African Union

Incremental Steps towards the International Ammunition Technical Guidelines (IATGs)

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Incremental Steps towards the International Ammunition Technical Guidelines (IATGs)

In settings of resource scarcity, full compliance with international standards can often be particularly difficult to achieve. Therefore, the aim of this Operational Guidance Note (OGN) is to provide practitioners and relevant national counterparts with information on the types of incremental "low-cost high-impact" steps that can be taken towards fulfilment of the International Ammunition Technical Guidelines (IATGs).

The key references for this OGN are:

- The International Ammunition Technical Guidelines (IATGs) *https://www.un.org/disarmament/convarms/ammunition/iatg/*
- The International Small Arms Control Standards (ISACS) *http://www.smallarmsstandards.org/isacs/*

This OGN should be read alongside two other guidance notes in this series:

- Incremental Steps towards the International Small Arms Control Standards (ISACS)
- Physical Security and Stockpile Management (PSSM): Preconditions and Sustainability

Context

Within almost 50% of the countries in Africa, unstable and insecure stockpiles of ammunition contribute to the illicit trade and proliferation of ammunition, as well as to devastating Unplanned Explosions at Munitions Sites (UEMS). The proliferation of ammunition fuels armed conflicts, crime, and terrorism, and can destabilize whole regions.

Unplanned explosions pose a risk for civilians and local authorities, causing deaths, injuries, and displacement. Globally, between 1979 and 2015, there were 528 serious ammunition storage accidents, which caused 28,000 deaths, injuries, the displacement of thousands, and major destruction of vital infrastructure. Within Africa, 25 of the 54 AU Member States experienced 76 serious unplanned explosions, and 35% of these accidents took place in Mozambique, DRC, and Libya alone.

The International Ammunition Technical Guidelines (IATGs) provide internationally acknowledged standards for the Physical Security and Stockpile Management (PSSM) of stockpiles of ammunition. Relatedly, the International Small Arms Control Standards (ISACS) provide internationally recognized guidelines for weapons management. The ISACS cover not only small arms, but also light weapons such as light and medium mortars below 100mm calibre, grenade launchers, anti-tank launchers, man-portable air defence systems (MANPADS), and all other man-portable weapons systems. This OGN is not designed as a substitute for either the IATGs or ISACS but, instead, is intended as an aide memoire. It takes salient points from the ISACS and IATGs in order to help ammunition officers and others involved in ammunition storage to significantly reduce the risk of theft, diversion, and accidental initiation in Ammunition Storage Areas (ASAs).

Risk Assessment and Prioritization

Ammunition and explosive stockpiles can be divided into the following types:

- Operational: These are the stocks required for normal routine military operations.
- War reserves: These are the stocks for sustaining operations during a general war or external conflict.
- Training: These are the stocks necessary to support routine training.
- Experimental: These are the stocks for testing and assessing new weapons which may come into service.
- Production: These stocks are usually held by countries with an ammunition production capability and are normally produced for sale.
- Awaiting Disposal: These are unserviceable or obsolete stocks or those surplus to requirements.

Three main factors can cause hazards in ammunition storage and can result in Unplanned Explosions at Munitions Sites (UEMS). These are:

1. Inadequate storage conditions e.g., lack of effective fire prevention procedures and insufficient safety distances.
2. Ineffective physical inspection of ammunition stocks, including chemical analysis of propellant and other munition fillings. This may include the failure to identify deteriorated ammunition which has become chemically unstable and dangerous.
3. The careless handling and movement of ammunition.

In addition to these main causes of UEMS, others include:

4. Accidental fires in vehicles or Explosive Store Houses (ESH).
5. Environmental effects (e.g. lightning or bush fires).
6. Human error.
7. Sabotage or enemy action.

To reduce the risk of UEMS, a combination of the following actions may be taken:

- Reducing ammunition stocks.
- Increasing safety distances.
- Improving the physical infrastructure of ammunition storage e.g., protective works between ESH.
- The effective physical inspection/chemical analysis and proof (i.e., testing) of ammunition to identify stocks that have deteriorated to a dangerous level.
- Closure of an ammunition depot where there is an unacceptable risk of explosive propagation, civilian casualties, and severe damage to infrastructure, with the transfer of the explosive stocks to a safer facility.

In contexts of resource scarcity, it may not be possible to implement all of the aforementioned risk reduction processes. Instead, it may be necessary to prioritize certain risk reduction measures, allocating scarce resources to certain measures rather than others. To do this, it may be helpful to first assess the different risks that are faced. Table 1 below can be used for this purpose. This table explains how the different stages of a risk analysis process can be used to capture potential risks and to identify their potential impact. It should also be noted that the process set out in Table 1 should be carried out in each separate Ammunition Storage Area (ASA) (for further information, refer to IATG 02:10).

Generic Area / Activity	Specific Area / Activity	Remarks
(b)	(c)	(d)
Risk Management	Identify and nominate specific individual responsible for risk management policy in explosive facilities.	
Risk Analysis	Identify 'Explosives facilities'.	
Risk Analysis	Identify 'At Risk' Groups.	• Workers in explosive Area (unqualified) • Workers in explosives Area (explosives qualified). • General public residing in proximity to explosives facility. • General public transiting in proximity to explosives facility.
	Decide on the appropriate level of risk	Risk levels should be comparable with other industrial processes.
Risk Acceptance	Obtain written Ministerial approval for tolerable risk levels.	This ensures that Ministers are aware of the risk, and of their responsibilities to allocate appropriate resources to manage the risk and maintain it within tolerable levels.
Risk Communication	Widely communicate the tolerable risk levels being applied to Explosive Facilities.	Communities in close proximity should be made aware of the risks they are exposed to.

Table 1: The Risk Analysis Process *Source: IATG 02:10*

The Hazard Identification Risk Assessment (HIRA) matrix is another useful way to assess and compare different risks (see Table 2 below). In contexts of scarce resources, the matrix helps the user to determine which risk to address first.

Table 2: The Hazard Risk Assessment Matrix

Probability of incidence		Severity of outcome	
1	Very unlikely	A	Negligible
2	Unlikely	B	Moderate
3	Possible	C	Significant
4	Likely	D	Severe
5	Very Likely	E	Catastrophic

Thus, 5E would be a very likely event leading to a catastrophic outcome.

Risk Management

Once the different risks posed by the storage of ammunition have been assessed, the IATGs recommend the use of Risk Reduction Process Levels (RRPL) (see IATG 01.20). These RRPLs are intended to help users achieve full IATG compliance in a series of incremental steps. There are three main RRPLs (see Figure 1 and Table 3 below), and the aim is for the gradual improvement of PSSM processes, going from Level One (the lowest and least resource intensive) to Level Three (the highest and most resource intensive).

