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On the retention and acquisition of cluster munitions

Ove Dullum
Detlev Justen, Stiftung für Wissenschaft und Politik

Forsvarets forskningsinstitutt/Norwegian Defence Research Establishment (FFI)

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Ove Dullum	Project Manager
Jan Ivar Botnan	Director

English summary

This report has been written upon request from The Royal Norwegian Ministry of Foreign Affairs as a contribution to the follow-up on the Convention on Cluster Munitions. This convention was signed by more than 90 nations in December 2008. The work connected to this report was sponsored by the Royal Norwegian Ministry of Foreign Affairs, Section for Humanitarian Affairs and has been finalized in cooperation between FFI and SWP.

In specific, the report deals with article 3, paragraph 6 in the Convention, which gives the signing parties the opportunity either to retain a part of their national inventory of cluster munitions or to acquire a limited number of those in order to conduct training and education of personnel for detection, clearance and destruction of such munitions. Development and qualification of equipment to be used in such processes may also justify retention. Development of armor, protection and other countermeasures may also require access to cluster munitions. The Convention does not limit the amount of retained munitions, but it is emphasized it should "*not exceed the minimum number absolutely necessary for these purposes*".

A number of tasks connected to education and training of personnel can be covered by the use of demilitarized submunitions. This term includes surrogates, replicas, inert submunitions and dummies that, more or less completely, mimic the properties of a real submunition in terms of appearance, materials and other properties. Those demilitarized submunitions do not have any operational value.

However, there are applications where the use of explosive submunitions (bomblets) is a necessity. On the first hand, this applies to education. Handling of real munitions is prerequisite for creating the trust and confidence needed for the EOD-trainees. For development and qualification of tools and equipment for detection and destruction of cluster munitions, the access to live munitions will also be required. In addition the use of explosive submunitions is a necessity for the development of cluster munitions countermeasures especially the protection capabilities of armed forces.

An alternative to retention of operational cluster munitions, is to store them in a way that ensures that their operational value is absent. This is obtained by removal or destruction of essential parts of containers, propellants, pyrotechnics etc. In order to develop methods for destruction of cluster munitions, operational munitions are required. However, this requirement could be covered by the inventory that is subject to destruction. Another need may appear for the testing of equipment and material for cluster munitions countermeasures and protection purposes.

On the next page there is a qualified overview on basic capabilities and tasks regarding EOD and safety of armed forces for which retention or acquisition of operational cluster munitions, explosive submunitions or the use of demilitarized submunitions is needed.

Sammendrag

Denne rapporten er skrevet på oppdrag fra Utenriksdepartementet som et bidrag til en oppfølging av Konvensjonen mot klaseammunisjon som ble undertegnet av drøyt 90 nasjoner i desember 2008.

Spesifikt omhandler rapporten punkt 6 i artikkel 3 som gir signaturlandene anledning til å holde igjen en del av sine eventuelle beholdning av klaseammunisjon i den hensikt å bruke den til utdanning og trening av mannskaper som skal rydde og ødelegge slik ammunisjon, og for å utvikle og kvalifisere utstyr som skal brukes i en slik sammenheng. Konvensjon setter ikke noen grenser for hvor stor denne beholdningen kan være, men understreker av den skal holdes på et minimum av det som er nødvendig.

En rekke oppgaver knyttet til utdanning og trening av mannskaper og til utvikling av utstyr kan dekkes av inerte stridshoder og surrogater. Med surrogater menes her gjenstander som i større og mindre grad er etterligninger av virkelige substridsdeler i form av utseende og egenskaper. I enkelte anvendelser bør imidlertid surrogatene i så stor grad ligne et reelt stridshode, at de i praksis kan bli en slik substridsdel. I slike tilfeller kan man altså like godt bruke reelle stridshoder.

Det er imidlertid en del tilfeller hvor bruk av reelle substridsdeler er en nødvendighet. Dette gjelder særlig i utdanningsøyemed, hvor omgang med ekte ammunisjon er en forutsetning for å skape den nødvendige trygghet og selvtillit hos elevene. Også innenfor utvikling av redskaper og metoder for deteksjon eller destruksjon av klaseammunisjon er det behov for at de testes mot reell ammunisjon.

Det er imidlertid ingen store hindre for at den tilbakeholdte klaseammunisjon kan lagres på en slik måte at den mister sin operative verdi. Ammunisjon kan gjøres inoperativ ved at essensielle deler av beholdere, drivmidler, tennere m v fjernes eller ødelegges. Det synes ikke å være noe stort behov for å beholde klaseammunisjon i sin opprinnelige tilstand. Det eneste behovet i denne retning synes å være ved utvikling av destruksjonsmetoder. Dette behovet vil imidlertid dekkes av den beholding som er øremerket for slik destruksjon.

