Defence
Safety Authority

DSA 03.OME Part 2 (JSP 482) - Defence Code of Practice (DCOP) and Guidance Notes for In-Service and Operational Safety Management of OME

Defence OME Safety Regulator

DOSR

DSA VISION

Protecting Defence personnel and operational capability through effective and independent HS&EP regulation, assurance, enforcement and investigation.

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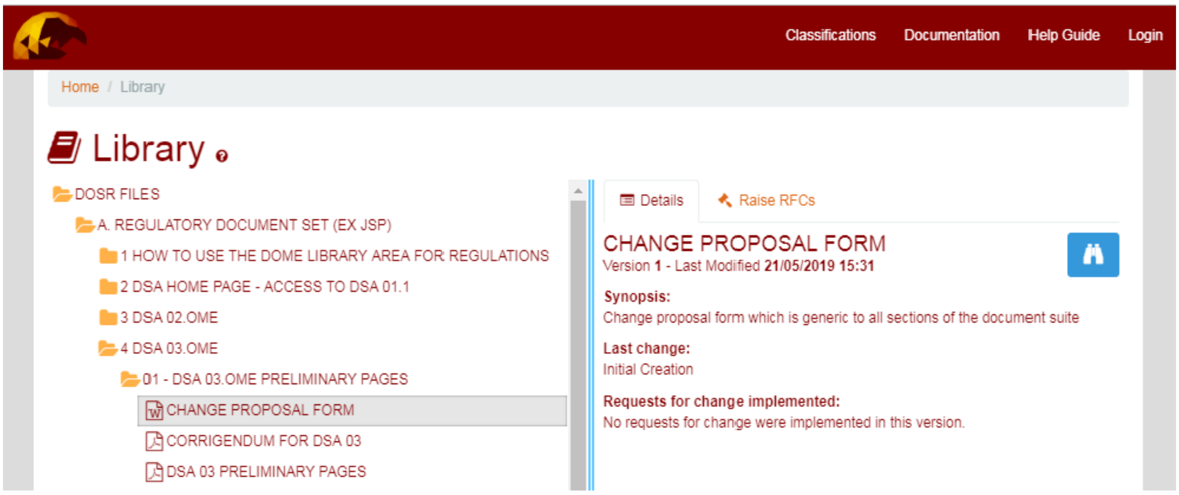

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7. Changes effecting Risk to Life will be published immediately.

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AMENDMENT RECORD

Version 1.0					
No	**Section**	**Para**	**Amendment Summary**	**Agreed**	**Date**

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CHAPTER 11

STORAGE OF ORDNANCE, MUNITIONS AND EXPLOSIVES (OME) IN SUPPORT OF OPERATIONS

CONTENTS

Para

1 INTRODUCTION

1.1 Operations

1.1.1 During operations there may be occasions when OME must be stored in a manner that does not fully comply with all normal provision of this publication. It is imperative that normal peacetime regulations are observed whenever possible in order to retain the most stringent safety standards and preservations of assets. However, the provision of reduced criteria may be utilised where operationally essential. These reduced criteria must always be authorised by the appropriate authorities.

1.1.2 This chapter details the minimum requirements in relation to operations and pre-supposes that there may be insufficient time or resources to construct permanent facilities. Furthermore it is not intended to be a substitute for the proper awareness of MOD Explosives Regulations, which are to be complied with where practicable for the licensing and administration of explosives storage during operations.

1.1.3 Any action undertaken within the definitions of this chapter is subject to the requirements of peacetime regulations, albeit that certain relaxations to criteria may be available in specially approved circumstances. It is imperative that, at all times full consideration is given to the requirements of the Health and Safety at Work Act 1974. This Act can only be suspended in times of conflict by the Secretary of State.

1.1.4 If a facility or circumstance is not covered in this chapter, or assistance in interpretation is required, or exceptional circumstances prevail, advice is to be sought from the relevant IE.

1.2 Acceptance of Risk (AoR)

1.2.1 The principles of explosives storage that may be used under this chapter should never reduce the normal level of protection afforded to the general public. However, HoEs/Commanders should be made aware that there may be increased risk to the general public, and there will be a reduction in the level of protection to military personnel and assets (including other nations) involved in operations.