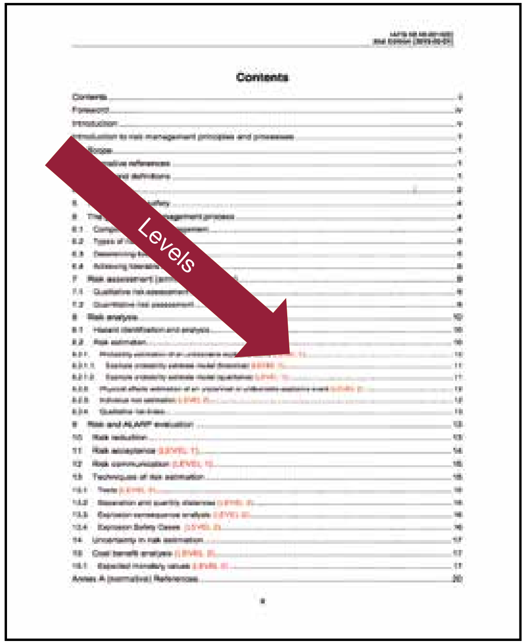


Figure 1: The contents page of IATG 02.10. Note how RRPL levels are highlighted in red.

Table 3: Risk Reduction Process Levels

RRPL	Meaning
LEVEL 1	▪ Basic safety precautions are in place to reduce the risk of undesirable explosive events during ammunition storage, but fatalities and injuries to individuals in local civilian communities may still occur. ▪ Although some potential causes of such explosions have been addressed (external fires, smoking, mobile phones etc), others remain (propellant instability, handling, lightning strike). ▪ Risk of explosion still remains as routine physical inspection of the ammunition does not occur and the chemical stability of ammunition during storage cannot be determined by analysis. ▪ Basic security precautions are in place to reduce the risk of theft by external actions. ▪ Ammunition has been accounted for by quantity, and a basic system of identifying loss or theft is in place. ▪ A minimal investment of resources has taken place in organisational development, operating procedures and storage infrastructure.

RRPL	Meaning
LEVEL 2	▪ Safety precautions, in the form of appropriate Separation and Quantity Distances, have been implemented to reduce the risk of fatalities and injuries to individuals within local communities to a tolerable level. ▪ Significant damage to ammunition stocks and storage infrastructure should still be expected as inadequate protection remains in terms of infrastructure robustness and safe internal separation distances. ▪ Ammunition can be identified down to type, lot or batch number, but surveillance and/or in-service proof systems are not yet in accordance with international best practices. Explosions due to chemical stability of ammunition may still be expected. ▪ Medium level investment of resources has taken place in organisational development, staff technical training, storage and processing infrastructure.
LEVEL 3	▪ A safe, secure, effective and efficient conventional ammunition stockpile management system is in place that is fully in line with international best practices. ▪ A significant investment of resources has taken place in organisational development, staff technical training, storage and processing infrastructure.

Source: IATG 01.20, pp1-2

As indicated above, RRPL Level One is the minimum acceptable level, involving minimal investment of resources. Level One measures are primarily intended to reduce the probability of an incident, including an UEMS or the loss of stock, and it is very important that Level One measures are introduced at all levels of management.

RRPL Level Two involves a greater investment in safety measures than Level One. These safety measures may also take longer to put into effect than simpler Level One actions. Level Two measures will help to manage risk by addressing both the probability of an incident and the severity of the outcome.

RRPL Level Three involves measures requiring a significant investment of resources. The full application of Level Three measures will result in a safe, secure, effective, and efficient conventional ammunition stockpile management system that is in line with international best practices. Examples of Level Three measures may include the re-siting of an ASA that has now become surrounded by a built-up area, and where safety distances are not achievable without significantly reducing the storage capacity of the ASA.

While this OGN does not cover all of the different measures listed under each RRPL in the IATGs, it focuses on those that are most relevant to the African context.

Risk Reduction Process Level One

Key Risk Reduction Process Level One actions include: fire prevention and fire-fighting, the physical security of ammunition stocks, stockpile management, temporary storage, and the destruction of damaged or unserviceable items. Each is explained in turn:

1. Fire prevention and fire-fighting

Fire is the main cause of explosions in munitions storage, often due to poor procedures including cooking, smoking, and rubbish burning. Level One safety measures will significantly reduce the chances of fire caused by human activity. The first measures that should be considered are the adoption of fire prevention procedures e.g., restricting or prohibiting the use of fire producing materials and other contraband items within the ammunition storage area, control of vegetation, and the removal of flammable materials from storage (see IATG 6.10. Control of Explosive Facilities).

Procedures should be put in place that allow a fire fighting plan to be rapidly implemented. If a fire starts, but not from within the ammunition itself, prompt action can prevent it from reaching the ammunition and from turning a minor incident into a major disaster. Lack of a plan can lead to panic, multiple casualties, and the substantial loss of ammunition stocks (for further information see IATG 02.50 Fire Safety).

2. Physical security of ammunition stocks

Ammunition stocks may be lost during an UEMS, but may also be lost due to theft. To counter this, stockpile security measures and procedures are designed to fulfil the following purposes:

- To deter and reduce any attempted incursions or internal theft.
- To thwart any attempted security breech.
- To immediately detect a security breech or threat.
- To assess the scale of any security breech or threat.
- To delay the time necessary for the illegal removal of ammunition and/or explosives from storage areas.
- To allow security personnel time to respond and take appropriate action.

More stringent security measures should be applied to items that are "Attractive to Criminal and Terrorist Organisations" (ACTO). These items include:

- Man-portable air defence systems (MANPADS)
- Detonators
- Bulk explosives
- Man-portable anti-tank missiles or rockets
- Hand grenades
- Small Arms Ammunition (SAA)

At Level One, there must be some form of physical security of ammunition stocks. While there are no international standards for the physical protection of ammunition or explosive stocks, there are a range of Level One best practices for the protection of ammunition storage areas and facilities. These are discussed below:

Control of access

In order to prevent the theft and/or sabotage of ammunition stocks, it is imperative that access to ammunition storage areas is controlled (see IATG 09.10. Security Principles and Systems). Level One measures to ensure access control include:

- Keys: Keys to the ammunition storage area, buildings, and containers are not to be left unsecured or unattended at any time. The keys must be accessible only to those individuals whose duties require them to have access to the ammunition storage area. A record should be kept every time a key is removed by an individual from the secure cabinet. The number of keys must be kept to an absolute minimum and master keys must be prohibited.

Physical Security of Buildings and Structures

In addition to key control, the following Level One physical security measures should also be considered in order to prevent the theft and/or sabotage of ammunition (see IATG 09.10. Security Principles and Systems):

- Windows (and other openings to ammunition storage buildings): Windows should be kept to a minimum and must be provided with the appropriate locks and security bars or grilles.
- Physical Security of Perimeter: Class one or class two security fencing is appropriate at Level One. Class One fencing is a fence designed with no particular security requirements and is at least 1.5m high. It is designed to act as a boundary and offers only minimal deterrence or resistance to anyone other than a determined intruder. Class two security fencing offers a degree of resistance to climbing or breaching and should be supported by other perimeter security systems.
- Patrols and Dogs: A guard and a response force (military, police, or civilian), should check the security integrity of ammunition storage areas during non-duty hours and at both prescribed and random occasions. These checks should be recorded and records maintained for a minimum of 90 days.

