



GICHD Advisory Note

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Sub-munitions and cluster bomblets - Render Safe Procedures (RSP)



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Sub-munitions and Cluster Bomblets - Render Safe Procedures (RSP)

1. Scope

This GICHD Advisory Note establishes principles and provides guidance on the EOD clearance of sub-munitions and cluster bomblets encountered during demining operations in a permissive post-conflict environment.

2. References

A list of normative references is given in Annex A. Normative references are important documents to which reference is made in this Advisory Note and which form part of the provisions of this Advisory Note.

3. Terms and definitions

A list of terms and definitions used in this document is given in Annex B. As in the Technical Notes for Mine Action (TNMA) series, the words 'should' and 'may' are used to indicate the intended degree of compliance. This use is consistent with the language used in International Mine Action Standards (IMAS), and guides.

- a) 'should' is used to indicate the preferred requirements, methods or specifications; and
- b) 'may' is used to indicate a possible method or course of action.

4. Types

There are numerous generic types of sub-munition and/or bomblets;

- a) chute stabilised;
- b) dual purpose improved conventional munitions (DPCIM);
- c) fin stabilised (anti-armour or fragmentation); and
- d) spin armed.

These are summarised at Annex C.

5. Background

The term 'submunition' generically describes any item of ordnance carried in or ejected by a dispenser. Anything from a scatterable mine to a remotely delivered radio jammer might be described as a submunition, the enormous diversity making it difficult to define their characteristics and effects.

EOD technicians are mainly concerned with submunitions having high explosive (HE) fillings, which tend to be referred to as 'bomblets'. However, for the purposes of this Advisory Note the term submunition will be used throughout.

A wide variety of launch or delivery systems are used, including missiles, rockets, projectiles and mortars. Submunition warheads for these types of land service ammunition are normally called 'carriers', while bombs containing submunitions are generally known as 'cluster bombs'. Some air-delivered submunitions are dispensed from canisters, which remain attached to the aircraft; examples include the British JP-233, German MW-1 and Russian KMG-U.

5.1. Typical operation

Once the dispenser has been fired, launched or dropped, opening is normally determined by a time delay or proximity fuze. The submunitions are normally dispensed in one of three ways: base ejection, nose ejection or case rupture. Base ejection is most common in projectiles, but is also used in other carriers and some cluster bombs. In both nose ejection and base ejection, the fuze usually initiates a small propellant charge, which opens the carrier and pushes the submunitions out.

Case rupture, used in some rocket and missile warheads, sometimes involves the use of small linear cutting charges to split the casing, and may also use a propellant charge to eject the submunitions. Most (but not all) submunitions incorporate a separate arming mechanism (such as wind-driven vanes) which functions, after ejection, as the submunition falls.

The majority use some form of stabilisation (normally fins, a streamer or a chute) to bring them into a nose-down attitude, but some are designed to spin in the air stream and use this movement for arming. Since submunitions disperse after ejection, the density of the impact footprint is dependent on the speed and altitude at which the dispenser opens. Most submunitions are designed to detonate on impact, but some (such as scatterable mines) are victim-operated or incorporate delays.

6. Submunition failures

Submunition failure rates are dependent on a number of factors;

- a) design ¹;
- b) length and condition of storage;
- c) drop height and velocity;
- d) vegetation; and
- e) ground conditions at the impact area.

The rigorous design and manufacture of newer 'smart' munitions make them less likely to malfunction than older mechanically fuzed types.

7. Disposal considerations

There are numerous disposal considerations dependent on the type of submunition encountered. Some, or all, of the following should be considered:

- a) some types of submunition may not arm if the release altitude of the cluster bomb is too low;
- b) the relatively high mass and narrow shape of some submunitions means that they may penetrate soft ground and become buried;
- c) armed submunitions are prone to failure if the angle of impact is too great, or if their fall is broken by vegetation or soft ground;

¹ For example, in the case of the M42 the drag ribbon may become detached in flight, hence the Bomblet may not become armed. Or, the detonator shutter does not move into the armed position due to incorrect assembly, for example the detonator shutter spring is missing and or the slide is jammed.