1.2.2 All reductions in safety standards are made with the authority of the relevant IE, but only after considered judgement on the balance of risk between reducing the safety of people and assets and the need to maintain or increase the practical efficiency of operations. This chapter cannot legislate for the decisions of HoE/commanders on grounds that have to be made in extremis. HoEs/commanders will make such decisions in the full knowledge that the will be held accountable for striking the correct balance with the information available if time does not permit reference back to the relevant IE. Nonetheless, the safety rules and procedures, practised in training and exercises, cannot be automatically dispensed with for operations.

1.2.3 The reduced criteria permitted within the bounds of this chapter may considerably increase the risk to personnel, assets, platforms, organisations and infrastructure. It is essential that theatre Command Staff are fully briefed as to the possible consequence of any reduced QDs to personnel and assets. Their acceptance of the increased risks in reducing certain QDs is to be documented on an ESC. Command Staff utilising Non-UK bases are to consult the Host Nation and other Nation Forces affected.

2 IMPLEMENTATION

2.1 NATO

2.1.1 Guidance on NATO explosives principles and their applicability can be found at Annex A.

2.2 OME Storage

2.2.1 The guidance and regulations for the storage of OME in support of operations can be found at Annex B. This Annex is applicable to all British forces and applies for all storage situations not covered by other Annexes in this chapter.

2.3 Explosives Safety Case (ESC)

2.3.1 The requirements for, and guidance for the compilation of, an ESC can be found at Annex C.

2.4 Unclassified OME

2.4.1 The guidance and regulations for the storage of DOSR unclassified OME in support of operations can be found at Annex D.

2.5 Treatment of Ordnance, Munitions and Explosives that have been Exposed to Chemical Warfare Agent Contamination

2.5.1 The guidance for personnel employed in the handling and destruction of contaminated OME can found at Annex E.

2.6 Royal Engineer Technical Report

2.6.1 The Royal Engineer Technical Report (Annex F) highlights points to be considered for the construction of Explosives Facilities in support of operations. In, addition advice is provided on relevant publications and contact details included for OME Subject Matter Experts (SME).

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CHAPTER 11

ANNEX A

NATO EXPLOSIVES SAFETY PRINCIPLES

CONTENTS

Para

1 NATO EXPLOSIVES SAFETY PRINCIPALS

1.1 Introduction

1.1.1 NATO Explosives Safety principles are intended to be used as a guide between host countries and NATO forces in the development of mutually agreeable regulations for the layout of ammunition storage sites and for the storage of conventional ammunition and explosives. These principles are also intended to form the basis of national regulations as far as is practicable. NATO has produced 2 publications which contain these principles for use where approved standards can be achieved as well as where operational situations demand lesser levels of protection. Whenever the UK plans to operate joint ammunition storage sites with coalition partners, on expeditionary operations, the NATO Explosives Safety principles described below are to be considered.

1.2 Allied Ammunition Storage and Transport Publication Number 1 (AASTP– 1) - Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives

1.2.1 AASTP-1 is intended to serve as a guide for authorities who are engaged in the planning and construction of ammunition storage facilities and for those who are responsible for the safe storage of ammunition. It also gives principles and criteria for other related matters such as storage design. The publication does not authorise the use of the principles and criteria without consent of the host nation and is intended for use where approved explosive safety standards can be applied. The separation distances recommended in this publication represent a compromise deemed tolerable by the NATO group of experts between absolute safety and practical considerations, including costs and operational requirements, and are very similar to the quantity distances laid down in Chapter 10.

1.3 Allied Ammunition Storage and Transport Publication Number 5 (AASTP–5) - NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations

1.3.1 Under certain circumstances operational requirements may prevent compliance with the guidelines given in AASTP-1/this document. In these cases, the principles in AASTP-5 may be followed where constructions that meet the AASTP-5 designs are established. These guidelines apply in a deployed environment and establish an acceptable level of safety for deployed NATO coalition forces. Compliance with these guidelines is recommended, where appropriate, except where compelling operational necessity requires further relaxation. Where that occurs, and the requirements of the NATO Guidelines and these regulations cannot be met, the risk and consequence analysis methodology described in Annex C is to be applied.

