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EOD clearance of ammunition storage area explosions

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Contents

Foreword

International standards for humanitarian mine clearance programmes were first proposed by working groups at an international technical conference in Denmark, in July 1996. Criteria were prescribed for all aspects of mine clearance, standards were recommended and a new universal definition of 'clearance' was agreed. In late 1996, the principles proposed in Denmark were developed by a UN-led working group and the *International Standards for Humanitarian Mine Clearance Operations* were developed. A first edition was issued by the UN Mine Action Service (UNMAS) in March 1997.

The scope of these original standards has since been expanded to include the other components of mine action and to reflect changes to operational procedures, practices and norms. The standards were re-developed and renamed as *International Mine Action Standards* (IMAS).

The United Nations has a general responsibility for enabling and encouraging the effective management of mine action programmes, including the development and maintenance of standards. UNMAS, therefore, is the office within the United Nations responsible for the development and maintenance of IMAS. IMAS are produced with the assistance of the Geneva International Centre for Humanitarian Demining.

The work of preparing, reviewing and revising IMAS is conducted by technical committees, with the support of international, governmental and non-governmental organisations. The latest version of each standard, together with information on the work of the technical committees, can be found at http://www.mineactionstandards.org/. Individual IMAS are reviewed at least every three years to reflect developing mine action norms and practices and to incorporate changes to international regulations and requirements.

Introduction

It is now acknowledged that in almost all post-conflict environments, and in many developing countries, a physical risk exists to individuals and communities from the presence of abandoned, damaged or inappropriately stored and managed stockpiles of ammunition and explosives. Additionally, large quantities of ammunition still exist in the many countries in Eastern Europe and Africa that are surplus to requirement and contain components that are well beyond the safe storage life.

Regrettably there have now been numerous examples of undesired explosive events in ammunition storage depots as a result of inadequate or inappropriate stockpile management. A database[1] of such events from over the last ten years (2002 - 2012) exists, which is based only on open source information from a range of sources;[2] That there have been over 200 known separate explosive events in only 10 years is a clear indicator of a significant threat, particularly as the casualty rate from these known incidents is well over 4,000 fatalities and injuries. The majority of which would have been preventable with even very limited stockpile management policies and procedures. All of these have necessitated an explosive ordnance disposal (EOD) clearance operation to restore a degree of normality to the situation; the cost of this has never been evaluated in terms of financial commitment or the loss of life within communities or of EOD clearance personnel!

Whilst IMAS 11.10 provides guidelines for the safety, security and logistic destruction of ammunition and explosives; this IMAS concentrates on the management and techniques of the EOD clearance operation once an undesirable explosive event has resulted. It is based on IATG 11.30 EOD clearance – ASA explosions, and will be updated in parallel with that IATG.

The post-explosive clearance of ammunition depots should not be based primarily on ‘demining’ standing operating procedures (SOP). Whilst this may seem a practical step at the outset, in real terms may not be particularly efficient, or at times even safe. The threat is different, the clearance options much wider, and some additional technical knowledge is required than that needed for traditional mine and unexploded ordnance (UXO) clearance operations.[3]

[1] The GICHD, SEESAC and Explosive Capabilities databases have now been integrated into the Small Arms Survey UEMS project (www.smallarmssurvey.org/?uems).

[2] NATO MSIAC, Small Arms Survey; Media, Internet and the GICHD, Explosive Remnants of War (ERW), Undesired Explosive Events in Ammunition Storage Areas, ISBN 2-88487-006-7, Geneva, November 2002.

[3] For example, techniques such as use of Nonel explosive systems, mobile ‘rotary kiln furnaces’, hydro-abrasive cutting at the logistic level; pollution control systems to international best practices, contained demolition chambers, etc all have the potential to improve clearance efficiency at an ammunition depot explosion beyond ‘normal’ demining procedures.

EOD clearance – ammunition storage area explosions

1. Scope

This standard provides specifications and guidelines for the Explosive Ordnance Disposal (EOD) clearance of the effects of an undesired explosion in an ammunition storage area, (in either a post conflict controlled stockpile or abandoned explosive ordnance (AXO) scenario).

In this standard, the term 'ammunition and explosives' is used to refer to ammunition, explosives, propellants, explosive ancillaries and other explosive materials, unless stated otherwise in the text. (See Clause 3 below).

2. References

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

3. Terms, definitions and abbreviations

A complete glossary of all the terms, definitions and abbreviations used in the IMAS series of standards is given in IMAS 04.10.

In the IMAS series of standards, the words 'shall', 'should' and 'may' are used to indicate the intended degree of compliance. This use is consistent with the language used in ISO standards and guidelines:

a) 'shall' is used to indicate requirements, methods or specifications that are to be applied in order to conform to the standard;

b) 'should' is used to indicate the preferred requirements, methods or specifications; and

c) 'may' is used to indicate a possible method or course of action.

The term National Mine Action Authority (NMAA) refers to the government entity, often an inter-ministerial committee, in a mine-affected country charged with the responsibility for the regulation, management and coordination of mine action.

Note: In the absence of a NMAA, it may be necessary and appropriate for the UN, or some other recognised international body, to assume some or all of the responsibilities, and fulfil some or all the functions, of a MAC or, less frequently, an NMAA.

The term 'explosives' is used to refer to *a substance or mixture of substances, which, under external influences, is capable of rapidly releasing energy in the form of gases and heat.*

The term ‘ammunition’ (or munition) *is used to refer to a complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions.* [AAP-6].

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

4. Hazards and risks

4.1 In storage

It is an unfortunate fact that ammunition and explosive storage can never be 100% safe in terms of the 'absence of risk', and the best that can be achieved is 'tolerable risk'.[4] This can only be achieved by a wide range of technical responses that are explained in the International Ammunition Technical Guidelines (IATG). It is appropriate, however, to highlight that in terms of national stockpiles the hazard is the physical presence of the ammunition and explosives, whereas the risk is primarily dependent on:

a) the physical and chemical condition of the ammunition and explosives;

b) the training and education of the personnel responsible for the storage and surveillance of the stockpiles;

c) the handling, repair, maintenance and disposal systems in place; and

d) the storage infrastructure and environment.

