicopters via the VSM-1 system, rockets via the VSM-2 system, RBK-500 cluster bombs, UMP universal minelayers, and PKM portable mining kits (Directory of Scout-Saboteur, 2021). Two PTM-4 mines with their wire frames folded are housed in a KPTM-4 cassette. When a mine is expelled from a cassette via a low explosive charge, a pyrotechnic delay charge is ignited, and the mine's wireframes and fabric cover unfold to slow the mine's descent. Upon impact, the device-stabilising frame and the mine's low centre of gravity ensure it is orientated correctly. Next, its pyrotechnic delay charge activates an expulsion charge which ejects the safety pin from mine—arming the munition—and drops the fabric cover from the frame (Popov et al., n.d.).

PTM-4 mines are triggered by the VT-14 fuze, a magnetic-influence proximity design which allows the mine to function underneath an armoured vehicle even without physical contact. Detonation is also triggered on contact, if an armoured vehicle's track or wheel roles over the mine. The PTM-4 also possesses two anti-tampering features. Firstly, the magnetic fuze detonates the mine when it is moved a certain amount relative to the earth's magnetic field. Secondly, a ball contactor triggers the mine when it is otherwise disturbed (Engineering Armed Forces of Ukraine, 2020).

The PTM-4 mine supposedly self-destructs after 8, 12, 24 or 48 hours, or self-deactivates after 120 days. In the 2018 case documented above, it seems as though the mine failed to arm completely, meaning the self-destruct countdown was never initiated. This is notable as the mines were only eight years old—PTM-4 mines have a reported shelf life of ten years. While in theory the mines could have self-deactivated, this seems unlikely seeing as how they would have had to remain unnoticed for 120 days.

Besides the scatterable PTM-4 version, there is a hand-emplaced version—the PTM-4R (ПТМ-4Р). This version can be emplaced using the KRM-T anti-tank manual mining kit. The versions are outwardly identical, featuring a spring-loaded wire frame holding a fabric cover. While the scatterable PTM-4 version is armed by a pyrotechnic delay fuze, the hand emplaced PTM-4R is armed by an operator removing a nylon safety thread (Evgenyevich et al., n.d.). Due to the few differences between the two versions, it cannot be determined with certainty if the PTM-4 documented in 2018 was manually emplaced or otherwise deployed.

PTM-4 Technical Characteristics

Length: 350 mm
Width: 110 mm
Height: 55 mm
Explosive compound: TG-40
Explosive mass: 1.4 kg
Total weight: 3.25 kg
Area covered by sensor: 350 × 110 mm