- d) submunitions incorporating stab-sensitive or all-ways acting fuzes are particularly dangerous;
- e) partially impacted mechanisms can be sensitive since the firing pin may be touching, or imbedded in, the stab-sensitive detonator;
- f) some types of submunition, such as DPICM, are subject to high failure rates and may therefore be encountered in large quantities;
- g) large numbers of unexploded submunitions at a contaminated site often substantially complicates an otherwise straightforward clearance operation. Small numbers could indicate the presence of more submunitions over a wider area;
- h) unexploded submunitions are often found above ground in vegetation or lodged in manmade structures;
- i) thick-walled varieties can produce heavy fragments, lethal at substantial ranges;
- j) submunition dispensers often incorporate hazardous components such as ejection charges and linear cutting charges;
- k) the presence of submunitions is often indicated by empty containers and packaging.
- l) proximity fuzes should never be approached from the front;
- m) the presence of ejection charges and linear cutting charges should be considered;
- n) unopened cluster bombs require special demolition techniques to ensure the destruction of all submunitions;
- o) nose fuzes are often badly damaged during impact and may not be identifiable;
- p) tail sections may incorporate powerful springs, which can cause injury; and
- q) thermal coatings will attenuate the power of demolition charges.

8. Render Safe Procedures (RSPs)

There are five RSPs applicable to the safe disposal or destruction of submunitions. The RSP selected will be dependent on the specific type of submunition and the operational scenarios. The decision as to which RSP to employ should be made by the clearance team manager, in conjunction with his EOD technician.

- a) destruction by detonation in situ;
- b) deflagration by the use of point focal charge in situ;
- c) deflagration by the use of pyrotechnic torch in situ;
- d) use of alternate techniques; and
- e) manual disarmament of the fuze.

Of these RSPs, (a) is the most common, (b) and (c) can be conducted by experienced staff with the correct equipment, whilst (d) and (e) should only be attempted by clearance teams with appropriately qualified EOD technicians.

WARNING: A major factor that should always be considered during the disposal of submunitions is the danger posed by the formation of the jet from the shaped charge. Shaped charge jets have the potential to fly over 1800 metres in free air. Therefore every attempt should be made to degrade the performance of this jet. This is usually achieved by placing the destruction charge in such a position that it also attacks the integrity of the cone liner. An alternative is to place a robust barrier in front of the submunition to degrade the charge that way.

WARNING: Wind speeds in excess of 8 miles per hour (mph) may cause the initiation of certain types of blind bomblets. According to information from American sources, winds in excess of 8 mph or dust devils (mini-tornadoes) may disturb the drag ribbon and firing pin assembly of the M42 bomblet. In this instance there is a possibility of the bomblet functioning. It is reasonable to assume that this risk is present for similar munitions such as the FRY KB1.

8.1. Destruction by detonation in situ

The submunitions are to be destroyed in situ without moving or touching the item unless in the case of certain bomblets, (such as M42 and KB1), they can be positively identified as being unarmed.

The recommended method is to place a donor high explosive charge adjacent² to the submunition taking care not to disturb the submunition. Normal demolition procedures should then be applied. Submunitions may be disposed of in multiples using cord detonating to link charges.

8.2. Point focal charge destruction

A purpose designed shaped charge, (often referred to as a point focal charge), such as the Swiss RUAG SM-EOD system may be used to induce deflagration of the main filling. This method is generally inherently safer than destruction in situ by demolition as the charge can be deployed at a distance from the target, (at least 80 mm).



WARNING: When employing point focal charges EOD technicians must be aware that detonation of the target munition may occur. Appropriate tamping and safety distances are therefore to be applied.

WARNING: The point focal charge should be positioned in such a way that the cone liner is degraded. In the event of a detonation this will significantly degrade the performance of the shaped charge jet.

8.3. Deflagration by the use of pyrotechnic torch

The use of a pyrotechnic charge to induce deflagration of the submunition has been used with some success, however the risk of deflagration to detonation transfer (DDT) in the submunition is possibly higher with this RSP than any other.

WARNING: When employing pyrotechnic torches EOD technicians must be aware that detonation of the target munition may occur. Appropriate tamping and safety distances are therefore to be applied.

² The donor charge does not even have to be that close to the submunition. Empirical data from demilitarization and trials facilities have suggested that anything within a 2 charge diameters will initiate. However, due to the relatively small explosive content of this RSP, and the thickness of the case compared to the explosive filling, then it is suggested that anything within ½ a charge diameter will produce a safe operating envelope.

WARNING: The pyrotechnic torch should be positioned in such a way that an attempt is made to degrade the cone liner. However as this RSP is orders of magnitude slower than a HE or shaped charge attack the effectiveness of this approach is open to question. If a DDT then takes place then it is very likely that little damage will have taken place to the cone, therefore an effective shaped charge jet should be expected!