3. Stockpile Management

Accurate accounting procedures, and frequent stock-taking checks, can rapidly determine where and, to a certain extent, when stock losses are occurring so that remedial measures and investigations can take place (see IATG 03.10 para 14: Inventory Management). At Level One, some form of accounting and stock-taking by quantity must be implemented in order to identify loss or theft. The exact form of the stocktaking process can vary, and may be done electronically or by a paper system. However, certain minimum requirements must be included in the accounting process and are set out below:

- Know what you have.
- Know what has been received.
- Know what has been issued.
- Know what has been disposed of.
- Know the shelf life of different 'natures.'
- Store appropriately.
- Use "First In, First Out" (FIFO) stock turnover processes, so that the oldest stock is always used first.

Ammunition stock management should also include stockpile rationalisation, i.e., processes for finding and dealing with unserviceable items. The basic points concerning stockpile rationalisation are set out in Box 1 below. Further information on inventory management can also be found in Annex A.

Box 1: Basic Principles of Stockpile Rationalisation

- Ammunition may be of dubious serviceability or may be obsolete and surplus to requirements.
- Loose unpackaged ammunition should be checked for safety by a qualified ammunition technician.
- Keep ammunition in serviceable factory sealed boxes; even so, it still needs to be inspected (see discussions on Level Two actions below)
- Inspection should be done in a separate Ammunition Process Building (APB) or away from the ESH
- Dispose of surplus ammunition as soon as practical.
- Certain ammunition types should be stored separately from other types.

Finally, at Level One, certain types of conventional ammunition should always be stored in separate Potential Explosive Sites (PES), or, under specific conditions, separate from other types of ammunition. These types of conventional ammunition include:

- Detonators and blasting caps.
- White phosphorous.
- Damaged ammunition.
- Ammunition in an unknown condition.
- Pyrotechnics and propellants.

For further information on the above points, refer to IATG 01.50 UN Explosive Hazard Classification System and Codes.

4. Temporary Storage

Temporary storage may be required when there are no acceptable permanent facilities available or when the storage facility has deteriorated to a condition that provides no protection for either the ammunition or the civilian population. Temporary storage may be used for a more extended period of time than field storage (normally up to five years) and will normally include basic security precautions such as concertina barbed wire fencing up to 3 coils thick and two coils high, guard patrols, guard dogs, and shipping containers to secure ammunition more prone to theft. It should be regarded as the minimum Level One storage standard. For further information on temporary storage, refer to IATG 04.20 Temporary Storage.

5. The Destruction of Unserviceable, Obsolete, and Surplus Ammunition

Some stockpiles may contain large quantities of ammunition that are of dubious serviceability, obsolete, or surplus to requirements. This occurs, for example, when the weapon for which the ammunition is designed is no longer in service or is no longer in a serviceable condition. The retention of such ammunition adds to the overall Net Explosive Quantity (NEQ) in the storage location as well as taking up valuable storage space. In the event of a UEMS, the additional NEQ also means that more stock loss and damage (both inside and outside the storage location) will occur. Following IATG 10.10, open burning and open detonation are Level One methods of destroying obsolete, surplus, and unserviceable ammunition. These methods are outlined in Table 4 below:

Table 4: Advantages and Disadvantages of Open Burning and Open Demolition

Method	Advantages	Disadvantages	Remarks
Open burning	Normally for propellants (including SAA) and pyrotechnics	• Hazardous for HE • Requires training to IMAS EOD 3 • May be environmental concerns	May be only option for small quantities of unsafe items requiring EOD action
Open demolition (OD)	Normally for HE	• Requires large safety distances • Not effective for propellants/SAA • Requires training to International Mine Action Standards (IMAS), explosive ordnance disposal (EOD) Level 3 • May be environmental concerns	May be only option for small quantities of unsafe items requiring EOD action

Source: IATG 10.10

6. Environmental Protection

Exposure to high temperatures will severely affect the shelf life and chemical stability of ammunition explosive fillings. Propellant stored at a constant temperature of +30 °C has a shelf life of between 15 and 40 years. This shelf life is halved if the temperature is raised to +40°C. Likewise where the ambient temperature is +50°C, the surface temperature of ammunition directly exposed to the sun could reach, in theory, as high as 101° C, which could cause a main filling of TNT to melt (TNT melts at 80°C). In White Phosphorus (WP) filled munitions, the WP would also liquefy at such temperatures. The following measures can be used to protect ammunition stacks from the effects of heat, inclement weather, or other climatic effects:

- Tarpaulins (directly over the ammunition stack but must not be used in hot climates).
- Shading using camouflage netting above the ammunition stack.
- Raising the stack off the ground (at least 75mm) using dunnage. This prevents damp from the ground adversely affecting the ammunition and allows for air circulation.
- ISO containers. These provide a very good degree of protection against the elements in addition to being lockable.
- Improvised structures such as large tents, locally constructed shelters etc. can also provide a good degree of protection against the elements.

Covered Storage

Where it is necessary to store ammunition in the open, the ammunition should be covered.

In order of priority, the following types of ammunition should be allocated covered storage:

1. Water actuated explosives.
2. Guided weapons and torpedoes.
3. Anti-Tank, ranging and spotting ammunition.
4. Propelling charges
5. Pyrotechnics
6. Mortar ammunition
7. Grenades and mines.

8. Boxed shells
9. SAA (Small Arms Ammunition)
10. Loose shells

Covers should be non-static and (preferably) fire resistant waterproof sheets. The sheets should be used, with supports, in such a way as to form a gap between the top layer and outer layers of the ammunition stack to allow a current of air to circulate around, and over, the stack. If sheets are to be laid directly over the stacks, the sheets are to be removed, at least once monthly, during periods of good weather, to air the ammunition. In hot climates, the stacks should be aired more frequently. For more information on covered storage, see IATG 04:10 Field Storage.

Risk Reduction Process Level Two

Key Risk Reduction Process Level Two actions include: additional training, the physical security of ammunition stocks, ammunition surveillance and proof (i.e., testing), the full application of hazard divisions and compatibility groups, increased safety distances, and industrial demilitarization. Each is explained in turn:

1. Additional Training

The first requirement in Level Two is a significant investment in organisational development, including the technical training of staff and the development of policies and procedures. A more extensive discussion of different training levels, can be found in the accompanying OGN: Incremental Steps towards the International Small Arms Control Standards (ISACS).