Retention or acquisition

Capabilities and tasks/ safety of armed forces	Categories for retention or acquisition		
	Operational cluster munition	Explosive submunition (bomblet)	"Demilitarized" submunition (i.e. surrogate, inert submuniton, dummy)
EOD capabilities			
Education and training		**X**	**X**
Reconnaissance and detection	**X**	**X**	**X**
Awareness		**X**	**X**
Recognition and identification		(x)	**X**
Evaluation of state, handling and removal		(x)	**X**
Destruction and dissassembly		(x)	**X**
Demonstration		(x)	**X**
Research, development, qualification on EOD tasks			
Education and training		**X**	**X**
Mechanical clearing			**X**
Manual clearing		(x)	**X**
Electromagnetic clearing		**X**	
Qualification of products		**X**	**X**
Demilitarization	**X**	**X**	
Development of armor, protection and other countermeasures	**X**	**X**	**X**

<u>Explanations</u>

- **X**: "yes"
- (x): in principle "yes" but with more or less restrictions

Contents

Preface

This report has been written in preparation to the Berlin Conference on Destruction of Cluster Munitions to be held on 25th and 26th June 2009.

The work connected to this report is sponsored by the Royal Norwegian Ministry of Foreign Affairs, Section for Humanitarian Work and has been finalized in cooperation with FFI and SWP.

The paper does not necessarily represent the Norwegian and German governmental position on retention or acquisition of cluster munitions. It shows the view of the authors.

In addition to the financial sponsor and the German Federal Ministry of Defence, the authors would also like to extend their gratitude to lieutenant colonel Even Mølmshaug of the Norwegian Defence School of Ammunition and EOD, the very experienced EOD-officer major Arnfinn Roseth, and, not to the least, Mr Colin King of C K Associates in England. They have all contributed with their insight, experience and viewpoints.

Explanation of terms

Demilitarized submunition	A category that includes dummies, inert submunitions, mock-ups and surrogates of explosive submunitions
Dud	An explosive device that has failed to detonate after use
Dummy	A simple or generic replication of live munition without explosives
EOD	Explosive Ordnance Disposal
Fuze	A mechanical or electronic device that initiates the detonation of a warhead
Inert submunition	An explosive submunition with the explosives removed and exchanged with non-explosive materials
Mock-up	A replication of a warhead with the same size, shape and appearance, but without any explosives
Explosive submunition	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 (the smallest explosive unit of a cluster munition)
Surrogate	A general replication of an explosive submunition including some of the functionalities. Depending on the purpose it may or may not include explosives
Warhead	The part of the munition containing the explosive

1 Introduction

The Convention on Cluster Munitions (CCM) that was signed in December 2008 states in article 3 paragraph 6 as follows:

> *… the retention or acquisition of a limited number of cluster munitions and explosive submunitions for the development of and training in cluster munition and explosive submunition detection, clearance or destruction techniques, or for the development of cluster munition counter-measures, is permitted. The amount of explosive submunitions retained or acquired shall not exceed the minimum number absolutely necessary for these purposes.*

The text does not explicitly state whether retention means storing the munitions in a fully operational condition or as individual submunitions. Neither does the text elaborate on what is quantitatively meant by *the minimum number absolutely necessary for these purposes.*

This report will discuss the aspects of retention from a technical, operational and educational point of view.

This report will also discuss the possibility of replacing live munition with inert munition or surrogate munition. Such options have the potential of further reducing the need for live ammunition. However, there are some areas in which real and live ammunition are needed.

The areas in which live cluster munitions may have a role are:

- education and training
- demonstration of effect
- development of novel equipment for submunition detection and clearing
- development and testing of new techniques for destruction of cluster munition
- development of armor, protection and other countermeasures for cluster munitions

In some of these applications, a complete submunition, may not always be necessary.

2 Characteristics of cluster submunition

This chapter gives a brief overview of the most common submunitions, or bomblets, currently used as content of cluster munition. Comparisons between bomblets and land mines are also made.

2.1 DPICM

DPICM is an abbreviation for Dual Purpose Improved Conventional Munition. The term *Dual Purpose* is due to the fragment effect and the armor piercing effect of the bomblet. The casing is often prefragmented, which means that it is built so that it fractures along predefined surfaces creating a fragment pattern that gives optimum effect. The armor-piercing feature is implemented as a shaped charge. Such a charge enables the bomblet to perforate up to 150 mm of steel.

These bomblets have a quite primitive fuze on the top of the charge. The fuze consists of a slider that is released a short time after the bomblet has been thrown out of the carrier. The release of the slider arms the fuze to detonate at impact with the target or with the ground. Some of these bomblets have a self-destruct device assembled together with the arming mechanism.

An EOD operator will usually be able to judge whether a DPICM is in an armed or unarmed state. The position of the slider is a reliable indicator. (see figure 3.2)

2.2 Combined effects munition

CEM, or Combined Effects Munitions, have much in common with DPICM, as their purpose is to inflict damage both by fragments and armor penetration. The principal design is also quite like DPICM, the difference is in the size – linear dimensions are approximately twice that of DPICM - and mode of delivery, as they are delivered from an aircraft while DPICM is ground artillery delivered. Duds of CEM-bomblets are renowned for being very sensitive and quite dangerous to remove. While some DPICM have a very simple ignition train, CEM may have a very intricate train and it may be difficult to see the state of arming of the bomblet. It is claimed than some CEM may trigger just by the blow of the wind, or by the vibration in the ground caused by an approaching person. These bomblets have caused many severe accidents among EOD people.