The concept of tolerable risk can only be achieved if the ammunition management systems and storage infrastructure are to appropriate standards or in accordance with 'best practices'. Past desk studies[5] by the Geneva International Centre for Humanitarian Demining (GICHD), supplemented by further SEESAC research, initially identified a significant number of recent explosive events that have occurred due to inappropriate storage or explosive safety procedures.[6] These studies clearly indicate that in almost all post-conflict environments, and in many developing countries, a physical risk exists to communities from the presence of abandoned, damaged or inappropriately stored and managed stockpiles of ammunition and explosives.

There are many possible causes of undesirable explosions in Ammunition Storage Areas, but these can usually be attributed under the following generic areas:

e) deterioration of the physical or chemical condition of the ammunition and explosives;

f) unsafe storage practices and infrastructure;

g) unsafe handling and transport practices;

h) external effects, (such as fire); or

i) deliberate sabotage.

Regrettably, the dramatic consequences of an ammunition explosion normally make the key witnesses to the event its first victims. Therefore any subsequent investigation tends to concentrate on the practices and regulations in force at the time, as key witnesses are not available. Due to the fact that a degree of technical knowledge is required for an effective investigation, the investigating authority is also usually the authority responsible for the

[4] An alternative methodology is that the risk should be As Low as is Reasonably Practicable (ALARP).

[5] *Explosive Remnants of War (ERW) - Undesirable Explosive Events in Ammunition Storage Areas*, ISBN 2-88487-006-7, GICHD, Geneva, November 2002; *Undesirable Explosive Events in Ammunition Storage Areas*, SEESAC, 2002 – 2007; *Undesirable Explosive Events in Ammunition Storage Areas*, Explosive Capabilities Limited, 2008 – 2011.

[6] There is absolutely no intention on the part of the authors to allocate or imply blame for any of the explosive events referred to in this paper; indeed the States involved should be congratulated on their transparency in allowing lessons to be learned from these unfortunate events. Details of these accidents may now be found on the Small Arms Survey website (www.smallarmssurvey.ch).

ammunition management and storage in the first place. This complicates impartiality, independence of investigation and leads to a reluctance to allocate responsibility!

4.2 Post explosion

Many, or even all, of the following hazards will exist after an undesired explosive event within an ammunition storage area:

a) ammunition may have been projected some distance from the explosion site, (e.g. there have been examples of free flight rockets travelling up to 20km). If the ammunition has been stored in a fuzed state, then it is very possible that the forces imparted to the ammunition during the explosion are similar to the forces required to arm the fuze. Therefore all fuzed ammunition, either within or at any distance from the explosion site, shall be regarded as unexploded ordnance (UXO) and dealt with appropriately;

b) the explosive content of ammunition natures may be either partially or fully burnt out. If partially burnt out then there will be the normal hazards presented by exposed explosive. Additionally there may be the hazards associated with melted explosives re-crystallising and forming undesirable, more sensitive isomers e.g. TNT;

c) ammunition may have been broken open leading to exposed explosive or other fillings (white phosphorous, bomblets etc) being spread across the site;

d) ammunition may have been broken open leading to exposed electrical leads;

e) propellant may not have burnt during the explosion and fires, therefore exposed propellant may be spread across the site. This may spontaneously ignite during EOD clearance operations; such ignition will be dependent on the chemical condition of the propellant and the ambient temperature;

f) ammunition that has been projected out of the site may well penetrate the ground surface, thereby leading to a requirement for sub-surface clearance;

g) at the 'seat of the initial explosion', if that can be identified, a crater will have resulted. There are, however, likely to be a multitude of craters after a serious event. It shall be assumed that ammunition is still contained within the crater, and subsequent explosions may have partially 'filled in' craters, thereby in effect burying ammunition;

h) the ammunition that has been involved in the explosion, but did not deflagrate or detonate, will be very susceptible to the weather; risks will increase significantly during lightning storms and further explosive events initiated by lightning strikes may occur;

i) the infrastructure (buildings, roads etc) is very likely to be in an unstable condition, and be at risk of collapsing;

j) subsequent bad weather may have led to flooding and mud slides covering up ammunition and UXO; and

k) exposed explosives may contaminate surface and subsurface water. This water may be coloured pink as the result of TNT, RDX and HMX contamination. Explosives are also toxic; for example people exposed to TNT over a prolonged period tend to experience anemia and abnormal liver functions. Personal protective equipment (PPE) (face masks and protective gloves) may therefore be required when collecting explosives that have been pulverized during an explosion, as will a thorough clean-down procedure.

5. Impact and effects

The damage, casualties and impact on communities of an explosion within an ammunition storage area can be devastating, and the economic costs of the subsequent EOD clearance can be far greater than the prior implementation of safer procedures, limited infrastructure development and stockpile disposal would have been.

It is also important to remember that there will inevitably have been a number of 'near misses', where an undesirable explosive event has been prevented or contained by the ammunition management or storage practices in place at the time. A major problem, however, is that during conflict, in post-conflict environments or during force restructuring as part of security sector reform, the specialist technical personnel that should be responsible for ammunition management may well have become casualties or left the armed forces; they are very difficult to replace without a comprehensive and effective training programme.

There are also economic costs in terms of the capital value of the stockpile itself; although this is really a factor for national consideration, the international donor community should be interested, as national finance for replacement stocks could potentially have been committed to social and economic development. For example, the ammunition explosion in Bharatpur, India on 28 April 2000 resulted in an estimated ammunition stock loss of US$ 90M. The explosion was as a result of a fire at the ammunition depot, which was exacerbated by excessive vegetation. The grass had not been cut for two years as a cost-saving measure!

6. Clearance principles

Safety during EOD clearance operations of ammunition storage areas after an explosive event shall be paramount and shall be based upon the principles of:

a) appropriate threat assessment;[7]

b) planning;

c) good training and technical education;

d) lessons identified from previous operational experience and competency standards;[8]

e) appropriate and effective operating procedures;

f) identification and use of appropriate equipment; and

[7] This is critical to the safety, effectiveness and efficiency of the clearance operation. The risks, hazards, threats, opportunities, technical skills and operating procedures for the clearance of an ammunition depot explosion, as opposed to Battlefield Area Clearance or Mine and UXO Clearance are slightly different. Ammunition technical skills are critical to the development of a safe, effective and efficient clearance.