2. Physical security of ammunition stocks

There are no international standards for the physical protection of ammunition or explosive stocks but there are a range of Level Two best practices for the protection of ammunition storage areas and facilities. These build on the Level One measures outlined above, and are discussed below (for further information, see IATG 09.10. Security Principles and Systems):

Control of access

- Entry to ASA: Strict personnel and vehicle access control must be established for all areas storing ammunition. Entry to ASAs should be authorised in writing by the authority responsible for ammunition security. Vehicles and individuals shall be subject to random inspection and search on entry to, and exit from, the ASA.
- Personnel Vetting: To reduce the likelihood of tampering or theft of ammunition, it is important that the personnel responsible for these stocks are thoroughly vetted. Requirements in this regard are laid out in IATG 09:10, pp5-6.

Physical Security of Buildings and Structures

In addition to control of access, the following Level Two physical security measures should also be considered in order to prevent the theft and/or sabotage of ammunition:

- Doors and Gates: Access doors and gates should be sufficiently robust and comply with national security standards. As a minimum, doors should be solid hardwood with steel on the outside face.
- Door Frames: These should be rigidly anchored to prevent disengagement of the lock bolt by prying or jacking of the door frame.
- Door and Gate Hinges: These should be located on the inside and be of the fixed pin security type or equivalent.
- Locks and Padlocks: For gates and Explosive Store Houses (ESH) these should comply with European Standard EN12320:2001 Building Hardware – padlocks and padlock fittings requirements and best methods.
- Class Three Security Fencing: Class Three fencing is an intermediate security barrier designed to deter and delay a resourceful attacker who has access to a limited range of hand tools. The design and construction of the fencing will offer resistance to attempts at climbing and breaching.
- Visual Perimeter Illumination: At Level Two, exterior and internal perimeter illumination shall be of sufficient intensity to allow detection of unauthorised activity by the guard force. An automatic backup generator and power system is essential on high risk and high value sites.

3. Ammunition Surveillance and Proof

The previous section of this OGN provides guidance on Level One fire prevention measures. However, fire precautions are unlikely, by themselves, to identify problems that may arise from unstable ammunition. This issue can only be addressed by an extensive ammunition surveillance and proof/test program.

Importantly, the same level of priority should be accorded to the development of an effective surveillance and proof system and program, as to the physical security of ammunition stocks. As defined in IATG 07:20 Surveillance and In-Service Proof:

- Surveillance is the systematic method of evaluating the properties, characteristics, and performance capabilities of ammunition throughout its life cycle. It is used to assess the reliability, safety, and operational effectiveness of stocks. Surveillance requires the gathering of data, the physical inspection of munitions, and sometimes, chemical testing.
- Proof is the functional testing or firing of ammunition and explosives to ensure safety and stability in storage and intended use.

At Level Two, ammunition should be identifiable by type and batch/lot number (see Box 2 below) , and some form of inspection, surveillance, and proof/testing should be in place. This may not necessarily be at an international best practice level, but it will go some way to identify ammunition that is no longer fit for purpose. For example, the visual inspection of ammunition will often allow inspectors to notice when ammunition is no longer serviceable nor safe to store, perhaps because the chemical stability of the explosive fillings is questionable.

Box 2: Definitions of batch and lot in ammunition manufacture

> Ammunition producers divide their production into lots or batches. In particular, the production of each component is divided into batches: the components of the same batch are produced under similar, if not the same, conditions using uniform elements and are expected to perform in the same way. A 'lot' of complete cartridges is assembled/produced using, ideally, subsets of the same batches of components.

More generally, it must be understood that all ammunition degrades over time, and that the typical degradation path is as follows:

1. Safe to use
2. Unsafe to use, safe to store
3. Unsafe to store, safe to transport (by road or rail)
4. Unsafe to transport, safe to move (by hand) over short distances
5. Unsafe to move

This degradation path shows how ammunition goes from being an asset to a liability. In particular, by the time an item reaches stage four, it will need to be rendered safe by a qualified explosive ordnance disposal (EOD) team somewhere in or near the grounds of the ASA itself. An item at stage five will require disposal in situ. For more information on methods of surveillance and proof, see IATG 07:20.

4. Hazard Divisions and Compatibility Groups

The primary way of identifying stocks in terms of their hazard is called the 'Hazard Division' (HD) system. Hazard divisions classify items of ammunition in terms of what is likely to happen to them in the event of an out-of-control fire. All ammunition items are considered 'dangerous goods' by United Nations (UN) hazard classification systems[1] used in assessing risks when transporting them, and so all hazard divisions begin with the first figure '1' (representing major risk). The second figure, normally placed after a decimal point, represents the hazard division of the item in question. The individual hazard divisions are set out in Table 5 below. More information on hazard divisions can be found in IATG 01:50 (Para 6.1 and 6.1.1).

1 *http://www.unece.org/trans/danger/danger.html*

Table 5: Hazard Divisions

Hazard Division	Description	Examples	Remarks
(a)	(b)	(c)	(d)
1.1	Ammunition with a mass explosion hazard	• High Explosive (HE) filled aircraft bombs • HE filled large calibre Artillery projectiles • Anti-Tank mines • Bulk HE • Detonators • Gunpowder*	*Not other propellants
1.2	Ammunition with a projection hazard but NOT a mass explosion hazard	• Most light/medium HE-filled mortar bombs • Grenades hand fragmentation HE • Most small-calibre thick-cased artillery ammunition (76mm and below) with an HE fill	For storage purposes hazard division 1.2 can be subdivided into 1.2.1, 1.2.2 and 1.2.3.
1.3	Ammunition with a fire hazard and either a minor blast or minor projection hazard (or both) but NOT a mass explosion hazard,	• Propellant charges and cartridges • Ammunition with a propellant charge but inert projectiles	E.g. Armour Piercing (AP) shot, AP Discarding Sabot (tracer) (APDS-T), Armour-Piercing Fin Stabilised Discarding Sabot (tracer) (APFSDS-T), Practice Inert
1.4	Ammunition that presents no significant hazard	Small arms ammunition (SAA) (Below 20mm calibre)	
1.5	Very insensitive substances with a mass explosion hazard.		
1.6	Extremely Insensitive articles which do NOT have a mass explosion hazard		

Source: IATG 01.50

Under ideal conditions, all hazard categories should be stored separately. This, however, is not always practical. Hence the idea of 'compatibility' groups. Compatibility groups show:

- Groups that can be stored together.
- Groups that must be kept separate.

A table summarizing the different compatibility groups is included below (see Table 6). A matrix showing the relative compatibility of each compatibility group with the others is also illustrated below (see Table 7 below). More detail on compatibility groups can be found in IATG 1:50 Para 7.2.

In addition to mixing rules for compatibility groups, the following types of ammunition should be stored separately:

- Detonators and Blasting Caps should be separated from compatibility groups C, D, E and F by a dividing wall capable of preventing sympathetic detonation of other items.
- White Phosphorus (WP) and PWP (Plasticized White Phosphorus).
- Damaged ammunition, if unsafe to store[2], is to be destroyed at the earliest convenience.
- Ammunition of unknown condition (to be stored at an adequate distance to prevent damage or propagation to other ammunition stocks).
- Ammunition that has deteriorated and become hazardous (to be stored at an adequate distance to prevent damage or propagation to other ammunition stocks and destroyed at the earliest convenience.
- Pyrotechnics and propellants.