2.3 Ball shaped bomblets

These devices are mostly released from bombs dropped from an aircraft. They have a spherical shape with flutes on the surface that induce spin once they are released into the airstream. The spin arms the bomblet, and it is supposed to detonate upon ground impact. These devices have no self-destruct mechanism. It is not possible to judge the state of a bomblet dud found intact on the ground, as the whole safety and arming device is situated in the center of the bomblet with no external indicators.

2.4 Self-destruct mechanisms

The purpose of a self-destruct mechanism is to provide a back-up in the case that the warhead does not detonate as expected.

At arming, two trains of initiation are initiated. If the normal initiation fails due to improper impact or for other reasons, the secondary train will initiate the charge. However, experience has shown that even this secondary train, i e the self-destruct mechanism, will also fail in many cases.

A general problem with self-destruct mechanisms is that they usually are initiated together with the arming of the bomblet. The arming process will normally start as the bomblets are released into air. Thus, if the bomblet fails to arm, the self-destruct mechanism will also fail. This state will inevitably result in a dud.

2.5 Bomblets versus mines

There is a considerable difference between bomblet submunitions and mines. This difference is of importance for determining the techniques to be applied for detection.

Mines are primarily defensive weapons used to defend own force’s stronghold, to block roads, fording sites, bridges etc. Mines can though be used semi-offensively for blocking the advance of enemy forces and thereby create well defined targets for artillery fire or anti-armor counterattacks.

Cluster munitions are mainly offensive weapons. The intention is to engage enemy targets with such munitions in order to inflict damage and, in the extreme case, to annihilate that force.

Technically the differences between mines and bomblets can be summarized as in the table below

Mines 	**Bomblets** 
Mines are left in an intended and intact state	Bomblets are left by accident in an unintended and failed state
Mines are usually laid in a controlled and regular manner, except for scatterable mines and those laid out in the intent of terror.	Bomblets are scattered randomly within an area. That area may also be offset from the intended area
Mines are armed when laid out	Bomblets are armed before ground impact
Mines are triggered by a defined force or interaction	Bomblets may be triggered by an unpredictable force
Most mines are designed to work by blast or by a directional effect	Bomblets are designed to work by fragments and/or directional effects
Mines may have a low metal content in order to hamper detection	Bomblets have a considerable metal content

There have been claims that some cluster submunitions intentionally have been given an unreliable fuze in order to leave a substantial part of the ordnance behind effectively as mines. No party has ever admitted such a policy, which in reality would have been a way to circumvent the Mine Ban Treaty. It is also hard to find technical evidence that such features have been implemented on any munitions. It is, however, known that fairly high failure rates were accepted in the early history of cluster munitions. In this analysis, we will assume that any cluster submunitions found on the battlefield are in an unintended and failed state.

Even if mines often are supposed to be buried, and bomblets are dropped onto the ground surface, the state of burial is not a state distinguishing mines and bomblets. When dropped at high velocity, bomblets may penetrate deep into the soil, especially if the soil is wet. The influence of wind and precipitation may also bury a bomblet that initially was at the surface.

Sometimes mines are used as weapons to terrorize especially the civilian population. Those mines are often laid neither exactly predictable nor regular. In contrast the area in which cluster munitions have been dropped by artillery or aircraft is far more calculable.

3 EOD tasks

Clearance or destruction of remaining ammunition in a war zone is the task of EOD-units (EOD – Explosive Ordnance Disposal).

Herein, the processes involved in EOD-work affiliated with cluster munitions will be discussed. Compared to EOD of ordinary munitions, cluster munition duds are inherently a challenge. These bomblets are often small, they may be hard to locate visually, they are spread out in a random way, they may be numerous and they may be quite hazardous by their sensitivity and unreliability.

Statistics from EOD-operation also indicate that operating in an area contaminated with bomblets is far more dangerous than operating in a minefield. Especially the experience after the Lebanon war in 2006 shows this.

3.1 Reconnaissance and detection

The lethal mechanism of almost all bomblets is the fragments ejected from the bomblet following detonation of the explosive. Such fragments are mainly made of steel. One fragment may typically have a mass between 0.1 g and 1.0 g, although both smaller and larger fragments are usually present. The initial fragment velocity is typically between 1000 and 1500 m/s. Due to the high drag on such fragments they are usually not harmful at ranges beyond 200 m.

In addition to fragments, some bomblets, like the DPICM group, have the additional effect of armor perforation. This effect is realized by having a conical copper liner at the front end of the bomblets. This adds an additional hazard to EOD-work, as their ability to perforate armor is substantial.

These two effects ensure that a bomblet must contain a considerable amount of metal. Above all, steel, but metals like aluminum, copper, tungsten, zirconium and magnesium may also be found.

The high content of metal and the fact that all metals have high electric conductivity, make a metal detector an obvious tool for detecting bomblets. It seems that all current bomblets have a metal content of minimum 40 g. This concentration of metal is so high that it will be easily detectable by any metal detector, even when set on low sensitivity. Such metallic object should also be detectable in lateritic soils, unless the soil metal content is very high.

Figure 3.1 The metal detector (left) is based on detecting changes in the electric conductivity, while the magnetic detector (right) detects changes in the magnetic field.

A magnetic detector is also a possibility. However, the distinction between metal detectors and magnetic detectors are somewhat subtle. Metal detectors are to some extent based on magnetism. Magnetic detectors are also a metal detector. Nevertheless, they are based on different principles.