8.4. Alternate techniques

Alternate techniques are designed to separate the fuze mechanism from the main charge of the submunition. Once separated, the fuze well cavity of the munition is to be inspected to ensure that no hazardous components of the fuze remain. If the fuze well cavity is clear of hazardous components then the munition can be moved and disposed of in a suitable location. It may even be possible to also move the fuze, provided that all component parts can be positively identified and the EOD technician is 100% certain that the initiation mechanism has been totally disrupted.

Alternate techniques include:

- a) the use of a 0.50" dearmor³; or
- b) the use of an explosively projected flat steel plate.

WARNING: When employing alternate techniques EOD technicians must be aware that detonation of the target munition may occur. Appropriate tamping and safety distances are therefore to be applied.

WARNING: This RSP should only be carried out by appropriately qualified EOD technicians who are familiar with ALL aspects of the submunition and fuze mechanism design.

8.5. Manual disarmament of the fuze

WARNING: This RSP is only suitable for DPICM munitions such as the M42 or KB1 bomblets. It is NOT recommended for any other type of submunition. The RSP is specifically designed for simple mechanically fuzed munitions and should NOT be attempted for any submunition with electronic or piezo-electric fuze components.

WARNING: This RSP carries an obvious inherent risk if the manual dexterity of the EOD technician is impaired for any reason. Therefore it should only be attempted for a "Category A" task⁴.

Sufficient small holes are to be dug to accommodate the Bomblets whilst the operator dresses in full EOD Suit complete with helmet. The operator should then approach each Bomblet and check to see if it is armed or unarmed.

The unarmed Bomblets can be disposed of in accordance with the specific procedures laid down by the parent demining organisation.

Armed Bomblets may be dealt with in the following manner:

³ Successful RSPs have also been conducted using the mini-disrupters designed for Improvised Explosive Device Disposal (IEDD). The same warnings apply.

⁴ A Category A EOD task is defined by NATO as "Assigned to EOD incidents that constitute a grave and immediate threat to life. Category A incidents are to be given priority over all other incidents, and disposal operations are to be started immediately regardless of personal risk". Category A tasks are not referred to in IMAS as time is rarely an immediate factor in humanitarian demining operations.

- a) the drag ribbon should be held with one hand and the body of the Bomblet grasped in the other. A light pull should be exerted to keep the drag ribbon taught to ensure that the firing pin assembly is kept away from the detonator;
- b) the complete submunition is then to be immersed in water to wash away any grit that may be on the exposed detonator pellet;

WARNING: Any movement of the detonator shutter before it is cleaned could induce grit sensitisation of the explosive. This makes it highly susceptible to friction initiation.

- c) with either the finger or thumb of the hand grasping the body, the detonator shutter is then pushed back into the fuze housing, the unarmed position. Once in the unarmed position the detonator shutter is maintained in that position by a steady pressure against the force of the detonator shutter spring;
- d) whilst maintaining the pressure on the detonator shutter the Bomblet is inverted so that the drag ribbon is to the bottom, then screw the firing pin assembly back into the inertia pellet;
- e) if the firing pin assembly will not screw back in, then, maintaining pressure on the detonator shutter, press down on the firing pin assembly so that it retains the detonator shutter in the unarmed position. Maintain the pressure on the firing pin assembly and carry out the procedures detailed in sub paragraphs 8.5 (g) and (h);
- f) if the firing pin assembly re-screws into the inertia pellet, screw it fully home. The detonator shutter may then be released as it is held by the firing pin assembly;
- g) tape the detonator shutter and firing pin assembly into place;
- h) move the Bomblet carefully to the prepared hole where it is to be destroyed. Ensure that a constant pressure is maintained on the detonator shutter the whole time.
- i) dispose of the Bomblet in accordance with the procedures detailed in paragraph 8.1.

Annex A (Normative) References

The following documents, when referred to in the text of this Technical Guide, form part of the provisions of this guide.

- a) IMAS 04.10. Glossary of demining terms; and
- b) Technical Note 02/2001. Clearance of Depleted Uranium (DU) hazards.

The latest version/edition of these references should be used. UNMAS hold copies of all references used in this Technical Note. A register of the latest version/edition of the IMAS standards and references is maintained by UNMAS, and can be read on the UNMAS web site: (See www.mineaction.org). National mine action authorities, employers and other interested bodies and organisations should obtain copies before commencing mine action programmes.