2 Including recovered illegal ammunition, providing any forensics requirements have been met.

Table 6: Compatibility Groups

Ser	Group	Description	Examples	Remarks
(a)	(b)	(c)	(d)	(e)
1	A	Primary explosive substances	• Lead Azide • Lead Styphnate	
2	B	Articles containing a primary explosive and not containing two or more protective features	• Detonators	
3	C	Propellant explosive substance or other deflagrating explosive substance	• Single or double based composite propellants • Solid propellant rocket motors (with no warhead or an inert warhead) • Ammunition with inert projectiles	Or article containing such substance
4	D	Secondary detonating explosive or an article containing a secondary detonating explosive without a means of initiation and without a propellant charge	• Bulk HE such as TNT • HE filled aircraft bombs (unfuzed) • Large calibre artillery projectiles	
5	E	An article containing a secondary detonating explosive without a means of initiation but with a propellant charge	• HE mortar bombs • Rockets with HE warheads • Guided missiles • HE artillery ammunition*	*Complete rounds
6	F	An article containing a secondary detonating explosive with a means of initiation and with a propellant charge	• Rocket propelled grenades	
7	G	Pyrotechnic substance or article containing a pyrotechnic substance or article	• Flares • Signals • Incendiary ammunition • Illuminating ammunition • Other smoke or tear producing agents	
8	H	Article containing both an explosive substance and White Phosphorus	• WP smoke bursting artillery projectiles/ mortar bombs or grenades, • Ammunition filled with Plasticized White Phosphorus (PWP)	
9	J	Ammunition containing both explosives and flammable liquids or gels	Liquid or gel-filled incendiary ammunition such as Napalm	
10	K	Articles containing both explosives and toxic chemical agents	Mortar bombs, artillery projectiles or aircraft bombs containing a lethal or incapacitating chemical agent	
11	L	Explosive substance, or article containing an explosive substance and presenting a special risk needing isolation of each type	• Pre-packaged hypergolic liquid fuelled rocket motors/engines • Any damaged or suspect ammunition of any group	* Including recovered illegal ammunition
12	N	Hazard Division 1.6 ammunition containing only extremely insensitive detonating substance (EIDS)	Examples certain aircraft bombs and warheads with especially insensitive fillings	Such as stores carried on aircraft carriers

13	S	Substance or article so packed or designed that any hazardous effects arising from accidental functioning are confined within the package.	• Small Arms Ammunition (Ball) • Explosive switches or valves	

Table 7: Compatibility Groups which may be stored together

Group	A	B1,3	C	D	E	F2	G	H	J	K	L	S
A	Yes	No	No	No	No	No	No	No	No	No	No	No
B	No	Yes	No	No	No	No	No	No	No	No	No	Yes
C	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes
D	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes
E	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes
F	No	No	No	No	No	Yes	No	No	No	No	No	Yes
G	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes
H	No	No	No	No	No	No	No	Yes	No	No	No	Yes
J	No	No	No	No	No	No	No	No	Yes	No	No	Yes
K	No	No	No	No	No	No	No	No	No	Yes	No	No
L	No	No	No	No	No	No	No	No	No	No	Yes	No
S	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes

5. Safety Distances and Protective Works

There are two main risk management measures that deal specifically with reducing the severity of the outcome of a UEMS. The greatest problem, once a single item detonates, is that the detonation 'propagates.' In ammunition terms, propagation is the term used to describe the chain reaction when one item explodes and then this in turn initiates one or two more items, and so on. The term 'Potential Explosion Site' (PES) is used to describe the point of possible explosion, with the term 'Exposed Site' (ES) used to describe a location that is exposed to the effects of the explosion (or fire) at the Potential Explosion Site.

Propagation can be prevented by two main interventions: separation of the explosive stacks by distance, or interruption of the explosive effect through protective works. Each is discussed below:

Quantity and Separation Distances

Quantity and separation distances (QD) are a vital part of ammunition storage principles.

While these actions do not reduce the probability of an item exploding, they do act to reduce the severity of the outcome. For example, to prevent propagation an Inside Quantity Distance (IQD) specifies the minimum permissible distance between a PES and an ES inside the explosives area. In contrast, an Outside Quantity Distance (OQD) is the minimum permissible distance between a PES and an exposed site (ES) outside the explosives area. This can help to stop the effects of a UEMS from spreading to civilian areas.

OQD are designed to give a high level of protection against blast and heat effects from a UEMS but will not guarantee protection against large fragments. Like IQD, OQD are sub- divided into (a) public traffic route distances (PTRD) applicable to roads, railways, airfields, waterways, footpaths, and certain recreational facilities such as playing fields and golf courses, (b) inhabited building distances (IBD) designed to prevent serious structural damage to buildings of 230mm solid brick (or equivalent) and protection against blast and heat effects for personnel in the open, and (c) vulnerable building distances (VBD) used where the buildings are of vulnerable construction or where large numbers of people congregate. Further details on the use of quantity distances can be found in Annex B.

At Level Two, it may not be possible to implement all these measures. For example, if the ammunition stockpile is stored on a restrictive site surrounded by an urban or semi-urban area, it may be difficult to ensure that appropriate outside quantity distances are met. Civilian encroachment around an ammunition storage area may also mean that outside quantity difficulties are difficult to achieve. To address these problems, the highest hazard division storage locations (HD 1.1) should be sited towards the centre of the storage facility while the lowest hazard division storage (such as HD 1.4) should be nearest the perimeter. This allows the most effective use of the area and reduces the OQD area outside of the perimeter of the storage facility. Additional possible solutions to these problems also include:

- Split Locations. Setting up a separate storage location for HD 1.1, and maintaining stocks of HD I.4, and HD 1.2 and HD 1.3 in the original location (If OQD/ IQD permit). Reference should be made to:
- IATG 05.10. Planning and Siting Explosives Facilities
- IATG 05.20. Types of Buildings for Explosives Storage
- IATG 05.30. Traverses and Barricades
- IATG 04.10. Field and Temporary Storage
- IATG 09.10. Security Principles and Systems
- IATG 02.20 Quantity and Separation distances
- Temporary Storage Location. Setting up a temporary storage location (see section on Level One actions above), in a new area as the old storage site may be considered unfit for purpose owing to insufficient quantity and separation distances for the stock and hazard divisions held.
- A combination of a) and b).