[8] Competency standards are now becoming the accepted way of assessing an individual's suitability for a particular task. An individual's competency is based on a balanced combination of their training, education and operational experience. Just because an individual has 20 years experience does not necessarily mean that they are competent, if the initial training was inappropriate; they may just have been lucky.

g) use of Personal Protective Equipment as the 'last resort' safety measure against explosive ordnance hazards.[9]

7. Clearance requirements

The future land use of the ammunition depot involved in the undesired explosion shall be a key factor in determining the exact EOD clearance requirements, and hence the allocation of necessary resources. Future land use should determine the level of clearance required; for example it would be inappropriate and wasteful in resources to clear the land to a depth of 2 metres if the land was going to be used for forestry. IMAS 09.10 states that:

Land shall be accepted as 'cleared' when the demining organisation has ensured the removal and/or destruction of all mine and UXO hazards from the specified area to the specified depth.

The specified area to be cleared shall be determined by a technical survey or from other reliable information which establishes the extent of the mine and UXO hazard area.

Note: The priorities for clearance shall be determined by the impact on the individual community balanced against national infrastructure priorities.

The specified depth of clearance shall be determined by a technical survey, or from other reliable information, which establishes the depth of the mine and UXO hazards and an assessment of the intended land use. In the absence of reliable information on the depth of the local UXO and mine hazard, a default depth for clearance shall be established by the national mine action authority. It should be based on the technical threat from mines and UXO in the country and should also take into consideration the future use to which the land is to be put.

Note: *For buried mines and UXO this depth should normally not be less than 130mm below the original surface level; this figure is based on the effective detection depth of the majority of metal detectors. It may be refined by the national mine action authority dependent on the type of metal detector that they currently use based on the results of the International Pilot Project for Technology Co-operation Final Report on the Evaluation of Commercial Off The Shelf Metal Detectors (EUR 19719 EN) (available from the EU JRC Ispra).*

Therefore the clearance requirements should be strategically developed based on; 1) the threat; and 2) future land use. It is very likely that 'surface clearance' may be appropriate for the majority of the land within the danger area radius, whereas sub-surface clearance would be appropriate for the 'crater' areas of the individual storage site[10] explosions. Once the clearance depth requirements have been formally established then the appropriate clearance methodology and technical equipment requirements may be established.

8. Development of EOD clearance methodology

The following factors shall be considered during the development of the EOD clearance methodology;

a) a technical evaluation shall be conducted, to include:

[9] PPE must be considered as the 'last resort' safety measure during EOD operations. It should be the final protective measure after all planning; training and procedural efforts to reduce risk have been taken. There are a number of reasons for this approach. Firstly, PPE only protects the person wearing it, whereas measures controlling the risk at source can protect everyone at the workplace. Secondly, theoretical maximum levels of protection are seldom achieved with PPE in practice, and the effective level of protection is difficult to assess. Thirdly, effective protection is only achieved by suitable PPE, correctly fitted, properly maintained and used, AND appropriate to the task rather than just a line item on a check list! Finally the restrictive effects of PPE versus task efficiency must be considered. PPE is rarely used for Conventional Munition Disposal (CMD) in low risk environments when appropriate training, education, operational experience and competency are present in the task organization.

[10] In this case a 'storage site' being defined as an individual Explosive Storehouse (ESH) or Exposed Stack.

(1) the identification of ammunition types, and possible instability or UXO risks;

(2) the identification of sub-surface risks; and

(3) an assessment of the UXO and ammunition density across the site and danger area radius (/m^2);

b) a formal risk assessment, based on the principles within ISO Guide 51, shall be made;

c) the clearance plan (see Annex B) shall be based on the technical evaluation and risk assessment. It should include:

(1) effective and appropriate SOPs;

(2) resource requirements, (including protected heavy lift vehicles to gain access); and

(3) a training programme to meet SOPs.

d) the time taken for the EOD clearance will always be difficult to estimate due to the large number of variables. The matrix below may be of assistance,[11] as it is based on experience to date, although it will require updating as experience is gained on each operational task;

Ground Preparation Factor [12]						
Type of Terrain	**Area (Ha)**	**Factor [13]**	**Man Days**	**Staff Available**	**Estimated Time (Days)**	**Remarks**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Short Grass	20	0	0	0	0.0	
Light Vegetation	5	10	50	10	5.0	
Dense Vegetation	5	30	150	14	10.7	Consider other techniques.
Search and Marking Factor						
Type of Search	**Area (Ha)**	**Factor**	**Man Days**	**Staff Available**	**Estimated Time (Days)**	**Remarks**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Visual	26	1.3	33.8	20	1.7	
Metal Detector	4	2.5	10	4	2.5	Factor for Low Density UXO and ammunition contamination only to shallow depth (130mm). For High Density UXO and ammunition contamination a much higher factor will need to be applied.
Destruction [14] / Recovery [15] Factor						

[11] It has been completed for an EOD clearance task of 30Ha with 30 staff available. The balance of staff between EOD trained personnel and general staff will also make a difference to the factors shown.

[12] This assumes that the ground is prepared by hand or with light mechanical systems. Use of techniques such as large contained burns will reduce the time period of ground preparation considerably. Preparing the ground in a hazardous area by mechanical means could involve removing or reducing obstacles to clearance e.g. vegetation, soil and metal contamination to make subsequent EOD clearance operations quicker and safer.

[13] The Factor is an estimate of the time in Days for 1 Person to complete the task for 1 Hectare.

[14] Destruction of fuzed ammunition 'in situ' by demolition.

[15] Recovery of unfuzed ammunition and scrap for further processing. The destruction by demolition of stockpiles of recovered unfuzed ammunition should be a concurrent activity. Do not forget to allocate separate staff for this task.