CHAPTER 11

ANNEX B

STORAGE OF ORDNANCE, MUNITIONS AND EXPLOSIVES (OME) IN SUPPORT OF OPERATIONS

CONTENTS

Para

Tables

Figures

1 REGULATIONS FOR THE STORAGE OF OME IN SUPPORT OF OPERATIONS

1.1 General

1.1.1 The regulations in this Annex apply to the storage of explosives at stockholding and user units, of all Services, in theatres of operations where the regulations for the storage of explosives in permanent facilities, licensed to quantity distances (QD), cannot be met. These regulations may also be applied on military exercises by units who are in a static field location for a period in excess of 24 hrs and are exercising an operational role. If exercising units are stationary for periods less than this, explosives are deemed to be in transit. On every occasion when these regulations are being considered for exercise purposes, planners are to seek prior approval from the appropriate Inspector of Explosives before they are brought into use.

1.2 Exceptions

1.2.1 These regulations do not apply to:

(1) Ammunition Supply Points (ASP)/Explosives Storage Areas (ESA). Even though the ASP/ESA may be under field conditions and may be holding war reserves, normal storage regulations and Quantity Distances (QD) are to be applied.

(2) Ready for Use Ammunition. These regulations do not apply to the management of ammunition held "ready for use" in Forward Operating Bases (FOB), Patrol Bases (PB), battery positions or other readiness areas unless the criteria in tables 3 and 4 are met.

1.2.2 Where available quantity distances are less than those detailed in these regulations, an Explosives Safety Case, comprising a Risk and Consequence analysis, is to be raised and staffed in accordance with Annex C.

2 OUTLOADING

2.1 Considerations

2.1.1 Moving Stock to the theatre of operations. Explosives invariably have to be outloaded from peacetime depots to operational locations to provide immediate support to combat personnel which also reduces the problems of quick resupply. Stocks of the required explosives can be dispersed into field locations and spread around theatre in relatively small tonnages. These reduced tonnages are easier to conceal and are less vulnerable to large losses from enemy action.

2.1.2 This policy also ensures that explosives can be delivered to combat personnel in the following manner:

(1) Right Quantity.
(2) Right Time.
(3) Right Place.

2.2 Quantity and Range of Explosives

2.2.1 On an operation, the factors that govern the quantity and range of natures of explosives that need to be held in operational storage areas are as follows:

(1) Size and Composition of the Force - Stocks of explosives will depend on the complexity of the operation and the size of the force. The force could comprise infantry, tanks, air, artillery, engineer support and the logistic elements.

(2) Level of Stocks to be Maintained - On operations, stocks of explosives are normally expressed as “Daily Consumption Rates” (DCR). A DCR worth of explosives is the estimated amount of explosives that the various units supported are likely to use in an average day. Holdings in operational storage areas will be determined by the operational headquarters and may be two, three, ten days or more. The number of DCR held will also depend on any resupply problems.

2.3 Estimated Duration of Operations

2.3.1 The duration of operations, if expected to be weeks rather than months, affects the quantity and the range of explosives required to be grounded in operational storage areas.

2.4 Unit Organisation

2.4.1 The unit logistics organisation will normally be responsible for stockholding in a FSA. The logistics organisation will have vehicles including rough terrain fork lift trucks and administrative vehicles. Whilst the personnel and their equipment are capable of a move, they are not capable of moving the stock any distance. Once an inload has taken place, the unit can only effect relatively minor internal stock moves. When transportation of explosives outside the FSA is required, or when major internal movement is required, the logistics organisation will require extra transport. In addition, the logistics organisations will invariably have insufficient personnel to provide an effective guard for the stocks of explosives held.

3 SELECTION OF SUITABLE LOCATIONS

3.1 General

3.1.1 The selection of suitable sites for operational storage areas will normally be carried out by a Senior Ammunition Technical Officer (SATO)/Detachment Armament Officer (DArmO), or similar, from the Operational Headquarters (HQ). Their task is to ensure that suitable locations are allocated. The procedure will involve seeking possible locations from a map of the theatre of operations and then visiting the locations to confirm their suitability.

3.2 Critical Factors

3.2.1 The critical factors that must be considered when selecting a location suitable for an operational storage area are:

(1) Ground - The ground is possibly the most crucial factor. When selecting possible locations for an operational storage area from a map, the map must be up to date. However, it is still most important that a detailed ground reconnaissance is carried out because apparently good areas on a map can

quickly become useless if built upon. Even an aerial reconnaissance will possibly miss underground hazards, such as oil or gas tanks and pipelines. From a map or from the air, it is impossible to assess the state of the ground for heavy vehicles. The locations chosen for operational storage areas must have firm ground that remains hard even in inclement weather. The ground must not cut up and must be capable of sustaining the very heavily laden explosives vehicles that deliver their loads from the air or sea ports of disembarkation. On resupply, similar vehicles must be capable of picking up the loads. Ideally, the ground should be dry, well drained, pervious to water and fairly level. However, natural traverses formed by hills are desirable to reduce the size of the area required. When considering the ground, large quarries, industrial estates and farm complexes often make suitable operational storage areas.