The latest version/edition of the Technical Notes can be read on the GICHD web site: (See <http://www.gichd.ch/>).

Annex B

(Informative)

Terms and definitions

1.1. cluster munition

a number of submunitions in one container that is aurally delivered.

1.2. explosive ordnance

all munitions containing **explosives**, nuclear fission or fusion materials and biological and chemical agents. This includes bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket and small arms **ammunition**; all **mines**, torpedoes and depth charges; pyrotechnics; clusters and dispensers; cartridge and propellant actuated devices; electro-explosive devices; clandestine and improvised explosive devices; and all similar or related items or components explosive in nature. [AAP-6]

1.3. explosive ordnance disposal (EOD)

the **detection**, identification, evaluation, **render safe**, recovery and **disposal** of **UXO**. EOD may be undertaken:

- a) as a routine part of mine **clearance** operations, upon discovery of the UXO.
- b) to dispose of UXO discovered outside **mined areas**, (this may be a single UXO, or a larger number inside a specific area).
- c) to dispose of **explosive ordnance** which has become **hazardous** by damage or attempted destruction.

1.4. munition

a complete device charged with **explosives**, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including **demolitions**. [AAP-6].

Note: In common usage, "munitions" (plural) can be military weapons, ammunition and equipment.

1.5. personal protective equipment (PPE)

all equipment and clothing designed to provide protection, which is intended to be worn or held by a employee at work and which protects him/her against one or more **risks** to his/her safety or health.

1.6. render safe procedure (RSP)

the application of special **EOD** methods and tools to provide for the interruption of functions or separation of essential components to prevent an unacceptable **detonation**.

1.7. submunition

any **munition** that, to perform its task, separates from a parent **munition**. [AAP-6]

mines or **munitions** that form part of a **cluster bomb**, artillery shell or missile payload.

1.8. unexploded ordnance (UXO)

explosive ordnance that has been primed, fuzed, armed or otherwise prepared for use or used. It may have been fired, dropped, launched or projected yet remains unexploded either through malfunction or design or for any other reason.

Annex C ⁵ (Informative)

Types of sub-munitions and cluster bomblets

1. Chute stabilised

1.1. Description

Some of the more modern submunitions use small parachutes or other forms of flexible airbrakes in preference to rigid fins. Other than the method of stabilisation, the characteristics of munitions within this category tend to be similar to those of fin-stabilised anti-armour bomblets (see below). However, since chute stabilisation tends to be used for newer submunitions, some do incorporate more complex components.

1.2. Typical operation

Shortly after deployment from the carrier, a drag chute or small inflatable 'air brake' is ejected from the rear. This often allows a telescopic body to extend and arms the fuzing system. When the bomblet strikes a hard object nose-first, the detonator at the rear of the shaped charge is initiated to produce an anti-armour effect. This can be achieved using a piezoelectric fuze or a rod, which strikes a stab-sensitive detonator at the rear of the casing to energise a piezoelectric element.

Secondary fuzing variants can exist to initiate the bomblet if it fails to land on its nose; these use all-ways acting mechanisms that incorporate a ball-bearing housed in a chamber with sloping sides. Sideways movement of the ball-bearing acts on the sloping surface to push a pin into a stab-sensitive composition. If these mechanisms are not actuated during impact, they can act like anti-handling devices when the submunition is subjected to further sudden movement. Like their fin-stabilised variants, most chute-stabilised submunitions produce an anti-personnel/anti-materiel effect as the body is shattered, and many are scored to produce consistent fragmentation.

2. Dual Purpose Improved Conventional Munitions (DPICM)

2.1. Description

Dual Purpose Improved Conventional Munitions (DPICM) are dispensed in large numbers using projectiles or artillery rockets, such as MLRS. Most DPICM are very similar in appearance and operation, tending to be based on the design of the US M42. The tubular body is normally made from steel with the open end housing a copper shaped charge liner, which is inset to provide stand-off on impact. In some examples, the side-wall of the casing is internally notched or fitted with a matrix of small steel balls set in plastic. The other end of the body is generally domed and has a simple impact fuze fitted. The fuze incorporates a small threaded striker attached to a loop of fabric ribbon, which is folded over the fuze. The striker retains a spring-loaded transverse slide fitted with a small stab-sensitive detonator. The configuration is designed so that the bomblets can be packed closely, nose to tail, in tubes within a dispenser. *(Picture shows examples of FRY KB-1 (Left) and US M42 (Right) PICM)*



⁵ Information and pictures extracted from Jane's Defence Equipment Library ©.