Magnetic detectors can only detect ferromagnetic materials. Ferromagnetism is present in a few metals, most notably iron. The other metals mentioned above are not ferromagnetic. There are even some steel alloys that are non-ferromagnetic, but these are high quality stainless steels for special applications. Otherwise, steel contains so much iron that the ferromagnetism is conserved. Bomblets are produced as inexpensive as possible. Hence, no advanced steel qualities have ever been used for this purpose. Bomblets are not supposed to be made in order to avoid detection.

Magnetic detectors are not reliable for detecting mines, as mines may contain non-ferrous metals only. They should, however, be quite reliable for detecting bomblets.

When the EOD operation is to be done in a firing range, the ground will often be cluttered with metal pieces from many sources – shell fragments, empty cartridges, scrap metal, etc. This is a major problem for all kind of detectors, but may be especially serious for metal detectors. Verifying that an alarm is false takes a lot of work and time. Under such conditions the use of metal detectors and magnetic detectors may be rendered useless. However, the high metal content in bomblets, enabling the use of less sensitive detectors, may reduce the false alarm rate.

Like mines, bomblets may be detected by sensing the migration of explosive molecules that escape the bomblets by leakages of different kinds. These fumes can be sensed by the olfactory organs of dogs, rats and other animals, or by artificial “noses” of different kinds. Some bomblets, like DPICM, are well sealed, letting just minute amounts of explosives escape to the environment. Other bomblets, like the spin armed spherical bomblets are not well sealed and may allow considerable amounts of explosive to escape. For such bomblets, the chemical detection may be relevant. This view also applies to bomblets that have been damaged during ground impact resulting in enhanced leakage of explosive.

The canine olfactory organ is definitely the most used chemical detector in mine detection. Apart from dogs, rats and bees have also been used, or proposed for use. Especially the African poach rat is very promising for this task. This animal is quite easy to train and have a simpler behavior than dogs.

When animals are used for chemical sensing, it is not always clear what they actually smell; whether that is the explosive, the detonator, paints, lubricating oils or other compounds found in the bomblet. In order to make realistic training, it is paramount that real bomblets are used. Surrogate bomblets, or inert bomblets, may be missing some of the essential compounds for detection. It is also important that such bomblets are untouched by human hands which may contaminate the bomblet.

The current state of detection is that the need for methods other than metal detection is limited, because of the high metal content in bomblets. Thus, the use of olfactory organ training is also limited. This state may not persist for ever. Detection methods for EOD constitute a highly evolving field. Over the recent years the use of ground penetrating radars has become established. That method was not available 20 years ago. A lot of research is currently put into the prospects of detecting explosives in bulk. This is mainly encouraged by the demand for airport security. This involves the exploitation of the explosive properties at the atomic level, and even at the nuclear level. Although such methods are promising, they still remain to be developed into practical devices adapted to field conditions and with the desired speed, reliability and range.

The quick evolution of novel methods requires that a number of bomblets and operational cluster munitions should be kept for future needs. For education and training of EOD reconnaissance personnel demilitarized submunitions are also of essential importance. The knowledge of ordnance must be saved in order to develop countermeasures against this threat.

3.2 Awareness

There is no formal requirement that the education should be done on live object. However, persons in charge of education of EOD-personnel emphasize the need for training with live objects. It is imperative that a professional EOD-course involves the handling of live objects. If not, the contact with live ammunition in the field may be too challenging. Even if most of the training, in principle, could be done with inert objects or mock-ups, the presence of a live object increases the awareness and makes the learning process more effective.

This kind of approach is used in many other kinds of education in a society. As examples, one cannot obtain a license for driving a car or flying an aircraft without ever driving or flying. Even if almost all dangerous situations cannot be created in a simulator, they cannot fully replace operating the real object. It is also generally accepted that operating real objects during education has the potential of being dangerous or even fatal, whether that is driving, flying, or EOD-work.

On the other hand, education does not have to be made on a specific object or a certain kind of warhead. All possible objects will not be obtainable, but the education for an EOD operator should cover a broad spectrum of objects as possible. It would certainly be advantageous to acquire a limited number of objects that are not available in the home country but might be of interest for future missions or operations. If no cluster bomblets were available for training it would certainly have negative consequences for the quality of the education.

3.3 Recognition and identification

By recognition we here mean that upon detection, it is verified whether the item found is a bomblet. Recognition is primarily done visually. If the bomblet is not directly visible, it is done after removal of vegetation and soil. Recognition can, in principle, be made electronically, e g by a ground penetrating radar (GPR), but most EOD personnel would require a visual identification.

Training for recognition and identification should, in principle, not require use of live bomblets. Surrogates or inert bomblets will serve the purpose as long as the construction and coloring replicate a the real bomblet. Hence, the surrogate should be so close to the real object that using a neutralized real bomblet may be the best practical solution

3.4 Evaluation of state, handling and removal

Some bomblets have indicators that tell EOD personnel about the state of the bomblet; whether it is armed, partially armed or unarmed.

A good example of bomblets satisfying such criteria is DPICM-bomblets. Different states are shown at the figure below. Here the position of the “slider” indicates the level of arming.