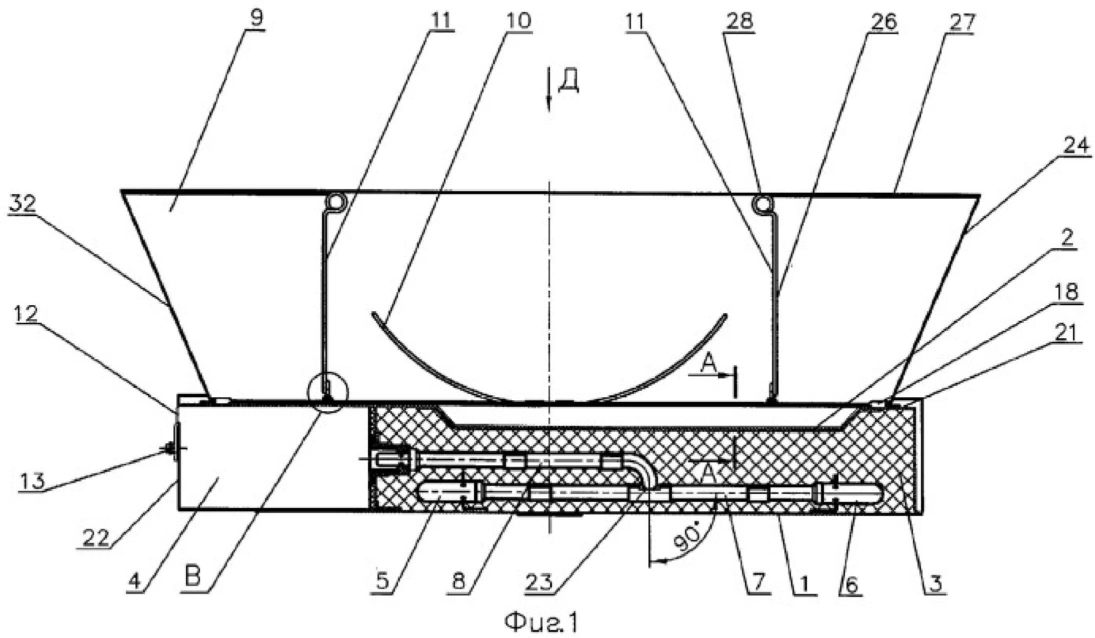

Figure 3.12 *A technical drawing of a PTM-4 mine with its wire frame and fabric unfolded. Note the safety pin (13), the dual explosive initiators (5 & 6), and the unfolded wire frame (26) holding up the fabric cover (27) (source: Baturin, et al., n.d.).*

Repurposed Submunitions

The problem posed by unexploded submunitions in Syria does not end at their high risk to non-combatants. ARES researchers have also documented numerous cases in which these fairly common unexploded ordnance items have been repurposed into hand grenades, IEDs, or other improvised munitions. This has been recorded for submunitions with both anti-personnel and anti-armour functions, as seen below. Overall, seven different models of submunition have been documented as having been repurposed in Syria: AO-1SCh, AO-2.5RT, PTAB-2.5, ShOAB-0.5, MZD-2, ZP-39A, and SPBE. In addition, the POM-2 scatterable anti-personnel mine has been documented with a repurposed delivery method.

The practice of repurposing UXO more generally is not uncommon in conflict zones, including in Syria, where different kinds of unexploded munitions and even parts of munitions (such as tail fins) have been repurposed into IEDs (ARES, n.d.(a)). However, the repurposing of submunitions is much less well documented than the application of the practice to other munitions, despite the threat it poses to the modifier, the end user, and the targets of the improvised munition. Broadly speaking, repurposing unexploded submunitions is attractive to non-state actors for two primary reasons. First, the high dud rate of some models of submunitions—particularly many seen in Syria—offers a relatively plentiful source of military-grade high explosives. Second, anti-personnel and anti-armour submunitions are professionally designed and manufactured to effectively fulfil their role, typically making them superior to comparable homemade devices. For example, anti-personnel submunitions usually feature a pre-fragmented body that maximises the dispersion and lethality of fragmentation, and anti-armour submunitions typically utilise some form of shaped charge that focuses the explosion's energy. These characteristics are often difficult and time-consuming for craftsmen to replicate at the individual level.

In many cases in Syria, the actors repurposing unexploded submunitions have not done so on a random or experimental basis, instead standardising their practices and procedures. In some cases assembly-line-style production has taken place (ARES, n.d.(a)). Video 'instruction manuals' have even been produced to teach militants how to repurpose the submunitions according to these procedures (Rufas, 2020; Fulmer, 2015b). This demonstrates a level of sophistication underpinning the design and employment of some of these seemingly crude munitions.

Repurposed Anti-personnel Submunitions

At least three models of submunition with a primary anti-personnel function have been repurposed in Syria.

AO-2.5 RT/RTM HE-FRAG submunitions have been identified as particularly unreliable when striking soft surfaces. Therefore, large numbers do not detonate and have been turned into improvised munitions or harvested for explosive content.

ShOAB-0.5 HE-FRAG bomblets have been regarded by some actors as particularly effective when repurposed into hand grenades, and they have been observed in use with armed groups such as Hay'at Tahrir al-Sham (ARES, n.d.(a)). In some cases, ShOAB-0.5 submunitions have been repurposed by drilling a hole into the munition and inserting a UZRGM-pattern (*Universal'nyi Zapal, Ruchnaya Granata, Modernizirovannyi*; 'Universal Igniter, Hand Grenade, Improved') fuze (see *Figure 3.13*). This turns the submunitions into a fragmentation hand grenade that contains more than 300 pre-formed spherical steel fragments (USSR, 1973).