UXO / Ammunition Density[16]	Area (Ha)	Factor [17]	Man Days	Staff Available	Estimated Time (Days)	Remarks
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Very Heavy (10.0/m^2)	2	180	360	10	36	
Heavy (5.0/m^2)	6	90	540	10	54	
Medium (1.0/m^2)	12	50	600	4	150	
Light (0.2/m^2)	10	10	100	4	25	
Estimated Task Clearance (Days)					**284.9**	

9. EOD clearance operation

9.1 EOD clearance process

There are a range of process options for the conduct of the EOD clearance operation after an ammunition storage site explosion. Other options are possible, but the one that follows is based on proven operational practices;

a) establish the radius of the danger area[18] that requires EOD clearance;

b) grid the area from the outside to the inside, (consider the danger area and the ammunition storage area as separate clearance requirements);[19]

c) the clearance of locations within the danger area radius where civilians are at highest risk shall be the first priority;

d) conduct marking operations using appropriately qualified ammunition personnel;[20] [21]

e) conduct the initial surface clearance, (unless the threat assessment makes sub-surface clearance an absolute necessity or priority). All fuzed ammunition shall be destroyed by detonation or deflagration 'in situ';

f) establish a demolition ground for the destruction of recovered unfuzed ammunition;

g) establish a 'Free From Explosive' (FFE) verification and scrap processing system; and

[16] UXO / Ammunition Density includes; 1) fuzed ammunition that must be destroyed in situ as UXO; 2) unfuzed ammunition that may be manually cleared; and 3) metallic fragments from detonated or deflagrated ammunition.

[17] This Factor estimates the time taken to lay clearance charges and manually recover unfuzed ammunition and metallic fragments. The Factor may have to be altered dependent on the proportion of fuzed ammunition versus unfuzed ammunition. It assumes access times have been considered under Ground Preparation, Search and Marking.

[18] The radius of the danger area should be based on the maximum range of the ammunition contained within the depot assuming a ballistically stable flight path. This will be the maximum range at which a very small amount of ammunition may be expected to have been projected. The majority of the ammunition will have been projected in a ballistically unstable manner and therefore the range will be much reduced from the theoretical maximum.

[19] Aerial photography and 1:10,000 scale mapping are very useful for planning and conduct of operations. Infrared aerial photography may also be useful in terms of identifying threats at depth.

[20] Ammunition qualified personnel, as opposed to EOD Operators are strongly recommended for this component of the clearance operation. They can save time, negate the requirement for destruction in situ and, in some cases, make recommendations for movement of munitions that a general EOD operator can't. Their training in the detailed ammunition design means that they may effectively speed up the clear up operation within the bounds of acceptable safety.

[21] The basic paint marking system should be; 1) GREEN - No explosive content and can be moved to scrap recovery by anyone; 2) ORANGE - Certified as 'Safe to Move' by an Ammunition Specialist for destruction at a central demolition point. The ammunition can then be moved by support personnel; and 3) RED - Destroy in situ by EOD teams in a planned daily demolition series

h) establish an ammunition accounting system for the EOD clearance and demolitions, (it may be possible to reconcile the ammunition account after EOD clearance has been completed in order to identify stock losses).

9.2 Process efficiency

The EOD clearance of an area after an ammunition depot explosion presents a range of process complications beyond that of traditional humanitarian mine and UXO clearance operations, (very high UXO density, ammunition components, exposed explosive and propellant, collapsed storage buildings complicating access, etc). Whilst safety shall be paramount, there are a range of proven techniques and systems that make a contribution to improved clearance efficiency. Time should not be a factor that influences safety, but there will often be political pressures for 'quick' clearance; this pressure should be resisted. Notwithstanding this, a major financial factor will be the human resources necessary for the task, and therefore the use of more effective systems can contribute to cost-effectiveness, whilst improving safe clearance times.

Equipment	Use	Examples
'Nonel' Shock Initiation System	▪ 'Nonel' is much easier to handle and is cheaper than military detonating cord. It should be considered due to the potentially very large number of 'in situ' demolitions necessary for destruction of the fuzed ammunition.	Nonel is a commercial product name. Other types on Non Electric initiation systems are available.
Radio Controlled Initiator (RS68, BIRIS or Mini RABS Type)	▪ The use of this type of system negates the requirement for the deployment of long firing cables. ▪ Safety and control of demolitions is improved as all can be fired from a central point, without the excessive use of firing cable. ▪ RC initiation is quicker to set up and take down than long runs of firing cable.	ExChem Limited are the major supplier of military systems in this area. Similar commercial systems are available, but have less capability in terms of RF safety as they are usually not RF coded.
Armoured Fire-fighting Vehicles	▪ The use of specialist armoured vehicles such as 'FIREFIGHTER 55' allows for the option of 'contained vegetation burns' to rapidly clear large areas of vegetation prior to further EOD clearance operations.	
Armoured Engineer Vehicles	▪ Specialist armoured vehicles such as the 'SDS 214' are an efficient alternative for the clearance of the 'explosion craters' and surrounding area, where large quantities of earth require safe processing. These areas are likely to have high density UXO contamination. ▪ Such vehicles can also be used to support 'contained vegetation burns' by rapidly establishing earth firebreaks.	

Equipment	Use	Examples
'Alternative' or Deflagration techniques	▪ Deflagration, rather than detonation, techniques may be appropriate for fuzed ammunition that is lying near sensitive locations (power lines, routes, etc). Although detonation must be assumed for the establishment of danger areas, deflagration techniques now routinely achieve a 80% success rate for 'low order' results.	Point Focal Charges (such as the Swiss SM Series), Thermites, 'Baldrick' and 'Crackerbarrel' are all examples of such techniques.

10. Responsibilities and obligations

10.1 United Nations

On behalf of affected communities and states the United Nations should be prepared to assess situations and assist in the collection of relevant information after ammunition storage area explosions.

The United Nations shall maintain information on:

a) clearance means and technologies for dealing with explosions in ammunition storage areas;

b) lists of specialists, specialist agencies or national points of contact on the EOD clearance of ammunition storage area explosions; and

c) technical information on relevant types of explosive ordnance.