Figure 3.2 Bomblet DM1385 found in an unarmed state (left) and an armed state (right)

Other types of bomblets do not have any such indicator whatsoever. Spherical bomblets, like the M74, have an arming mechanism that is embedded inside the explosive charge in the center of the bomblet. (see figure 3.3) Current methods are not practical for revealing the internal state. Future methods, however, may be capable of doing this.

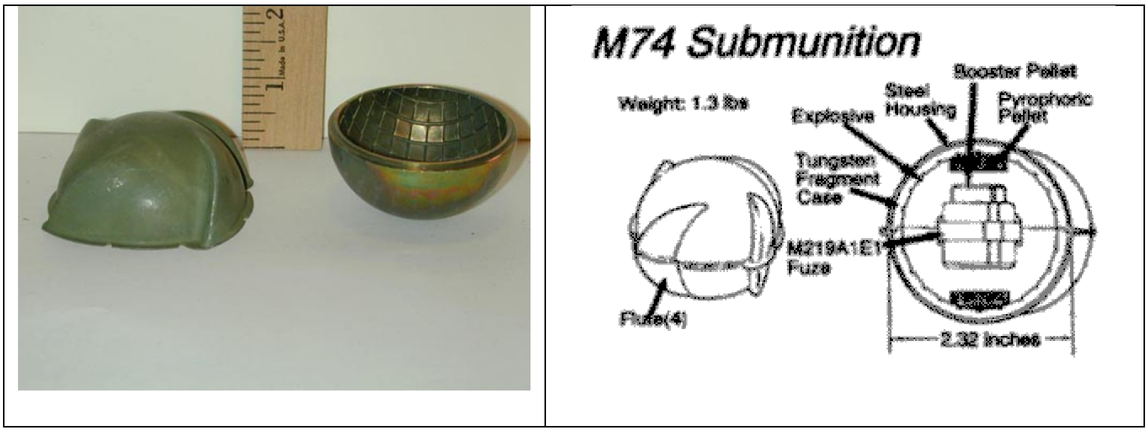

Figure 3.3 The M74 bomblet

Just as for detection and recognition, evaluation of state may require replicas of bomblets that have to be very close to real object. Thus it may be practical to use real munition instead of inert objects or surrogates. Such a solution requires, however, that the bomblets used have an acceptable risk level, which can be achieved in several ways. Here we are again faced with the dilemma of either using a real bomblet, accepting a certain risk level, or using a surrogate, without any risk at all. With the arguments in section 3.2 in mind, the first option is preferable.

Even if the first option is chosen, the role of surrogates may still be present for training basic operations. Mock-ups where the effector is replaced by more benign devices emitting sound or smoke would be a good complementary tool.

3.5 Destruction and disassembly

Destruction of submunition duds is almost exclusively done by detonating an amount of explosive at, or adjacent to the object. If the bomblet can be manually handled, it is brought to a site dedicated for demolition of ammunition. If not, the destruction must be done on the site where it was found. In the case where the bomblet is considered to be extremely sensitive, firing at the bomblet with small caliber projectile is an alternative.

Demolition at site may be very challenging if the bomblet is found inside a building, or near buildings or other objects that may be vulnerable to the detonation. In such a situation there are two options:

- The blast and shock effect from the bomblet can be mitigated by improvised materials or commercial devices made for that purpose.
- The warhead can be disassembled, mostly by removing or neutralizing the fuze. However, this requires well educated personnel with very good knowledge of the construction of the object.

Procedures for destroying submunitions or other warheads are found in the international database ORDATA, or in national manuals.

The use of live ammunition is not considered necessary for training on the destruction process, but if disassembly is required, previous experience with real bomblets is a prerequisite.

3.6 Demonstration

An important part of any EOD education is to become aware of what forces are involved in a detonation of a warhead. Seeing what a few tens of grams of high explosive gives in terms of audible and visual effect is quite amazing. Without such a demonstration a vital part of the education would be missing.

However, the effects of a warhead come from the explosive and from the hull encapsulating the explosive. The action of the safety and arming device and the primary explosive starting the initiation train is not of any importance. Thus, there is really no need to use fully operational bomblets for this purpose. A piece of explosive is not adequate to demonstrate the effect of a certain bomblet. A demonstration has to be done with a replica of the bomblet with the casing and the main explosive intact. However, the most delicate parts of a bomblet like the fuze with the detonator may not be required.

If real bomblets are to be used for demonstration, it is worth noting that some bomblets, which could be subject to retention, are not suitable for that purpose. This includes the family of spherical bomblets, on which the ignition train is not accessible without seriously destroying the bomblets. It may also include bomblets with electrical ignition which may be very sensible and not safe to handle for such a purpose.

3.7 Ageing of ammunition

All kinds of ammunition have a finite lifetime. The main factor contributing to the deterioration is

- corrosion of metal components
- decomposition of the explosive
- deterioration of polymer components
- battery power drainage (if applicable)

The speed of deterioration is extremely dependent on the environment in which it is kept. A cool and dry depot is usually the best storage, but even when it is left in the soil the longevity can be impressive, especially when the exposure to oxygen is limited. However, deterioration will eventually take place. When encountering a live bomblet or mine in a corroded state, an extensive knowledge of the technical detail is needed in order to judge the state of the mine. An old bomblet may imply an enhanced hazard if the safety mechanism has deteriorated, but it may also be almost harmless if the firing pin or the detonator is damaged. The figure below exemplifies the degree of deterioration that may take place in a mine. A bomblet may be affected in the same manner.