For solutions to the specific problem of civilian encroachment, see Table 8 below:

Table 8: Possible options for dealing with encroachments on ASA

Ser	Option	Description	Remarks
(a)	(b)	(c)	(d)
1	Reduction	Reduction of stocks held in the ASA, so that the OQD is now compatible with the new situation	
2	Reloca-tion	Relocate the ASA into a more remote area, and then undertake the precautions set out above	
3	Protection	Improve the construction of ESH and/or protective works so that the OQD is now compatible with the new situation	May need the construc-tion of a temporary storage area while work is done.
4	Removal	Use legal measures (such as compulsory purchase) to remove buildings etc. that have now encroached on the OQD of the ASA.	

Protective Works: Traverses or Barricades

In addition to inside and outside quantity distances, traverses or barricades[3], if constructed and used correctly, are also an effective means of shielding an Exposed Site (ES) from the effects of a nearby explosion and reducing the likelihood of propagation. As outlined in Table 9 and Figure 2 below, there are four types of traverse (see IATG 0.530). In permanent storage, traverses are normally earth mounds (RRPL Level One) or earth mounds supported with concrete walls, or simple concrete or brick walls (RRPL Level Two). However, temporary traversing can also be made from the following:

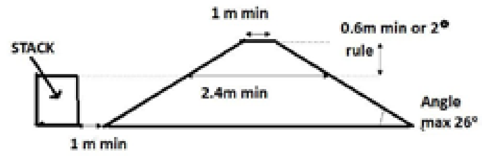
- Waste oil drums, HESCO bastions, or water tanks filled with earth or sand to a minimum width of 450mm and a minimum of 600mm above the top of the ammunition stack.
- Shipping containers filled with earth or sand, double width two containers height.
- Thick concrete walls (minimum 450mm width, height 600mm, above the top of the ammunition stack) thin concrete walls (less than 450mm thick) will require earth backing (see IATG 5.30).
- Fencing would normally be of barbed wire coils (up to 3 coils deep, 2 coils high) around the perimeter of the storage area. Temporary fencing could be replaced with more permanent fencing and the ISO containers gradually replaced by purpose built ESH as resources permit.

3 The terms are interchangeable: the term 'traverse' is used in the remainder of this document.

Table 9: Traverse purpose and design

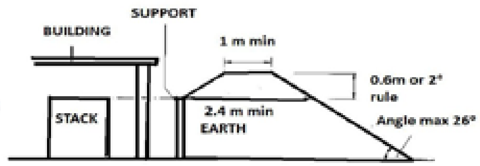
Ser	Type	Role	Position	Remarks
(a)	(b)	(c)	(d)	(e)
1	Receptor Traverse	Protects the ES it surrounds from low angle high velocity fragments and debris from an adjacent PES.	As close as possible to the ES	
2	Interceptor Traverse	Protects ES from direct attack from Low angle High Velocity Fragments.	As close as possible to the PES	
3	Container Traverse	Designed to contain High Velocity fragments from the explosion within the PES. Only generally suitable for low quantities of explosives (under 1000 kg)	Generally used around APB or small stacks.	APB = ammunition process building
4	Screening Traverse	Acts as a screen between a PES and ES. Designed to intercept fragments at a higher angle than normal, and should remain largely intact after an explosion.	Can be situated at the ES but is more effective near the PES	
5	Traverse positioning	The face of the traverse should be a minimum of 1 metre away from the building it protects.		Can be earth, or combination of earth and brick/concrete
6	Traverse geometry	Earth traverses should have the correct geometry (i.e. angles of slope and thickness). Lines of sight should be totally blocked. Slopes should be no steeper than 1:2 or 26° from the horizontal. See Figure 6 below.		
7	Traverse dimensions	The traverse should be 2.4 metres thick at a point of the maximum stack height, and the height should be a minimum of 600mm above the maximum stack height of the ammunition.		

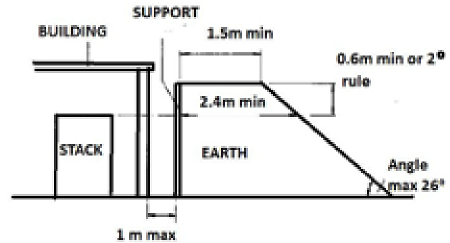
Figure 2: Traverses



Double Slope earth mound construction

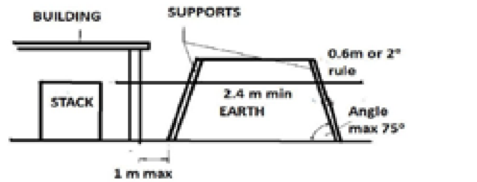
Partly vertical partly faced slope





Single slope vertical face

Steep double slope



6. Industrial Demilitarization of Ammunition

In addition to the Level One methods of open burning and open detonation (see above), ammunition may also be destroyed through methods of local and industrial demilitarization (see Table 10 below). These Level Two and Level Three methods are often prohibitively costly to implement and highly specialist operations to plan (see IATG 10.10 Demilitarization and Destruction of Conventional Ammunition).

Table 10: Level Two Methods of Industrial Demilitarization of Ammunition

Method	Advantages	Disadvantages	Remarks
Local demilitarisation	• Production of FFE training items • Can be used on small quantities of ammunition	• Requires extensive training and specialised equipment • Most hazardous	Not suitable for unserviceable ammunition
Industrial demilitarisation	• Most cost effective over 1,000 tons • Safest option	• Facilities may not be available or expensive to set up	Some international support may be available

Source: IATG 10:10

Risk Reduction Process Level Three

At Level Three a safe, secure, effective and efficient conventional ammunition stockpile is in place that is fully in line with international best practices. Furthermore, a significant investment of resources has taken place in organizational development, staff technical training, storage and processing infrastructure (IATG 01.20). As Level Three measures are resource intensive, they are covered only briefly in this OGN and include the physical security of ammunition stocks, stockpile management, and ammunition surveillance and proof. Each is discussed in turn:

1. Physical security of ammunition stocks

In addition to the Level One and Level Two physical security measures introduced in earlier sections, the following Level Three measures are also considered best practice:

- Combination Locks: These should be dealt with in the same way as keys (see Level One). Combinations should be changed at regular intervals and when individuals change or move positions. The combination numbers are to be kept in sealed envelopes. Every container or combination lock guarded facility must have a record of access by the individual, date and time of entry, and must be prominently displayed on its door.
- Class Four Security Fencing: Class Four fencing consists of a high-security barrier designed to offer the maximum deterrence and delay to a skilled and determined intruder who is well equipped and resourced. It should be designed and constructed to offer a high degree of resistance to a climbing or breaching attack. Class Four security fences should always be used in conjunction with CCTV and an intruder detection system.
- Intrusion Detection Systems (Alarms): Buildings and structures used for storing ammunition should be fitted with appropriate alarms or Intrusion Detection Systems (IDS). IDS should be fitted to all doors, windows, and other openings. Interior motion or vibration detection systems may also be fitted. All alarm signals should be received at a central control or monitoring system from which a response force should be dispatched.
- Visual Surveillance Systems: These usually consist of Close-Circuit Television (CCTV) or other motion initiated systems.