10.2 National Authority

The national authority, which may often be the NMAA, shall:

a) where possible, specify the area to be cleared and depth of clearance in contracts and agreements;

b) specify the criteria for clearance to allow clearance organisations the flexibility to clear out to the limits of a suspect area;

c) specify the standards and guidelines for QA and QC to be applied to clearance contracts and agreements;

d) accredit organisations to undertake clearance;

e) maintain records of cleared and uncleared land showing the clearance status for each suspected area;

f) collect and make available technical information and accident / incident information / analysis to aid the EOD clearance operation; and

g) specify the core EOD competencies to be applied within clearance organisations.

10.3 Demining organisation

The demining organisation shall:

a) gain from the NMAA[22] accreditation to operate as a EOD clearance organisation for ammunition storage area explosions;

b) apply the NMAA clearance standard. In the absence of national standards, the demining organisation shall apply the IMAS, or such standards as are specified in their contract;

c) maintain and make available documentation of clearance as specified by the NMAA;

d) apply management practices and operational procedures which aim to clear the area of the ammunition storage area explosion to the requirements specified in the contract and tasking agreement(s);

e) ensure that the affected community is fully cognisant of all clearance activities in the area and the implications for the community, (particularly related to the depth of clearance); and

f) ensure that men and women employed in EOD clearance operations are competent and suitably trained.

In the absence of a NMAA, the demining organisation shall assume additional responsibilities. These include, but are not restricted to:

g) for each ammunition storage area (ASA), agree the requirement and formally document in accordance with IMAS 08.20 land release:

   (1) the area of the clearance; and

   (2) the depth of the clearance;

h) establish and apply a system of monitoring the clearance activities, detailed reporting of the UXO and AO encountered and post-clearance inspections of cleared land; and

i) assist the host nation, during the establishment of a NMAA, in framing national standards for clearance quality.

10.4 Monitoring body

The monitoring body shall:

a) gain from the NMAA accreditation to operate as a monitoring body;

b) monitor the EOD clearance organisation and its sub-units in accordance with the intentions of IMAS 07.40 and the requirements of the NMAA; and

c) maintain and make available documentation of monitoring inspections as specified by the NMAA.

[22] Or other appropriate authority.

10.5 Inspection body

The inspection body shall:

a) gain from the NMAA or organisation acting on its behalf accreditation to operate as an inspection body;

b) apply sampling procedures in accordance with the requirements of the NMAA or IMAS 09.20; and

c) maintain and make available documentation of inspections as specified by the NMAA.

Annex A
(Normative)
References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this part of the standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of the standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid ISO or EN:

a) IATG 11.30 ASA Explosions – EOD Clearance; and

b) ISO Guide 51 - Safety.

The latest version/edition of these references should be used. GICHD hold copies of all references used in this standard. A register of the latest version/edition of the IMAS standards, guides and references is maintained by GICHD, and can be read on the IMAS website (http://www.mineactionstandards.org/). NMAA, employers and other interested bodies and organisations should obtain copies before commencing mine action programmes.

Annex B
(Informative)
Example EOD Operation Order

Copy No of copies

Total pages:

General Staff
Ministry of Defence
BLUETOWN
Redland

Civil: (+99) (12) 26648

July 2012

File Number

EOD OPO 1/12 (LOCATION 1)

References:

A. EOD SOPs 6 and 7.
B. Map Sheet K-34-112-D-d, 1:25,000.
C. The Pink Book.

Time Zone Used Throughout the Order: LOCAL

Task Organisation:[23]

SER	RANK	NAME	APPOINTMENT	TASK
(a)	(b)	(c)	(d)	(e)
1			Chief EOD	Technical Direction
2			D/Chief EOD	Operations Officer
3			EOD Team (Ground) Commander	Command and control of operation on the ground.
4			EOD Team Deputy (Ground) Commander	
5			Ammunition Specialist	Technical Advisor on Ammunition Types.
6			EOD Team (1) Leader	Clearance
7			EOD Team (2) Leader	Logistic Destruction and Demolitions
8			Medical Doctor	

1. SITUATION

a. EOD and UXO Background Intelligence.

[23] Options included, which are task dependent.

(1) During the civil unrest in Redland in 2012 there were a number of explosions at the BLUETOWN Ammunition Storage Area (ASA) on the 18 April 2012.

(2) Three Explosive Storehouses (ESH) and an Ammunition Laboratory were involved in the explosions; these contained approximately 1,200 tonnes of ammunition and explosives at the time of the explosive events. One of the ESH and its contents, bulk HE and mines, was completely destroyed by a detonation. **This area will be referred to as Area 1.** See Annex A.

(3) Subsequent to these explosions there were a series of fires set to piles of ammunition placed in front of the remaining 12 underground ammunition storage bunkers on site, which are still in use. These had no impact on the bunkers but resulted in UXO contamination of surrounding areas. This area will be referred to as Area 2. See Annex A.

(4) EOD clearance Operations to clear access roads and the areas around the exploded ESH were carried out in March 2012**.** As a consequence of these operations there has been significant consolidation of UXOs and access roads appear to be clear

(5) A total area of 45 Hectares (Ha) requires EOD clearance. This area has Very Heavy (10.0/m^2) to Heavy Density (5.0/m^2) UXO and ammunition contamination.

(6) BLUETOWN ASA is still an active stockholding unit. Throughout any EOD clearance task it will be essential, for safety and operational reasons that close liaison is maintained with the Commander BLUETOWN ASA.

(7) Since April 2012 there have been at least 14 wounded as a result of explosions in these areas, and the subsequent civilian handling of the unexploded ammunition.

b. Ammunition Natures. The following general ammunition natures were stored in BLUETOWN and can be expected to be found during the EOD clearance operation. Technical References, together with the associated components, are at Annex B:

SER	AMMUNITION NATURE	REMARKS
(a)	(b)	(c)
1	152mm HE	Fuzed - MUST be treated as UXO.
2	122mm HE	UNFUZED - Destroy in Bulk (If safe to move)
3	122mm Rocket	Fuzed - MUST he treated as UXO.
4	82mm Mortar HE	UNFUZED - Destroy in Bulk (If safe to move)

2. MISSION

To conduct a safe EOD clearance operation of the BLUETOWN ammunition storage area, within the boundaries indicated at Annex A, in order to restore the situation to normality.