Figure 3.4 A manipulated picture showing the deterioration of a Type 72 mine. (photo Colin King)

4 Research, development and qualification

In the previous chapter, different techniques for detecting bomblets have been mentioned. The UXO-problem can also be handled by the use of mechanical or other means that eliminate the bomblet threat. Although all submunitions of the cluster type initially are surface laid, they will over time be buried due to seasonal accumulation of withered plants and to soil drift caused by water flows or wind.

4.1 Mechanical clearing

Mechanical clearing involves the process of destroying the bomblets. This destruction may involve the triggering of the detonator resulting in a detonation of the bomblets. It may as well involve mechanically destroying the bomblets without provoking a detonation. Most mechanical clearing processes should result in one of these options. The mechanical means available for this purpose includes:

- rollers
- flails (rotating chains)
- ploughs
- tillers
- explosive compaction of the soil
- sifting

Figure 4.1 Flails for mine clearance put on a tank. Upon use, the drum will rotate with high speed.

Among these methods some aim at destroying the object, as with flailing. Others, like sifting, involves a, more or less gently, removal of the object. They can, in principle, also be used with bomblets. Some will, like ploughs, just move the bomblets without solving the problems of UXOs remaining in the ground. Experience have shown that even flails, being a violent method may also just throw a landmine away from the field and the landmine may still be intact.

On the whole, mechanical clearance may not be the primary tool against bomblets, but in some cases it may still be an option. Any qualification of equipment must include the robustness of the tool and the reliability of the process. This requires bomblets in an unarmed state or surrogates that are quite close to a real bomblet.

4.2 Manual clearing

Manual clearing involves detection, recognition and destruction using the methods described in chapter 3. In addition, the detection can also be done mechanically by prodding. In order to safely sustain these processes, the operator is in need of having protective gears that, to the extent possible, protects him, or her, from the effect of a bomblet detonation. Such gear may include protective garments like:

- vest
- apron
- leg protection
- gloves
- visor or face mask
- boots
- helmet

The quality of this equipment must be adapted to the type of bomblet that is likely to be found in the actual area.

There is also a lot of other equipment the operator needs like medical aids, communication, cooling devices etc., but they are not directly related to the bomblets.

Manual clearing could include special demolition methods by using explosive and shelling techniques - especially if a manual disassembly is not possible or too dangerous. Therefore the retention of explosive submunitions is needed. In order to obtain confidence in the equipment, test against an explosive device with the same characteristics as a bomblet would also be required.

4.3 Electromagnetic clearing

In work concerning countermeasures against improvised explosive devices, the use of microwaves to set off ignition trains causing premature detonation of such devices has been tried with some degree of success. The same approach can also be used on bomblets and this may destroy the armed bomblets which constitute the greatest danger for EOD personnel. Testing of such methods definitely requires live bomblets.

4.4 Qualification of products

Any equipment to be used in combat or in post-combat work has to be approved based on tests that are relevant for the environment in which it is supposed to be used. This is the qualification of the product.

For products in the EOD branch such tests include:

- sensitivity tests
- reliability tests
- durability tests

- maintenance and reparability
- climatic tests
- tests in various soils
- tests in corrosive environment
- test of rough handling and transport

In principle, such types of test are valid for any equipment – electronic equipment, mechanical equipment, chemical detectors and even when qualifying dogs for mine detection. However, the nature of the tests must be adapted to the nature of the product. Some of the tests need a live object or an object having the same characteristics as a real object.

Based on what was said about the different phases of EOD work in chapter 3, it seems that live munitions in the EOD branch are predominantly required for the qualification of dogs, or other animals, as the mixture of odors that an animal smells must be as close as possible to odors that are found on the battlefield. Removal of any component in this composition will reduce the quality of the qualification.

For qualification of other EOD tools, access to real, but disarmed or unarmed bomblets may be an advantage, but not an absolute requirement. Use of replicas and surrogates may fill the role to satisfaction.

4.5 Demilitarization

Demilitarization involves handling the munitions in a way that renders it unfit for any regular use or reuse in a operational context. Usually, this involves a brute force destruction of the munitions by bringing it to detonation in a controlled manner. From the point of views of environment and safety, such a method may not be acceptable. Alternative methods for demilitarization include:

- separating and reclaiming metallic parts for other purposes
- reuse or destruction of propellants, pyrotechnics and explosives without emissions to the environment
- removing or destroying certain parts of the munitions so that it loses all operational capabilities

As the environmental issues are becoming increasingly important, a considerable research is made on how to demilitarize munitions in the best way possible. This kind of research has to be done on live ammunition. Individual bomblets may not be sufficient, but the munitions should be in a complete state as in a stored condition. This may be one of the few fields where complete and almost operational munitions are requested. However, some of the needs for complete munitions will be covered by the stock that is scheduled for destruction.

4.6 Prioritizing

Not all kinds of bomblets have the same value for education, training and development of tools. Some types of cluster munitions have never been used, and they probably never will be used, in combat. This may apply to munitions produced in limited numbers by a nation that has signed the Convention, and exported to nations that also have adhered to the Convention. Bomblets that have been used in vast numbers are more important to keep for the tasks mentioned.