(2) Dispersion - The locations required for operational storage areas are frequently large because adequate space must be allowed for dispersion of the stock. Specific explosives natures should be split between at least two locations to prevent all the stock of a specific nature being lost in a single incident. Authority to dispense with “two point” dispersal should only be issued by the operational headquarters.

(3) Expansion - Extra space must be planned to allow for expansion in case of a requirement to hold increased levels of stock. Such extra space can alternatively be used should a part of the area in use become unsuitable. This could occur as result of enemy action or as a result of inclement weather and the cutting up of tracks by heavily laden vehicles.

(4) Communications - Suitable locations for operational storage areas must be readily accessible, but away from the Main Supply Route (MSR), which may attract enemy air activity. Good minor roads leading into the area, capable of taking heavy vehicles, are required. It is also advantageous if railway sidings are fairly close for deliveries by rail, and landing sites for the largest helicopter are available.

(5) Camouflage - Since it is always difficult to acquire labour and sufficient camouflage nets to cover the explosives, it is normal to endeavour to select a location that has good natural cover. Locations of operational storage areas could include warehouses, barns, woods and hedgerows. If a forest is chosen as the location for the operational storage area, it should have firebreaks to prevent the spread of fire from one site to another. Roads of corresponding width to a firebreak are normally considered to be firebreaks. Should the local weather include the possibility of lightning, then appropriate measures must be taken and stacks of explosives should not be placed under lone trees, telegraph poles and pylons. Brush and scrub must be kept clear of pallets of explosives to prevent the spread of fire.

(6) Security - A large area inevitably leads to security problems, particularly when the unit organisation is comparatively small. Sabotage of unguarded operational storage areas is extremely easy. Representation to the Formation HQ must be made for additional resources to provide a cohesive protection force for the area.

(7) Isolation - Tactical limitations allowing, an operational storage area should not be located adjacent or close to other main storage areas, airfields or hospitals. These organisations tend to be centres of a great deal of activity and therefore attract enemy attention. It is also inadvisable to have radio sites and transmitters close to explosives. Every effort should be made to ensure that explosives are kept well away from spurious radio signals and any activity that might increase or enhance the chances of fires or explosions.

(8) Improvement - When considering locations for operational storage areas, an early bid should be made for Royal Engineer (RE) assistance to improve the area allocated, especially where roads and bridges are involved. RE

assistance is normally heavily committed to urgent tasks and such help may therefore be limited. However, RE assistance may become essential if the weather is inclement and tracks become unusable.

4 IMPLEMENTATION

4.1 Introduction

4.1.1 When explosives are outloaded into the field none of the normal hazards associated with explosives are reduced. Indeed, owing to the fact that the explosives are in operational storage locations that may not be specifically designed to store or protect explosives, the risk factors for accidents and deterioration of the explosives may increase. It is therefore essential that the guidelines laid down for operational ammunition storage are strictly observed.

4.2 General Principles

4.2.1 The quantity of ammunition and explosives held in any operational storage area must be limited to the minimum consistent with safe and efficient operations. No ammunition should be held that does not support the mission. The NEQ per storage site should be kept as low as practically possible, consistent with the mission and the available QDs.

4.3 Internal Safety

4.3.1 The internal safety of FSA must be afforded the highest priority. Storage sites are to be positioned in such a way that the probability of a sympathetic reaction of adjacent sites is minimised. If the prescribed minimum IQD cannot be observed, the NEQ used to calculate both inside quantity distance (IQD)

and outside quantity distances (OQD) is to comprise the sum of the NEQ of all the Potential Explosion Sites (PES) involved. As a result, all QDs will be considerably larger.

4.4 External Safety

4.4.1 External safety must be optimal. Complying with the minimum OQDs to military and civil exposed sites will result in an acceptable level of risk for military personnel and civilians. The OQDs for military and civil exposed sites will result in a layout of the FSA in which PES are sited further from the most vulnerable Exposed Sites (ES) than less vulnerable ES.