3. EXECUTION

a. Concept of Operations.

(1) Assembly Phase:

(a) Serviceable ammunition stocks pre-positioned at BLUETOWN.

(b) Confirm the availability of personnel.

(c) Equipment and expense stores pre-positioned at Unit No 5013, BFU Bluetown and checked for presence and serviceability.

(e) Briefings as required.

(2) Deployment Phase:

(a) Advance party deploy with equipment and stores to the BLUETOWN site.

(b) Preparation of administrative and clearance area.

(c) Arrival of main body.

(d) Briefings – to include Clearance Operation Safety Brief.

(3) Clearance Phase - Area1:

(a) Visual surface and electronic subsurface, search for and identification of UXO and ammunition up to the boundaries of the ESHs and Ammunition Laboratory.

(b) Removal of ammunition and items identified as safe to move.

(c) Demolition of UXO in situ.

(d) Demolition of safe to move items on the Demolition Ground. (Separate Demolition Order to be issued by Comd EOD).

(e) Mechanical removal of ESH/Ammunition Laboratory roof slabs and remaining substantial structures.

(f) Recovery and demolition of ammunition assessed as safe to move.

(g) Demolition of UXO in situ.

(h) Free From Explosive (FFE) certification of inert metal scrap/ammunition items.

(i) Quality checks of cleared areas and demolition site.

(4) Clearance Phase - Area 2

(a) Visual surface search for and identification of UXO and ammunition, along the Underground Bunker/BLUETOWN Storage Site access road including pedestrian accessible verges.

(b) Recovery and subsequent demolition of ammunition assessed as safe to move.

(c) Demolition of UXO in situ.

(d) Free From Explosive (FFE) certification of inert metal scrap/ammunition items.

(e) Quality checks of cleared areas and demolition ground.

(f) Post warning notices along the BLUETOWN road at the base of the downhill slope of uncleared mountain scree area (some 8 hectares).

(5) Recovery Phase:

(a) Check and pack equipment, expense stores and ammunition and explosives.

(b) Return to base location.

b. Detailed Tasks. The following detailed tasks have been identified:

(1) Conduct a detailed recce of the BLUETOWN site in conjunction with the Deputy EOD Team Ground Commander and Ammunition Specialist.

(2) Route power lines to the BLUETOWN ASA away from the clearance area; demolition activity has the potential to cause inadvertent interruption of supply.

(3) Ensure the removal of Anti Personnel Mines within the BLUETOWN site before and throughout the clearance operation.

(4) Mark the outer limits of the UXO and ammunition contaminated ground to be cleared.

(5) Identify and establish a Demolition Ground to safely dispose of the recovered munitions.

(6) Confirm safety of area for further operations after burning if required.

(7) Identify, mark and remove munitions that are “Safe to Move”.

(8) Dispose of remaining munitions in situ by demolition.

(9) Conduct sub-surface search using Metal Detectors.

(10) Dispose of recovered munitions as appropriate.

(11) Continually certify that recovered scrap is Free From Explosive (FFE) and arrange its final disposal.

(12) Conduct final clearance.

c. Limitations. The EOD Team will have the following operational limitations:

(1) Render Safe Procedures. The only authorised Render Safe Procedures (RSPs) to be used are:

(a) If positively identified by both the EOD Team and Ammunition Specialist as ‘Safe to Move’, then ammunition may be recovered for disposal at the adjacent Demolition Ground. These munitions are to be clearly marked with **YELLOW** paint. **UXO requiring demolition in situ will be indicated by RED PAINT AND marker poles in the ground immediately adjacent to the item.**

(b) If positively identified by the Ammunition Specialist as ‘Free From Explosive’, an item or inert ammunition should be clearly marked with **GREEN** paint marking. This inert ammunition can then be recovered directly to the Scrap Storage Area.

(c) Disposal in situ by alternative deflagration techniques.

(d) Disposal in situ by detonation.

(2) Under Cover Requirements. During the physical clearance of UXO by detonation **ALL** personnel, with the exception of the nominated EOD Operator, are to be under cover during the ‘detting up’ phase.

(3) Control. The EOD Team Leader controlling UXO clearance operations **must stop** operations if he feels that safety has been, or is about to be, compromised. He must ensure that **ALL** personnel are aware of the system for them to stop operations if they feel safety is, or is about to be, compromised.

(4) Search Techniques. Only those Search Techniques laid down in EOD SOP 6 are to be used.

d. Fire Fighting. The following fire fighting and preventative measures are to be observed:

(1) Smoking and the use of flame producing equipment such as cookers are to be limited to those areas specified by the EOD team Ground Commander.

(2) Effective firebreaks are to be cut prior to using burning to remove vegetation. The local Fire Service is to advise on their suitability.

(3) A manned Fire Service tender is to be on site during all demolitions.

(4) The siting of Fire Fighting Points and all fire fighting activities are to be co-ordinated by the EOD Team Ground Commander in consultation with the Commander BLUETOWN ASA and any local Fire Service resources in attendance.

e. Assessment of Tasks. An assessment of the detailed tasks, in Man-Days, is as follows:

GROUND PREPARATION FACTOR [24]						
TYPE OF TERRAIN	**AREA (Ha)**	**FACTOR [25]**	**MAN DAYS**	**STAFF AVAILABLE**	**ESTIMATED TIME (DAYS)**	**REMARKS**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Short Grass	35	0	0			
Light Vegetation	5	10	50			
Dense Vegetation	5	30	150			Consider other techniques.
SEARCH AND MARKING FACTOR						
TYPE OF SEARCH	**AREA (Ha)**	**FACTOR**	**MAN DAYS**	**STAFF AVAILABLE**	**ESTIMATED TIME (DAYS)**	**REMARKS**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Visual	41	1.3	53.3			
Metal Detector	4	2.5	10			Factor for Low Density UXO and ammunition contaminatio n only to shallow depth (130mm). For High Density UXO and ammunition contaminatio n a much higher factor will need to be applied.
DESTRUCTION [26] / RECOVERY [27] FACTOR						
UXO / AMMUNITION DENSITY [28]	**AREA (Ha)**	**FACTOR [29]**	**MAN DAYS**	**STAFF AVAILABLE**	**ESTIMATED TIME (DAYS)**	**REMARKS**

[24] This assumes that the ground is prepared by hand or with light mechanical systems. Use of techniques such as large contained burns will reduce the time period of ground preparation considerably.