2.2. Typical operation

Once released from the dispenser, the ribbon unfurls and brings the bomblet into a nose-down attitude. As the ribbon vibrates in the airstream, the threaded striker unscrews and releases the detonator slide. Once free, the slide is moved across by its spring, bringing the detonator into line with the striker. On impact, inertia carries the striker forward into the detonator, beneath which is a small booster pellet and the main charge. The body is shattered and the shaped charge fired downwards into the target. Ball-bearings can surround the body to enhance the anti-personnel fragmentation effect.

3. Fin stabilised (anti armour)

3.1. Description

The majority of the older designs used fixed fins with a central void to enable the submunitions to be packed tightly nose to tail. The US M118 'Rockeye' was one of the first such designs. This bomblet has a cylindrical body incorporating a HEAT warhead with a rear-mounted fuze and fixed plastic fins. Most fin-stabilised anti-armour bomblets have arming impellers and either piezoelectric or impact fuzes, though many variations exist. All types create some stand-off for the shaped charge, either by mounting the charge well back in the body, or by placing a probe on the front. Configurations vary, and the presence of a HEAT warhead may not be obvious from the external shape. *(The picture shows a bomblet from the UK BL 755 system).*



3.2. Typical operation

On ejection from the cluster bomb, folding fins (if present) deploy to bring the bomblet into a nose-down attitude. The air-stream passing over the vanes on the arming impeller causes it to rotate, eventually arming the fuze. When the bomblet strikes a hard object nose-first, the detonator at the rear of the shaped charge is initiated to produce an anti-armour effect. Most also produce an anti-personnel/anti-materiel effect as the body is shattered, and many are scored or notched to enhance fragmentation.

4. Fin stabilised (fragmentation)

4.1. Description

Fin-stabilised fragmentation bomblets are normally dispensed from cluster bombs carried on fixed-wing aircraft. They generally have cylindrical cast steel casings that are relatively thick in proportion to the size of the munition. Exceptions include the casing of the US BLU-3/B, which is made from aluminium with steel balls set into it. Fins are normally made from sheet steel or plastic, and may be either fixed or spring-loaded. During transit, spring-loaded fins tend to be folded around the body to make the bomblet compact, allowing more submunitions to be carried within the dispenser. Most use simple impact fuzes, which are normally fitted to the nose.

4.2. Typical operation

Once ejected from the dispenser, fins bring the bomblet into a nose-down attitude. Fragmentation submunitions generally use basic mechanical fuzes; some arm as the fins deploy (for example the BLU-3/B, which uses a sliding shutter) while others (such as the Russian AO-2.5) are armed by vanes rotating in the air stream. The fuze fitted to the Russian AO-1SCh simply uses a pin suspended in front of the detonator; it is permanently armed and relies on the structure of the fuze body for protection during transit and deployment. Fuzes function on impact, normally by the direct action of a pin being driven into a stab-sensitive detonator assembly. As the main charge detonates, the body is shattered to create a lethal radius of 10 - 20 m.

5. Spin armed

5.1. Description

Spin-armed submunitions are dispensed from cluster bombs dropped from fixed-wing aircraft. Most of them are basically spherical, though some have parallel-sided bodies with hemispherical ends. All types have external vanes to induce spin as they fall from the dispenser; these may be built into the shape of the casing, or fixed onto it in the form of a band or tail assembly.



The casing is normally cast steel and may be internally or externally notched to improve fragmentation; some of the US variants are made from aluminium with steel balls set into it. The casings tend to be made in two halves, which may be crimped together or joined using a metal band. In most cases, the fuze mechanism is in the centre of the submunition, surrounded by the main charge.

5.2. Typical Operation

When dispensed at sufficient altitude, the vanes impart spin to the bomblet as it drops. Centrifugal force is used to arm the fuze once the speed of rotation is high enough, with sprung weights moving outwards to release a rotor containing the stab-sensitive detonator. Most bomblets then function on impact, though some are also initiated by a decrease in centrifugal force.

For impact initiation, the all-ways-acting fuzes use weights, either falling directly on the firing pin, bearing on it at a tangent as they ride down internal slopes, or a cam moves a ball bearing out of a recess. Most detonate immediately on impact, though some may incorporate a short delay. In unexploded submunitions, all-ways-acting fuze mechanisms can behave like an anti-disturbance device and may function if subjected to sudden movement.