4.5 Structures

4.5.1 Ammunition storage sites can consist of open sites, lightly covered structures (tentage etc), shipping, International Standardization Organization (ISO), containers, purpose built ESH and, nationally approved, specially constructed, hardened structures, with or without traverses (barricades). The type of structure used will depend upon many factors including protection of assets, threat, size of stockpile, cost and available area. Senior ammunition technical staff must be involved at the planning stage of all operations with the mounting authority in order that the highest level of explosives safety can be maintained.

4.6 Traverses

4.6.1 Traverses around PES should always be used, since they considerably reduce minimum IQD necessary to prevent instantaneous propagation between stocks of explosives. Traverses function by stopping low angle, high velocity, ammunition fragments and protect the stored ammunition against external threats, like enemy fire. If traverses are not available, the corresponding larger IQDs are to be observed. Traverses should be thick enough to stop high velocity fragments, be stable over time and not be susceptible to environmental factors. To be effective, a traverse must be constructed of specified materials to approved designs. The detailed specifications for traverse construction, and requirements for filling, can be found in Chapter 7.

4.6.2 Additional information regarding NATO approved traverse construction and siting can be found in AASTP-5, Part 2.

4.7 Lightning Protection

4.7.1 In order to mitigate the adverse effects of a lightning strike (accidental initiation, damage etc), all PES should be provided with a lightning protection system (LPS). In addition, PES should be located no less than 15m from trees, telegraph poles, pylons in order to reduce side flash. ISO containers used to store ammunition may be considered a “Faraday cage” thereby not requiring additional lightning protection. However, they must be effectively earthed as described in Chapter 8. Testing of LPS is to be in accordance with Chapter 8, Annex D and ESTC Standard No 6, Part 1.

5 DEFINITIONS

5.1 Introduction

5.1.1 These basic definitions are included to ensure that they are fully understood.

5.2 Stack

5.2.1 A Stack (see Fig 1) consists of a pallet of explosives and, for planning purposes, it is deemed to equate to 1 tonne gross weight.

Fig 1 Stack (Pallet Base or 1 Tonne)

5.2.2 The explosives should always be in their approved ammunition container assembly (ACA) unless it is normally transported without a container. Examples of explosives that may be transported without a container are loose shell and HE aircraft bombs. All loose explosives should be stacked on dunnage (normally timber) or brick and raised from the ground at least 0.1m. Loose shell, unless palletized, should be stacked on the dunnage with alternate layers reversed to provide some stability. Grommets should be checked to ensure that they are firmly secured to the driving bands before stacking. Chocks should be nailed to the dunnage to prevent the stacks from collapsing.

5.2.3 Explosives should be orientated so that the markings can easily be read. Dirty munitions/ACAs should be cleaned before they are stacked in order to do so.

5.3 Stack Module

5.3.1 A Stack Module (see Fig 2) consists of ten pallets of explosives. A vehicle loaded with explosives is considered to be a Module of explosives and, under the Drops system of re-supply, a Flatrack is also to be considered a Module of explosives as is an ISO container holding up to 8 pallets of ammunition.

5.3.2 A Stack Module, not in an ISO container, will occupy approximately 3m x 7m x 1.5m and therefore a Storage Site will demand a minimum length of road or track of 50m. This assumes a distance of 1m to 2m between Modules and 10 Modules stacked on each side of the track. A Storage Site comprising 20 x ISO containers located back to back will occupy a space approximately 27m by 15m.