Figure 3.13 *A repurposed ShOAB-0.5 HE-FRAG submunition fitted with a UZRGM-pattern fuze, creating an improvised hand grenade (source: Syrian social media via ARES CONMAT Database).*

AO-1SCh HE-FRAG submunitions are also often repurposed into hand grenades. This is sometimes done by removing the tail fins of the bomblet as well as its original fuze. In one notable cases (see *Figure 3.14*) approximately 100 mm of safety fuze appears to be inserted into the main A-IX-2 charge. A non-electric detonator may also be employed. Other times, the tail fins remain attached, but the original fuze is replaced by a safety fuze or pyrotechnic detonator.

Figure 3.14 *With the tail fins section of the submunitions and the AM-A B/V fuze removed, a length of safety fuze has been inserted and sealed into the top of several of these AO-1SCh munitions, creating improvised hand grenades (source: Syrian social media via ARES CONMAT Database).*

Repurposed Anti-armour Submunitions

In addition to submunitions being repurposed into anti-personnel fragmentation munitions, at least two models of HEAT submunitions have been turned into anti-armour munitions.

The PTAB-2.5M has been frequently repurposed. As noted in this report, the PTAB-2.5M is operated by a fairly complex arming mechanism and is prone to duds when dropped from insufficient height or onto soft ground. PTAB-2.5M submunitions have been documented as repurposed mortar projectiles, as well as improvised rocket warheads (ARES, n.d.(a); Higgins, 2013). In both cases, the PTAB-2.5M's fuze and tailfins were removed and replaced. To function as rocket warheads, a sophisticated workshop was documented that manufactures rockets purpose-built to carry PTAB-2.5M submunitions, with custom-made fittings and fuzes (Higgins, 2012).

Figure 3.15 *A PTAB-2.5M submunition, with a length of safety fuze that appears to be inserted into the primary explosive charge of the munition. A non-electric detonator may also have been employed (source: Syrian social media via ARES CONMAT Database).*

SPBE IR HEAT submunitions have been repurposed as anti-armour IEDs. In this case, the submunition's EFP is utilised. Homemade IEDs using EFPs designed to destroy armour have been documented numerous times in Iraq (Horton, 2020), Yemen (Knights, 2018), Syria (ARES, n.d.(a)), and elsewhere. However, the effectiveness of the Misznay-Schardin effect—translating explosive energy into an EFP—is highly dependent on the geometry and material of the warhead (Walters & Zukas, 1989). Therefore, an unexploded SPBE represents a potentially repurposed anti-armour IED of particular concern, as the SPBE is likely to be significantly more effective in directing its energy than most craft-produced IEDs.

Figure 3.16 *Still from a video by Jabhat al-Nusra from October 2015 showing the disassembly of a SPBE submunition (source: Syrian social media via ARES CONMAT Database).*

An IED using ZP39A DPICM submunitions may have been used near Aleppo in March 2022 (Eyon & Othman, 2022). Little is known about this case.

Some unexploded submunitions have been repurposed for easy delivery by commercial UAVs. Models that have been documented as repurposed in this way include the PTAB-2.5M HEAT submunition and ShoAB-2.5 HE-FRAG submunition (Rufas, 2021), but also the Chinese-made MZD-2 and ZP39A HEDP submunitions (Wright & Jenzen-Jones, 2018). Whilst perhaps not as dramatic as the 'domain change' seen in some other repurposed uses, this phenomenon demonstrates how even non-state actors with limited funds can improve the combat capabilities of commercial off-the-shelf UAV technologies by repurposing conventional munitions.

Figure 3.17 *An intercepted commercial UAV with a modified PTAB-2.5M munition (source: Syrian social media via ARES CONMAT Database).*

Finally, POM-2 scatterable anti-personnel mines have occasionally been repurposed to be fired as part of a rocket-assisted projectile powered by an RPG-7 rocket motor instead of their purpose-built canisters. Converting a POM-2 to be transported by an RPG-7 rocket motor is a relatively simple task. A machine screw can be inserted in place of the stabilising ribbon attachment, which allows the mine to be screwed onto the rocket motor (Sheldon, 2020). Such modified POM-2 mines were positively identified in Syria in November 2020; however, it is likely they were used earlier in the conflict. The use of such POM-2 mines dispersed by RPG-7 projectiles has been attributed to members of the Wagner Group—both in Syria's Idlib governorate and on multiple occasions in Libya.[47]