Even a rare bomblet, which may never have been used in combat, will have been used in tests, and some probably remain as duds in a firing range. The need to detect and destroy such bomblet is anyhow very limited. However, all types have a unique design that may be of interest for EOD people. The principal design of such a bomblet is supposed to be known, also by persons who may try to replicate that device. With this in mind it is important that a few samples are kept even of the most rarely used bomblets. This may include the acquisition or transfer of those bomblets absolutely needed which are not available in the home country but necessary for training, education or development.

When British EOD-teams operated on the Falklands a few years ago, they came upon the American M1-mine. This mine was, of course, affected by the Mine Ban Treaty, and all stocks in the signature countries had been destroyed. American stocks had also been destroyed due to the obsolescence of the mine. The lack of available information became a problem for the EOD campaign.

This last example again shows the need to keep the documentation and some samples for future reference. Even though these are devices that have been developed in an aggressive and destructive context, the design is still a part of the human base of knowledge that cannot be “de-invented”.

5 Armor, protection and other countermeasures

While previous chapter have primarily addressed tasks connected to EOD, this part of the paper will focus more on the reasons and needs to retain cluster munitions to protect armed forces and therefore develop suitable protection programs.

Although the Convention has been signed by nearly 100 states, it is obvious that many governments will not support and ratify it in a foreseeable future. A considerable number of states worldwide will remain outside the Convention and still produce or stockpile cluster munitions. Hence, a non-predictable probability of further deployment and use of such munitions still exist as well as the possibility of contaminated areas.

As it cannot be definitely excluded that armed forces might be engaged in i.e.

- high intensity operations with a possible numerous use of cluster munitions,
- missions where opposing powers might use cluster munitions a few times only or
- in any operations conducted in areas contaminated by unexploded or abandoned submunitions

forces should be well equipped and trained to protect themselves and help to save health and lives.

With the mentioned general conditions in mind, armor, protection and other countermeasures are necessary for the effective continuation and improvement of the protection of deployed forces against the impact of cluster munitions both by shelling as well as the threat posed by duds. Considering the possible current and potential theaters of operations mentioned above, only an adequate amount of different types of cluster munitions will ensure the effective testing and training capabilities. A well defined, limited and reported stock of operational cluster munitions and live bomblets could enable a cost-saving and efficient execution of technical examinations in the area of force protection, i.e. vehicle or/and equipment protection programs.

Comparable to the worldwide efforts that have been undertaken to test and evaluate mine action equipments, systems and technologies, a corresponding effort should be possible concerning cluster munitions.

For this account retention might be acceptable for a number of full operational cluster munitions without any operational value or live explosive submunitions. Furthermore it could be necessary and reasonable to acquire a limited number of both categories if external or less known munitions are needed for testing. For training and education it may be useful to demonstrate the effect of a complete cluster munition, a single explosive submunition, or a dud.

6 Surrogate ordnance

Surrogate ordnance objects are developed for training, education and research. Basically, surrogate object are designed to simulate real objects. Look-alikes for both mines and bomblets have been made for several types of warheads, as the illustrations below shows.

6.1 Copy surrogates

Copy surrogates can resemble the real thing at different levels, depending on the purpose and usage. At the most primitive level, the surrogate should have the same size, shape, color, and preferably also surface texture, as the real object. Usually it is just the external shape that is recreated. The internal configuration is usually ignored. Such object can then be used for education on recognition of the object. It can also be used for outdoor exercises on visual recognition in the field. Such surrogates are usually made of a polymer that is cast or machined to its correct shape. It is then painted to give the correct surface color and texture. If the polymer is a substitute for metallic parts, such an object will, of course, not be suitable to recreate the correct signature in exercises with metal detectors, magnetic detectors and chemical detectors. Not even mechanical methods may be suitable as the mass and rigidity of the bomblet may not be correct.

Figure 5.1 A collection of surrogate land mines(left) and DPICM bomblets (right) (photos: Colin King)

At a more advanced level, surrogates should not just resemble the properties mentioned above, but it should also be made of the same materials. Often, energetic parts, like the main explosive charge and the safety and arming system and the detonator may be omitted, but the bomblet will give the correct signature when approached by magnetic detectors, metal detectors and mechanical means.

A surrogate can be made as close as required to the object it is supposed to imitate. However, such an approach may be controversial, as what is then made, may be rendered as a true and fully working bomblet.

6.2 Generic surrogates

Surrogate warheads have also found their role in threat standardization. However, such surrogates are generic, i e they do not pretend to look like any specific warhead, but should be representative for a class of warheads.

For anti-personnel mines, surrogate devices have been defined e g in an official NATO-document where two types of surrogate mines for experimental purposes have been defined. These charges are not mines per se, but warheads that give a destructive effect comparable with that of a mine. Such devices can be used to qualify any kind of equipment, both military and civilian to be in military operations as well as humanitarian campaigns. It should be emphasized that these warheads cannot ever function as mines. It is thus a different approach from what is described above. Hence, they do not conflict with the Mine Ban Treaty.

It would be possible to specify a small number of objects with properties representing cluster bomblets. These would serve the same purpose in qualification as the surrogate mines do today. Surrogate bomblets may serve their purpose for a majority of applications.