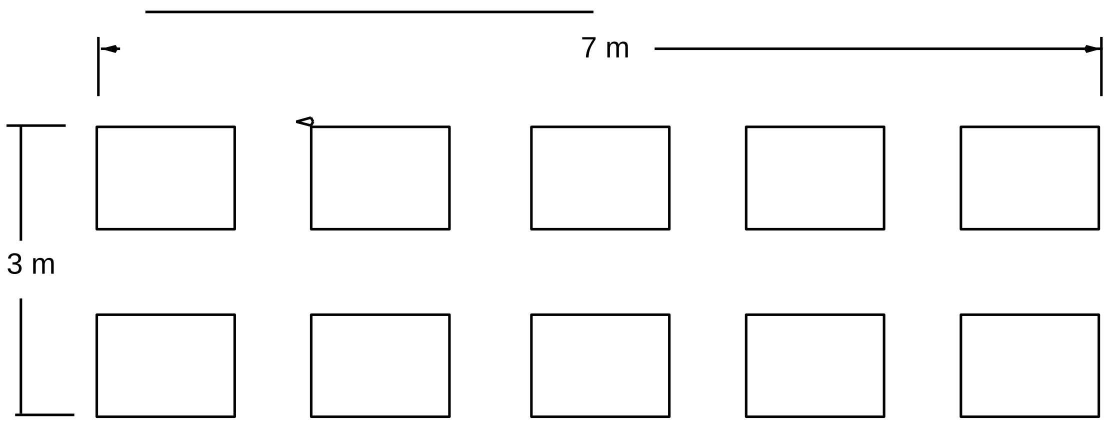


Fig 2 Module (10 Stacks or Pallet Bases)

5.3.3 In ideal circumstances, a Module will occupy a space of approximately 3 m wide x 7 m long x 1.5 m high. This allows ease of access for personnel to check containers and ready access for the rough terrain fork-lift truck. Modules can be laid out rapidly and ammunition can be issued from them very quickly.

5.4 **Storage Site/PES**

5.4.1 A Storage Site/PES (see Fig 3) will normally hold up to 20 Modules of 10 pallets or 20 x ISO containers/Flatracks each holding 8 pallets. Modules may be located apart or in close proximity and comprise a single PES for safety distance purposes.

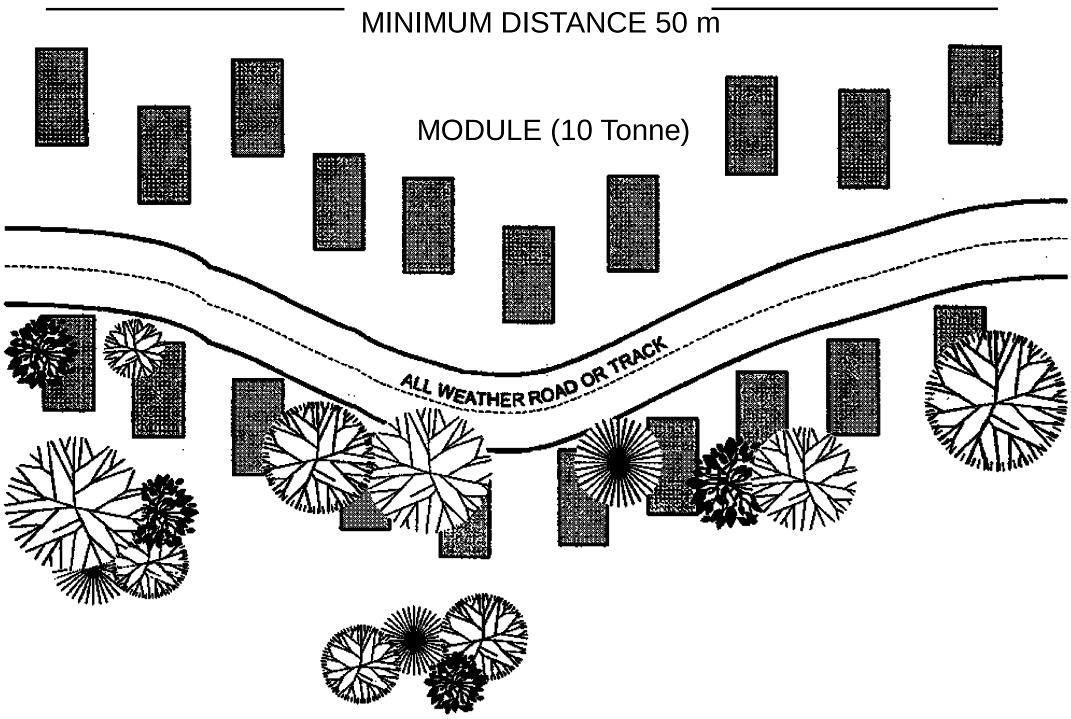


Fig 3 A Storage Site of 20 Modules

In many circumstances, a Storage Site may comprise a purpose built explosives storehouse (ESH), which may be traversed, or a specially built, hardened, structure with overhead protection.

5.5 **Field Storage Area (FSA)**

5.5.1 A Field Storage Area (FSA) will normally store the theatres operational ammunition holdings, although in certain circumstances, more than one FSA may be built. Within the FSA, there will be a number of ESH or Storage Sites. The number of these depends on the mixture and the quantity of the explosives needed to be stored.