Figure 3.18 *A deployed POM-2 mine with the RPG-7 rocket motor next to it, Jabal Zawiya area, south of Idlib town (source: Syrian social media via ARES CONMAT Database).*

47 Author's correspondence with a confidential source.

Appendix 1 – Technical Characteristics of Identified Submunitions

Submunition	Delivery Munition[48]	Submunitions in Delivery Munition	Body Diameter	Overall Length	Total Weight[49]	Fuze	Explosive Weight & Composition	Country of Origin
AO-1SCh	RBK-250-275 AO-1SCh air-delivered cluster bomb	140	49 mm (body); 60 mm (tail fins)	153–158 mm	1.2 kg	AM-A B/V	38 g A-IX-2 (73% RDX, 23% aluminium, 4% wax)	USSR
9N235	9M55K 300 mm cargo rocket 9M27K 220 mm cargo rocket	72 30	65 mm	263 mm	1.75 kg	9E272	312 g A-IX-10 (95% RDX, 5% oxazine)	USSR/ Russia
9N210	9M27K 220 mm cargo rocket 9M55K 300 mm cargo rocket	30 72	65 mm	263 mm	1.8 kg	9E246 or 9E246M	300 g A-IX-10 (95% RDX, 5% oxazine)	USSR/ Russia
9N24	9K79 missile with 9N123K cargo warhead	50	88 mm	373 mm	7.45 kg	9E237	1.45 kg A-IX-2 (73% RDX, 23% aluminium, 4% wax)	USSR
O-10	240 mm cargo mortar projectile 3O8 Nerpa	14	65 mm	300 mm	3.9 kg		640 g A-IX-2 (73% RDX, 23% aluminium, 4% wax)	USSR
ShOAB-0.5	RBK-500 ShOAB-0.5	560–570[50]	64 mm	64 mm	417 g	AV-281	85 g TG-30 (70% RDX, 30% TNT)	USSR
AO-2.5RT	RBK-500 AO-2.5RT BKF A0-2.5RT	60 12	90 mm	150 mm	2.5 kg	I-352V	300 g TG-40 (60% RDX, 40% TNT)	USSR
AO-2.5RTM	RBK-500 AO-2.5RTM BKF AO-2.5RTM	60 12	90 mm	150 mm	2.8 kg	I-352V	300 g[51] TG-40 (60% RDX, 40% TNT)	USSR
AO-2.5RTM	RBK-500 AO-2.5RTM air-delivered cluster bomb	108	90 mm	150 mm	2.5 kg	I-352V	550 g TG-40 (40% TNT, 60% RDX)	USSR
PTAB-2.5M	RBK-250 PTAB-2.5M air-delivered cluster bomb	42	68 mm (body); 87-90 mm (tail fins)	332–339 mm	2.8 kg	AV-524M	450 g TG-50 (50% RDX, 50% TNT)	USSR
PTAB-2.5KO	BKF PTAB-2.5	12	60 mm	307 mm	1.82 kg	I-350AM	184 g A-IX-10 (95% RDX, 5% oxazine)	USSR
PTAB-1M	RBK-500 PTAB-1M air-delivered cluster bomb BKF PTAB-1M	268 31	42 mm	260 mm	944 g	PIBD with SD feature	110 g K991 (RDX-based)[52]	USSR

48 Potential delivery munitions observed or plausibly in Syria. Other delivery munitions may exist for some of these submunitions.