For further information on the above points, refer to IATG 09.10

2. Stockpile Management

At Levels Two and Three, a system of Through Life Management (TLM) should form part of the inventory management process as it enhances explosive safety and prolongs the useful life of the ammunition. An essential component of TLM is Munitions Life Assessment (MLA), which is a systems approach to optimising the useful life of ammunition. MLA requires an appreciation of how ammunition ages and what environmental factors (due to storage conditions), will influence the ageing process. If a stockpile management organization can confidently know the actual conditions that ammunition has experienced throughout its life, and understands the way that ammunition degrades under such conditions, then the in-service life can be extended for that particular ammunition without compromising safety. At Level Three, life improvement measure options may be applied individually or as part of an overall policy designed to reduce the ageing effects of the environment on particular ammunition types. These measures are shown in Table 11 below:

Table 11: Ammunition In-Service Life Improvement Measures

Generic In-Service Life Improvement Measure	Specific In-Service Life Improvement Measure	Explanation
Controlled Storage	• Use high quality Explosive Storehouses (ESH) with effective temperature and humidity control. • Use a dual-inventory process, whereby a small proportion of a particular lot or batch of ammunition is used for training or operations, with the main stock remaining in controlled storage conditions. • Use high quality ammunition packaging.	• Explosives degrade when there are conditions of high temperature and humidity. Controlled storage conditions can defer the onset of, and control the rate of, degradation.
Recording	• Temperature and humidity records of an ESH are maintained, (ideally by use of a data logger). • Exposure to environmental conditions outside controlled storage is recorded. (Meteorological conditions and period of exposure). • Exposure to operational transport and use conditions, (i.e. time spent by a missile vibrating on an armoured vehicle).	• To be most effective MLA requires complete visibility of the environmental conditions a munition has been subjected to.
Data Logging[10]	• Use of an electronic data logger to record temperature and humidity conditions in each ESH.	• If environmental conditions may be accurately recorded, then the percentage of in-service life consumed may be estimated.

Source: IATG 03:10

For more information on Through Life Management and Munitions Life Assessment, see IATG 03.10 Inventory Management.

3. Ammunition Surveillance and Proof

In addition to the Level Two surveillance and proof measures already outlined, at Level Three a proofing schedule should be developed and implemented for each type of ammunition in the stockpile. The results of these tests should also be recorded in a standard form designed to contain all of the information required by the proof schedule. For a sample proof schedule, see IATG 07:10, p7.

Conclusion

The IATGs set out a series of comprehensive guidelines that help to reduce the potential for UEMS and also increase the security of ammunition. However, it is recognised that the implementation of all of these measures can be expensive and impractical, particularly in conditions of scarce resources. To that end, the IATGs describe three 'Risk Reduction Process Levels' (RRPL), where RRPL 1 represents minimal additional investment, and where RRPL 3 represents full IATG compliance and international 'best practice.' As all of the different measures contained within the different Risk Reduction Process Levels cannot be outlined in full here, this OGN focuses on certain Level One and Level Two measures that are thought to have particular relevance to the African context. These measures can be implemented incrementally, and can help to reduce the probability of unplanned explosions and ammunition stock losses.

Annex A: Inventory Management

Ammunition Storage Unit Responsibilities. Units must effectively implement the ammunition accounting system by recording stock levels by ammunition type, quantity, lot and/or batch numbers and storage location.

Recording Issues/Receipts. Records of ammunition receipts and issues must be recorded including details of quantities received or issued, dates of receipt/issue, details of the unit and responsible person the ammunition was issued to/received from as well as the appropriate issue/receipt voucher number.

Accounting Systems. Computerized systems are the best option as they can be automatically updated and up to date printouts can normally be instantly available. Computer systems can also share data from a local ammunition storage facility to a national ammunition stock database. Computerized systems can, however, be expensive to set up and the personnel inputting data often require specialist training. For this reason manual systems are often used as they require little specialist training, and are generally cheap, but can be labour-intensive.

Accuracy. Ammunition accounting systems are rarely 100% accurate as human error can lead to inaccuracies (e.g. the right type of ammunition may be issued but the wrong lot /batch number identified and this would lead to a stock discrepancy, with an apparent shortfall in one lot/batch and an apparent surplus in another lot/batch.

Stack Tally Cards. Stack tally cards, one for each individual stack of ammunition, can help support accurate accounts. The stack tally cards should include the following information:

- Grid Locator Reference
- ESH number
- Full Description of the ammunition as follows:
  - o Type of ammunition Item (e.g. mortar bomb)
  - o Calibre (e.g. 81mm)
  - o Role (e.g. HE)
  - o Model (e.g. M61A1)
  - o Fuze details (if applicable) (e.g. Fzd DA V19)
- Ammunition Descriptive Asset Code (ADAC) (such as the NATO Stock Number (NSN) system).
- Lot and/or batch number
- Ammunition condition codes/category as per Table 12 below
- A record of transactions (e.g. issues or receipts) by quantities and dates, with voucher reference number for each transaction

The Stack Tally cards should be placed in plastic envelopes or similar, to protect them from moisture.

Stock Taking. Stock taking and audits are an essential part of accounting and security as they can detect ammunition loss or theft. Those conducting the stock take should not be given records of actual quantities to ensure the stock found tallies with the accounts, and any discrepancies can be easily identified. Stock taking should occur every three months but where large ammunition stocks are held a continuous rolling stock take can be instigated. Audits should be carried out by an independent body.

Table 12. Typical ammunition condition code system

Ser	Condition code	Description
(a)	(b)	(c)
1	A	Serviceable stocks for issue
2	B	Ammunition under investigation and not for issue
3	C	Ammunition requiring repair or modification prior to issue
4	D	Ammunition which is unserviceable and/or is for disposal.

Annex B: Quantity and Separation Distances

These are a Level Two measure. IATG 02.20 provides detailed guidance on their use.

Distances. QD are calculated from the PES to the relevant building/facility at risk. All distance measurements should be in a straight line, regardless of traverses, earth cover or intervening structures, between the nearest points of the PES and the building/facility at risk.

Net Explosive Quantity (NEQ). The NEQ should be calculated using the total explosive content of each item of ammunition stored, this includes not only the HE content but also any low explosive charges such as propellant and primers. Thus, for example, 1,000 rounds of 100mm ammunition, may have an HE content of 2.14 kg TNT and 7 kg propellant per round, giving an NEQ of 9.14 kg per round, and a total NEQ for 1,000 rounds as 9,140 kg. The NEQ QD calculation should not include substances such as White Phosphorus, smoke or incendiary agents unless they contribute significantly to the dominant hazard division.

Mixing Hazard Divisions. Where an ESH/PES contain a mix of HD 1.1 and HD 1.2/1.3, guidelines are provided in IATG 02.20 to aggregate the QD estimate; otherwise count all as HD 1.1.