5.5.2 The factors governing the number of Storage Sites in an FSA are:

(1) The type and quantity of munitions to be stored against sustainability requirements.

(2) The necessity for at least two point dispersion.

(3) The need to store incompatible munitions separately.

5.5.3 In FSAs some, or all the facilities described below, may be required.

(1) Inspection and/or Repair of Returned Explosives - Whilst repair of ammunition is not normally undertaken on operations, a Mobile Ammunition Inspection Facility (MAIF), or similar, will be required for all ammunition inspections and a site, capable of storing HD 1.1, should be set aside for use as the need arises.

(2) Preparation/De-preparation of Aircraft Munitions - FSA that support Air Operations will normally require process facilities for the preparation/de-preparation of aircraft munitions. Where the aircraft munitions include EEDs electro-static precautions in the form of a conductive regime in accordance with Chapter 8 will be required.

(3) Disposal Site - An area for disposal by demolition or burning should be set aside for dangerous and/or unserviceable explosives.

(4) Administrative Area - When the numbers of personnel are limited, the location of the Administrative Area is exceptionally important. It is normal to co-locate the facilities required with another function, such as Site Access Control. When it is sited, due account should also be taken of the following:

(5) Quantity Distances - Outside quantity distances should be applied to the Administrative Area, however, in extremis, security of the explosives (vital stock) and other factors may preclude this.

(6) Ease of Access - There must be easy access to the stocks and the working areas.

(7) Communications - The site chosen for the Administrative Area needs to be able to reach all parts of the FSA by radio. Ideally, the site should be provided with a telephone facility.

(8) Water and Drainage - A good water supply and adequate drainage are a necessity.

(9) Traffic Circuits - Units may be made responsible for route signing to and from the MSR, although in most formations the task is undertaken by Military Police (MP). It is however, normal for the unit to be responsible for the following:

(10) Routing - A sketch, or map, of the FSA is to be available at the Site Access Control for drivers to consult. The routes should be sign-posted, with reflector signs, so that drivers can find their way to the appropriate storage sites and to Exit Control. It should be remembered that in-load, issues and re-supply may be carried out at night with minimal lights. Individual Storage Sites should also have reflector signs, with alpha-numeric identification, so that they can readily be found. All signs must be visible to drivers yet hidden from the air.

(11) One-Way Circuits - Unless the roads and tracks within the FSA are exceptionally wide, traffic should be one-way. Two-way traffic should only be permitted where there is sufficient width to allow freedom of movement in both directions when vehicles are being unloaded and/or loaded at the operational storage areas.

6 HAZARD DIVISIONS AND COMPATIBILITY GROUPS

6.1 Hazard Divisions

6.1.1 Ideally, each storage site should contain explosives of only one Hazard Division (HD), although any site may be topped up to capacity with HD 1.4. When HDs have to be mixed, the mixing rules for HDs (aggregation) at Chap 10, Sect 1 are to be complied with.

6.2 Compatibility Groups

6.2.1 Where possible explosives of different Compatibility Group (CG) should be stored in a separate Storage Sites/PES. However, when it is necessary to store different CGs together, the mixing of CGs rules at Chapter 13, Annex E are to be followed.

7 ADDITIONAL REQUIREMENTS

7.1 Two Point Dispersion

7.1.1 Explosives of the same nature should be stored in more than one Storage Site/PES to prevent total losses due to fire or explosion.

7.2 One Stack - One Batch

7.2.1 When building stacks, explosives of the same Batch Key Identity (BKI) batch or lot should not be mixed with other BKIs, batches or lots.

7.3 Isolation and Segregation

7.3.1 In addition to isolation and segregation principles at Chap 13, Para 3 the following explosives are not to be stored in the same storage site/PES as serviceable explosives:

(1) Explosives returned from units which have not been inspected.

(2) Explosives in damaged or incomplete containers awaiting inspection and/or repair.

(3) Explosives of unknown origin.

(4) Captured enemy ammunition.

7.4 Other Commodities

7.4.1 Storage Sites/PESs containing explosives are not to be used for the storage of other commodities such as:

(1) Empty containers and accessories.

(2) Stacking materials.

(3) General Stores.

(4) Other dangerous goods. These require to be separated by the appropriate QD.