Although surrogate bomblets may serve their purpose for a majority of applications, they may not be satisfactory in some cases. These may be any testing of equipment or material for protection purposes or cluster munition countermeasures. Also training with animals that are supposed to react on the smell from gases emanating from the bomblet is not practical on the basis of surrogates.

7 Operational aspects

Keeping a piece of ordnance within the inventory of an army, has to be justified by a significant operational value. This value has to exceed the costs connected to

- storage
- maintenance of the technical knowledge of the ordnance
- training
- maintenance of the delivery platforms

Although these costs can be assigned a quantitative value, it is generally not possible to assign a quantitative operational value. The operational value will depend on whether alternative ordnance exists. If the ordnance constitutes a unique capability, even a small quantity may be seen as an asset. If alternatives are available, a limited amount may, however, constitute a burden rather than an asset.

It is not possible to say whether a certain amount of retained cluster munitions have a net operational value. However, most of the following questions should be given an affirmative answer in order to render the amount of cluster munitions as an asset.

- Is the amount capable to inflict a significant effect upon the foreseen threat?
- Is the retained amount a unique capability or more effective than the alternatives present in the inventory?
- Can the cluster munitions be deployed without any use of special training, equipment, vehicles or platforms?
- Is the retained amount adequate to give a significant effect timely and in the required area?
- Are the retained munitions stored in a way that maintains its full operational value?

The value of munitions cannot be measured by the number of bomblets. Factors like charge weight, explosive content, accuracy, range, and delivery mode will all be of importance.

As discussed earlier, there are good reasons to retain and store cluster munition in an operational state. These are training, development of armor, protection and other countermeasures and demilitarization of munitions. Disabling of the potential not needed in an operational condition could also be envisaged.

- The submunitions can be removed from the canister.
- The canister can subsequently be destroyed.
- Vital components like fuzes, ejection charge, propellants, lugs, driving bands and arming devices can be removed.

Bomblets cannot be used in warfare without the delivery system. A potential reuse of the bomblets can, however, be possible by remaking the canisters or shell. It should be noted that most delivery platforms, like aircraft, mortars, guns and rocket launchers are not affected by the convention as they all can still deliver legal munitions.

Storage of bomblets outside their containers creates some problems with respect to safety. Cluster munition are qualified to be stored in regular munitions depots. Bomblets, removed from their container, are not qualified in that sense. Special storage arrangements may thus be needed which might be connected with the development of special bomblet boxes as well as the preparation of suitable storage facilities. This could produce high additional costs and might be an obstacle for states parties to do so.

8 Conclusions

The technology on how to make cluster munitions constitutes a part of the human knowledge that will not disappear by the removal of the current stock of such munitions. The technology simply cannot be "de-invented". This claim is reinforced by the fact that many nations have no intentions to sign and ratify the Convention in a foreseeable future. Hence, further deployment and use of such munitions cannot be definitively excluded. This could consequentially leave behind more areas contaminated with unexploded submunitions. The need for using and developing tools and methods for clearing such areas will persist. The continued possibility of a cluster munitions use additionally indicates the necessity for armed forces to furthermore prepare and protect themselves against the impact of those weapons.

In this report the basic properties of cluster bomblets have been reviewed.

Compared to mines, bomblets may be more sensitive and have a more unpredictable behavior. From the point of view of an EOD operator, bomblets constitute a greater challenge and a greater hazard than mines.

However, bomblets will usually be easier to detect and locate compared to mines. This is caused by the general fact that bomblets contain a substantial amount of metal, which makes them well adapted to metal detectors or magnetic detectors. However, there may be environments that prohibit the use of metal detectors. Such environments are characterized by high natural content of iron, or high metal contamination caused by warfare or peacetime firing range activities.

There is a suite of methods available for detecting UXOs. The principles behind them vary considerably and include electromagnetic effects, mechanical interaction, radiation response, chemical detection, olfactory organs and visual signature. Some of these methods, like the olfactory organs training and some electromagnetic measures, require that the development and training includes access to real and live submunitions. It is also paramount that live munitions are used in education and training of EOD-personnel, as that will contribute to the trust and confidence needed in such operations. It must however be stated that the need for bomblets in development of means and methods is limited, and that EOD awareness training does not have to be done on a specific type of bomblets.

Storing bomblets for the purpose of being training objects for EOD personnel and development can be done in a state void of any operational value. The bomblets can be permanently removed from its original canister used for combat deployment of the ammunition. With the canisters disabled, it will be very difficult and expensive to rebuild canisters and refill them with the current stock of bomblets.

Transfer and acquisition of cluster munitions or explosive bomblets for the purpose of being objects for training of EOD personnel and olfactory organs might be acceptable. This need also applies to the development of armor, protection and other countermeasures. The munitions that are transferred or acquired may not be available in the home country, but may be urgently necessary for training, education or development. Their number has to be the minimum absolutely necessary.

Storing bomblets for the purpose of training in their original state in a ready-to-use state would also be acceptable, provided that this amount is so small that it will not have any operational value, i e it does not constitute any net positive asset in a combat situation. It may be difficult to accurately state whether a given stock of munitions has any operational value. However, there are cases where access to operational cluster munition would be an asset, but some of these may be satisfied by the stock of munition earmarked for destruction.