TNT Equivalence. The distances quoted in the tables are for ammunition with a TNT main fill. A "TNT equivalent" should be used where the explosive substance is considered to be more, or less, powerful than TNT.

Using QD tables The QD (Quantity Distance) tables shown in Annexures A to Q of IATG 02.20 make use of a number of symbols to represent different types of ESH and facility. Examples are shown below in Figure 3. The tables use the top row to denote the PES, whilst the left hand column shows the symbol for the effected site (ES) i.e. the nearest ESH or facility at risk.

An example of the use of QD Tables.

The example in Figure 4 involves HD 1.1 in above ground storage (Annex D to IATG 02.20). The PES is an earth covered ESH perpendicular to the direction of the ES, and the ES is a semi-reinforced building.

The situation would be classified as D4 (if notes 25 and 26 in the table apply) or D7 if these notes do not apply. If it was planned to store 30,000kg of HD 1.1 then Annex E columns D4 and D7 would show a minimum of 25 metres and 75metres respectively.

If the distance from PES to ES was actually 24 metres, the NEQ of HD 1.1 which would be permitted for storage in the PES would be still be 30,000 kg if D4 applied,

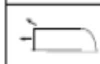
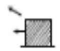
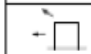
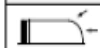
Symbol	Type of Structure / Area	Description	Directional Effects
	Potential Explosion Site (PES)		
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls.	Through the rear of the structure.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls.	Perpendicular to the direction of the ES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls.	Through the door and headwall towards the ES.
	Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). Protective Roof of 150mm RC. Door is Barricaded if it faces a PES.	Through the rear or perpendicular to the ES.
	Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). Protective Roof of 150mm RC. Door is Barricaded if it faces a PES.	Through the door and headwall towards the ES.
	Semi-Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). No Protective Roof. Door is Barricaded if it faces a PES.	Any direction to ES.
	Light Building, Barricaded or Traversed	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Barricaded side to PES.
	Light Building	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Any direction to ES.
	Open Stack, Barricaded or Traversed	Open stack of ammunition with an effective traverse or barricade on all sides.	Barricaded side to PES.
	Open Stack	Open stack of ammunition with no protection.	Any direction to ES.
	Exposed Site (ES)		
	Standard NATO Igloo	Building with earth on the roof and against three walls. 7BAR Door.	Door facing away from PES.
	Standard NATO Igloo	Building with earth on the roof and against three walls. 7BAR Door.	Perpendicular to the direction of the PES.

Figure 3. Symbols used to donate PES/ES. Note direction of arrows showing the predicted path of the explosion

Symbol	Type of Structure / Area	Description	Directional Effects
	Standard NATO Igloo	Building with earth on the roof and against three walls. 7BAR Door.	Door facing towards a PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. 3BAR Door.	Door facing away from PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. 3BAR Door.	Door perpendicular to a PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. 3BAR Door.	Door facing towards a PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. Headwall and door resistant to high velocity projections.	Door facing towards a PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. Barricade in front of door and headwall.	Door facing towards a PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. Headwall and door resistant to high velocity projections.	Door facing away from PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. Headwall and door resistant to high velocity projections.	Perpendicular to PES.
	Earth covered ESH or Igloo	Building with earth on the roof and against three walls. Headwall and door may be resistant to low velocity projections.	Door facing towards a PES.
	Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). Protective Roof of 150mm RC. Door is Barricaded if it faces a PES.	Any direction to PES.
	Semi-Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). No Protective Roof. Door is Barricaded if it faces a PES.	Any direction to PES.
	Open Stack, Barricaded or Traversed	Open stack of ammunition with an effective traverse or barricade on all sides.	Barricaded side to PES.
	Open Stack	Open stack of ammunition with no protection.	Any direction to PES.
	Light Building, Barricaded or Traversed	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Barricaded side to PES.
	Light Building	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Any direction to PES.
	Ammunition Process Building (APB), Barricaded or Traversed	Protective roof.	Barricaded side to PES.
	Ammunition Process Building (APB), Barricaded or Traversed	No protective roof.	Barricaded side to PES.
	Ammunition Process Building (APB)	No protective roof or barricade/traverse.	Any direction to PES.
	Public Traffic Route (PTR)	Road, Railway, Waterway or Right of Way. Usage density will be shown in QD Matrix.	Any direction to PES.
	Inhabited Building	Civilian Buildings or Places of Assembly..	Any direction to PES.
	Vulnerable Building	Hospitals, Glass facade Buildings etc.	Any direction to PES.

PES ⇒ ES ⇓			
	D4 [25,26] Virtually Complete Protection or D7 High Degree of Protection	D4 [25,26] Virtually Complete Protection or D7 High Degree of Protection	D9 Limited Degree of Protection
	D4 [25,26] Virtually Complete Protection or D5 [25] High Degree of Protection	D4 [25,26] Virtually Complete Protection or D5 [25] High Degree of Protection	D4 [25,26] High Degree of Protection or D6 Virtually Complete Protection
	D6 Virtually Complete Protection or D4 [25,26] High Degree of Protection	D6 Virtually Complete Protection or D4 [25,26] High Degree of Protection	D6 Limited Degree of Protection
	D4 [25,26] High Degree of Protection or D7 High Degree of Protection	D4 [25,26] High Degree of Protection or D7 High Degree of Protection	D9 Limited Degree of Protection
	D4 [25,26] High Degree of Protection or D7 High Degree of Protection	D4 [25,26] High Degree of Protection or D7 High Degree of Protection	D7 High Degree of Protection or D5 [25,26] High Degree of Protection
	D4 [25,26] High Degree of Protection or D7 High Degree of Protection	D4 [25,26] High Degree of Protection or D7 High Degree of Protection	D7 High Degree of Protection or D5 [25,26] High Degree of Protection

NEQ (kg)	Quantity Distance (M)						
	D1	D2	D3	D4	D5	D6	D7
900	4		5	8	11	18	24
1,000	4		5	8	11	18	24
1,200	4		6	9	12	20	26
1,400	4		6	9	13	21	27
1,600	5		6	10	13	22	29
1,800	5		7	10	14	22	30
2,000	5		7	11	14	23	31
2,500	5		7	11	15	25	33
3,000	6		8	12	16	26	35
3,500	6		8	13	17	28	37
4,000	6		8	13	18	29	39
5,000	6		9	14	19	31	42
6,000	7		10	15	20	33	44
7,000	7		10	16	22	35	46
8,000	7		10	16	22	36	48
9,000	8		11	17	23	38	50
10,000	8		11	18	24	39	52
12,000	9		12	19	26	42	55
14,000	9		13	20	27	44	58
16,000	10		13	21	28	46	61
18,000	10		14	21	29	48	63
20,000	10		14	22	30	49	66
25,000	11		15	24	33	53	71
30,000	11		16	25	35	56	75

Figure 4. Example of the use of QD tables.

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Incremental Steps towards the International Ammunition Technical Guidelines (IATGs)

Peace and Security Department

African Union Commission