[25] The Factor is an estimate of the time in Days for 1 Person to complete the task for 1 Hectare.

[26] Destruction of fuzed ammunition 'in situ' by demolition.

[27] Recovery of unfuzed ammunition and scrap for further processing. The destruction by demolition of stockpiles of recovered unfuzed ammunition should be a concurrent activity. Do not forget to allocate separate staff for this task.

[28] UXO / Ammunition Density includes; 1) fuzed ammunition that must be destroyed in situ as UXO; 2) unfuzed ammunition that may be manually cleared; and 3) metallic fragments from detonated or deflagrated ammunition.

	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Very Heavy (10.0/m^2)	30	180	5400			
Heavy (5.0/m^2)	15	90	1350			
Medium (1.0/m^2)	0	50	0			
Light (0.2/m^2)	0	10	0			
ESTIMATED TASK CLEARANCE TIME (DAYS)					**7,014**	

f. Co-ordinating Instructions

(1) Timings

SER	DATE	TIME	EVENT	REMARKS
(a)	(b)	(c)	(d)	(e)
1	11 May 12	0600	Initial EOD Recce.	
2	To Be Notified		Detailed recce.	
3	D Day		Advance party deploys	
4	D +1		Preparation of clearance area.	
5	D + 2		Main party deploys.	
6	D + 3		Clearance commences	Ongoing till completion.

4. SERVICE SUPPORT

a. Personal Equipment. Team personnel are to deploy with the appropriate personal equipment for field operations.

b. Accommodation. All personnel are to be accommodated at Unit No 5013, BFU BLUETOWN.

c. Rations. Rations are to be provided through Unit No 5013, BFU BLUETOWN on the basis of:

(1) Breakfast and evening meals at Unit No 5013, BFU BLUETOWN with packed rations for lunch at the clearance site on working days.

(2) On non-working days rations to be provided in accordance with local routine at Unit No 5013, BFU BLUETOWN.

(3) Daily ration strengths/nominal rolls will be provided by the EOD Team Ground Commander as required.

d. Transport. The following transport will be required to support the task:

SER	DATES	TYPE	QTY	TASK
(a)	(b)	(c)	(d)	(e)
1	21 Apr 06	4 x 4 Car	1	Recce
2	D day onward	4 x 4 Car	1	Safety Vehicle
3	D day onward	4 x 4 Truck	1	Serviceable Ammunition and stores.
4	D day onward	4 x 4 Truck	1	Movement of Unserviceable Ammunition to the Demolition Ground.
5	D day onward	4 x 4 Car	1	Movement of personnel and miscellaneous stores.
6	D +1 onward	Ambulance	1	Medical Support

[29] This Factor estimates the time taken to lay clearance charges and manually recover unfuzed ammunition and metallic fragments. The Factor may have to be altered dependent on the proportion of fuzed ammunition versus unfuzed ammunition. It assumes access times have been considered under Ground Preparation, Search and Marking.

SER	DATES	TYPE	QTY	TASK
(a)	(b)	(c)	(d)	(e)
7	D + 2 onward	Winch Veh/Crane	1	Removal of roof slabs. Completion estimated for D + 5.

e. Equipment. The equipment at Annex C will be required:

f. Serviceable Ammunition and Explosives. The list at Annex D is an estimate of the serviceable ammunition and explosive requirements; **this will be re-assessed as the operation continues.** Serviceable ammunition and explosives are to be stored and accounted for in accordance with National Regulations.

g. Medical.

(1) First Aid. A Doctor **MUST** be present during all operations at the site. The EOD Team Leader **MUST** cease operations if there is no medical cover available. The Doctor should be suitably qualified in the treatment of explosive shock and trauma injuries. He should render all appropriate medical support to any casualties, but must not expose himself to any unnecessary risk from UXOs by doing so.

(2) MEDEVAC. An Ambulance is to be available to MEDEVAC casualties to the nearest medical facility. A helicopter should be on standby during the EOD clearance operation to evacuate any very serious casualties.

(3) Surgery/Hospital.

(a) BLUETOWN.
Tel: (062) 34222**.**

(b) Disney. Any very serious casualties are to be evacuated to the Disney Military Hospital on the advice of medical personnel.
Tel: (042) 26601 Ext 344

5. COMMAND AND SIGNAL

a. Operation Commander. Maj M MOUSE, Chief EOD, REDLAND.

b. EOD Team Ground Commander. To Be Notified.

c. Deputy EOD Team Ground Commander. To Be Notified.

d. Reports and Returns. The following information is to be compiled and submitted to the EOD Cell, MOD on a weekly basis:

(1) Ammunition Recovered for Disposal by Demolition. (Annex E).

(2) Ammunition Disposed of In Situ by Detonation. (Annex F).

(3) Ammunition Recovered for Storage. (Annex G).

(4) Scrap Recovered. (Annex H).

e. Contact Numbers.

SER	UNIT	NAME	TEL [1]	FAX
(a)	(b)	(c)	(d)	(e)
1	Chief EOD			
2	D/Chief EOD			

SER	UNIT	NAME	TEL [1]	FAX
(a)	(b)	(c)	(d)	(e)
3	Ground Commander			
4	EOD Ammunition Specialist			
5	D/EOD Team Ground Commander			
6	Commander 5013			
7	BFU BLUETOWN			
8	Commander BLUETOWN ASA			

f. A post operation report is to be completed within 2 weeks of completion of the clearance task and submitted to the Chief of EOD.

Annexes:

A. Map – Boundary of Clearance Area**.**
B. Technical References for expected UXO.
C. Equipment Requirements.
D. Serviceable Explosive Requirements.
E. Ammunition Recovered for Disposal by Demolition.
F. Ammunition Disposed of In Situ by Detonation.
G. Ammunition Recovered for Storage.
H. Scrap Recovered.