49 Total weights are approximate.

50 Nominally 565 submunitions +/- 5 pieces.

51 Some sources suggest 550 g.

52 Evans & Seddon, 2022.

Sakr Type B	Sakr-18 122 mm cargo rocket Sakr-36 122 mm cargo rocket Sakr-45 122 mm cargo rocket	72 98 72	38.5 mm	77 mm	187 g	Unknown[53]	31 g RDX (96% RDX, 4% wax)	Egypt
ZP39A	122 mm cargo projectile	33[54]	39.2 mm[55]	80 mm[56]			~ 40–50 g unknown compound	China
MZD-2	Type 81 122 mm cargo rocket COTS UAV	39[57]	42.5 mm[58]					China
3B30	9M218 122 mm cargo rocket 9M55K5 300 mm cargo rocket	45 588	43 mm	128 mm	240 g	N/A	46 g unknown compound	Russia
SPBE	RBK-500 SPBE air-delivered cluster bomb 300 mm 9M55K1 cargo rockets	15 5	185 mm	384 mm	17.3 kg	IR seeker	5.8 kg TG-40 (60% RDX, 40% TNT)	USSR
ZAB-2.5	RBK-250 ZAB-2.5 air-delivered cluster bomb	48	68 mm	244–249 mm	2.2–2.5 kg		3 Variants. All contain thermite. Variants 2 and 3 contain PETN bursting charges. Variant 3 contains a thickened incendiary mixture.	USSR
ZAB-2.5M1, M2, S	RBK-500 ZAB-2.5SM air-delivered cluster bomb	297	60 mm (ZAB 2.5M1 & M2) 90 mm (ZAB 2.5 S)	240 mm (ZAB 2.5M1 & M2) 140 mm (ZAB 2.5S)			ZAB-2.5M1 with N-16 incendiary composition ZAB-2.5M2 with N-17 incendiary composition ZAB-2.5S with OM-68-35 composition	USSR/ Russia
BetAB-20	RBK-500 BetAB-20 cluster bomb	12	140 mm (tube) 76 mm (penetrator)	660 mm	25 kg	Delayed contact fuze	A-IX-2 (73% RDX, 23% aluminium, 4% wax)	USSR/ Russia
9N279[59]			280 mm	530 mm				Russia
Type 84	GLB212 122 mm cargo rocket	6	114 mm	270 mm	3.125 kg	GLD220 or GLD220A or GLD221	780g RDX	China
POM-2	KPOM-2 cassette	4	63 mm	105 mm	1.6 kg	VP 095 (for POM-2S)	140 g TNT or TNT/ RDX	USSR
PTM-4	KPTM-4 cassette	2	110 mm	350 mm	3.25 kg	VT-14	1.3 kg TG-40 (60% RDX, 40% TNT)	Russia

53 Likely to be a copy of the M233 Impact-inertia fuze.

54 Estimated based on Norinco, 2011, pp. 35–36.

55 Estimated based on Norinco, 2011, pp. 35–36.

56 Estimated based on available imagery and similarity to other Chinese submunitions.

57 Estimated based on Norinco, 2011, p. 80.

58 Estimated based on Norinco, 2011, p. 80.

59 Estimated based on available imagery and measurements done in the field.

Appendix 2 – Chronology & Geography of Submunitions in Syria

First documented appearance of submunition types in Syria by date and location.

Date	Submunition Type	Location
July 2012	AO-1SCh	Jabal Shahshabu, Hama Governorate
August 2012	PTAB-2.5M	Talbiseh, Homs Governorate & Abu Jamal, Deir al-Zour Governorate
November 2012	ZAB-2.5	Maraat al-Numan,Idlib Governorate
December 2012	Sakr Type B	Jabal al-Zaweya, Idlib Governorate & Latamneh, Hama Governorate
March 2013	ShOAB-0.5	Heish, Idlib Governorate
May 2013	PTAB-2.5KO	Basqala, Idlib Governorate
May 2013	ZP39A[60]	North-west Syria
June 2013	AO-2.5RT	Harbnafeh, Hama Governorate
February 2014	9N210	Daraa Governorate
February 2014	9N235	Keferzita, Hama Governorate
April 2014	Type 84[61]	Al-Sawaysa, Quintera Governorate
October 2015	SPBE	Aleppo Governorate
October 2015	AO-2.5RTM	Douma Governorate
October 2015	O-10	Damascus Governorate
November 2015	ZAB-2.5M1, ZAB-2.5M2 & ZAB-2.5S	Idlib Governorate
February 2016	PTAB-1M	Al-Ghanto area, Homs Governorate
August 2016	MZD-2	Aleppo Governorate
February 2017	BetAB-20	Al-Tamanah, Idlib Governorate
April 2018	PTM-4	Homs Governorate
May 2018	9N24	As-Suwayda Governorate
January 2019	POM-2	Northern Syria
April 2019	3B30	Unclear

***Note:** Should you know of earlier use cases than those listed above, please email details to: contact@armamentresearch.com*

60 (Ansar Alhaq, 2013)

61 (diaa hariri, 2014)

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