Distribution: Copy No

External:

Action:

Commander 5013 -
EOD Team Leader -

Internal:

Action:

Chief EOD -
D/Chief EOD -
EOD / Ammunition Specialist -

Information:

Chief Engineer -
Chief Ammunition and Armaments -

ANNEX B TO
EOD OPO 1/11

TECHNICAL REFERENCES

SER	AMMUNITION NATURE		ASSOCIATED FUZES		REMARKS
	TYPE	"PINK BOOK"[30] REFERENCE	TYPE	"PINK BOOK" REFERENCE	
(a)	(b)	(c)	(d)	(e)	(f)

[30] The 'Pink Book' is a generic title for any national set of technical publications on ammunition and explosives.

ANNEX C TO
EOD OPO 1/11

EQUIPMENT REQUIREMENTS

SER	ITEM	QTY	REMARKS
(a)	(b)	(c)	(d)
1	Crackerbarrel	50	Deflagration Technique
2	Baldrick	20	Deflagration Technique
3	Plastic Adhesive Tape	30	
4	RC Initiation System	2	
5	RC Initiation System Battery Charger	2	
6	EOD Tool Kit	2	
7	Hook and Line Set	2	
8	Knives Steel	4	
9	Shovels General Purpose	10	
10	First Aid Kit	2	
11	Search Equipment Electronic	4	
12	Tape Barrier Marking	10000m	
13	Hand Shovel	10	
14	Marker Posts (1m)	150	
15	Marker Posts (20cm)	500	
16	Crowbar	2	
17	Sand Bags	1000	
18	Sand		As Required
19	Sledge Hammer	2	
20	Pick Axe	3	
21	Whistles	10	
22	Flag Red	20	
23	Flag White	20	
24	Radio Set	10	
25	Radio Battery	TBN	
26	Charger Radio Battery	TBN	
27	Camera Photographic	1	
28	Photographic Film	4 rolls	
29	Pliers General Purpose	2	
30	Loping Shears	6	
31	Hand Shears	6	
32	Torch Hand	4	
33	Lamp Gas/Kerosene	2	
34	Kerosene/Gas Cylinder		As Required – see Ser 33
35	Batteries Hand Torch	TBN	
36	Battery Electronic Search Equipment	TBN	
37	Measuring Tape 100m	1	
38	Gloves Industrial Leather	25 Pairs	
39	Table	4	
40	Chairs	25	
41	Camp Bed	2	
42	Typewriter	1	
43	Stationary		As Required
44	Grappling Hook	4	

SER	ITEM	QTY	REMARKS
(a)	**(b)**	**(c)**	**(d)**
45	Pulley	4	
46	Grappling Hook Rope	500m	
47	Tent	2	
48	Technical Publications	2	Ammunition “Pink Book” AAF EOD SOPs 1 to 7
49	Earthing tool	2	
50	Winch gear, pulleys and ground anchors.	TBN	Removal of roof slabs.
51	Face Masks (half and quarter)	TBN	As required – to BS EN 140 or equivalent – collecting bare explosives involved in the Incident.
52	Nitrile Gloves	TBN	As required – handling bare explosives.

ANNEX D TO
EOD OPO 1/11

SERVICEABLE EXPLOSIVE REQUIREMENTS

SER	NATURE	QTY	REMARKS
(a)	(b)	(c)	(d)
1	Detonators (Plain)	20	
2	Detonators (Electric)	300	Based on 33% failure rate.
3	Detonating Cord (Metres)	1000	
4	Safety Fuze (Metres)	25	
5	Plastic Explosive (KG)	200	
6	Match Igniter Safety Fuse	40	
OR			
7	Nonel Shock Tube System	10,000	
8	Plastic Explosive (KG)	200	

ANNEX E TO
EOD OPO 1/12

AMMUNITION RECOVERED FOR DISPOSAL BY DEMOLITION

WEEK:		**WEEK ENDING:**	

SER	AMMUNITION TYPE	WEEKLY TOTAL			OPERATION TOTAL			REMARKS
		QTY	AUW (KG)	NEQ (KG)	QTY	AUW (KG)	NEQ (KG)	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)
	TOTALS							

ANNEX F TO
EOD OPO 1/12

AMMUNITION DISPOSED OF IN SITU BY DETONATION

WEEK:		**WEEK ENDING:**	

SER	AMMUNITION TYPE	WEEKLY TOTAL			OPERATION TOTAL			REMARKS
		QTY	AUW (KG)	NEQ (KG)	QTY	AUW (KG)	NEQ (KG)	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)
	TOTALS							

ANNEX G TO
EOD OPO 1/12

AMMUNITION RECOVERED FOR STORAGE

WEEK:		**WEEK ENDING:**	

SER	AMMUNITION TYPE	WEEKLY TOTAL			OPERATION TOTAL			REMARKS
		QTY	AUW (KG)	NEQ (KG)	QTY	AUW (KG)	NEQ (KG)	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)
	TOTALS							

ANNEX H TO
EOD OPO 1/12

SCRAP RECOVERED

An ESTIMATE should be made of the amount of scrap recovered during the operation, as it is a type of Performance Indicator that is necessary for estimating manpower requirements for future operations.

Free From Explosive procedures must be strictly followed to ensure that dangerous munitions do not end up in the possession of the civilian population.

WEEK:		WEEK ENDING:	

SER	SCRAP TYPE	QUANTITY (KG)	REMARKS
(a)	(b)	(c)	(d)
	Ferrous		
	Non Ferrous		
	Copper		
	Miscellaneous		
	Packaging		
	TOTALS		

Amendment record

Management of IMAS amendments

The IMAS series of standards are subject to formal review on a three-yearly basis, however this does not preclude amendments being made within these three-year periods for reasons of operational safety and efficiency or for editorial purposes.

As amendments are made to this IMAS they will be given a number, and the date and general details of the amendment shown in the table below. The amendment will also be shown on the cover page of the IMAS by the inclusion under the edition date of the phrase 'incorporating amendment number(s) 1 etc.'

As the formal reviews of each IMAS are completed new editions may be issued. Amendments up to the date of the new edition will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended IMAS will be the versions that are posted on the IMAS website at www.mineactionstandards.org.

Number	Date	Amendment Details