8 ISOLATED STORAGE

8.1 White Phosphorus Munitions

8.1.1 Munitions of CG H containing White Phosphorus (WP) should be stored in a Storage Site/PES that is near a supply of readily available water. If water is not readily available near the site, then a container should be obtained that is large enough to totally immerse the largest package of the munitions. More comprehensive storage/handling precautions for WP are detailed at Chap 13.

8.2 Missiles in a Propulsive State

8.2.1 Rockets, rocket motors, and missiles in a propulsive state, often considered as vital by the formation HQ, should be stored in a traversed Storage Site/PES. If this is not feasible, they should be moved to the most isolated part of the FSA. However, guarding such vital stocks may then become a problem. Irrespective of the problems, such explosive items should be pointed in the safest direction possible.

9 QUANTITY DISTANCES

9.1 General

9.1.1 Explosives in FSA are vulnerable to attack and inadequate separation between sites may cause large losses through secondary effects such as fires and explosions. It is therefore important that consideration be given to applying adequate Quantity Distances (QD) between sites and ensuring that natural traverses and overhead protection are used wherever possible.

9.1.2 The aim of the paragraphs below is to detail the minimum QDs required. In all cases, QDs are to be measured from the nearest point of the PES to the nearest point of the ES.

9.2 Inside Quantity Distances

9.2.1 Inside Quantity Distances (IQD) are the minimum inter-storage site quantity-distances for ammunition and explosives and are shown in the following table. These distances do not cover asset preservation but will prevent the instantaneous propagation of one site causing instantaneous propagation to another. Because of distance, the IQDs also give some protection from firebrands, projections and lobbed munitions.

9.2.2 The IQDs for HDs 1.1, 1.2, 1.3 and 1.4 for Operational Storage are shown in Table 1 below.

HD	Factor	1.1	1.2	1.3	1.4
1.1	Normal	200 m	100 m	100 m	100 m
1.1	Traversed	100 m	100 m	100 m	100 m
1.1	Vital Stocks	300 m	100 m	100 m	100 m
1.2	Normal	100 m	100 m	100 m	100 m
1.3	Normal	100 m	100 m	100 m	50 m
1.3	Propelling Charges	200 m	100 m	100 m	100 m
1.4	Normal	100 m	100 m	50 m	25 m

Table 1 Minimum Inside Quantity Distance for Field Storage Sites.

9.2.3 Explosives in HD 1.4S may be stored without regard to safety distances provided that they are stored in their FSSP.

9.3 Unserviceable Explosives

9.3.1 The following natures are to be at least 300 m from any Storage Site that contains serviceable explosives:

(1) Explosives that have not been inspected.
(2) Unserviceable explosives.
(3) Explosives that are awaiting destruction.

9.4 Inspection

9.4.1 Explosives which are safe to move should not be inspected at an operational storage site. The package or item of explosives requiring to be inspected should be moved at least 50 m away from the nearest stack of explosives or to an ammunition processing facility.

9.5 Packing and Stacking Material

9.5.1 Any storage sites containing packing, stacking and site material, must be at least 50 m from a site containing explosives and located in a discrete and marked area.

9.6 Other Dangerous Goods

9.6.1 Other than explosives, any storage site that contains dangerous goods in bulk, such as petrol, oil and lubricants, must be at least 400 m from a site containing explosives.

9.7 Outside Quantity Distances

9.7.1 The Outside Quantity Distance (OQD) is the minimum distance required to prevent the consequences of an explosives event at any site directly affecting, by blast, flame or by radiant heat, inhabited buildings, places of congregation and traffic routes, etc. By distance, the OQD will also give some protection from firebrands, projections and lobbed munitions. The OQD for Field Storage are shown in the Tables 2 below.

Location or Area at Risk	HD at Site	Minimum Distance (m)	Remarks
Lateral or axial route or railway that must not be interrupted.	1.1 1.2 1.3 1.4	400 400 200 50	This would include an MSR or any route considered vital by formation HQ.
Inhabited Buildings where the occupants must not be put at risk.	1.1 1.2 1.3 1.4	500 500 300 50	This would normally include friendly forces and local civilians who are not to be the subject of abnormal operational hazards.
Hospitals,Stations,Air fields,Other Military Storage Locations and Radio/Radar sites.	1.1 1.2 1.3 1.4	1000 1000 500 50	This does not include other explosives field storage sites or ammunition depots, for which IQD are used.

Table 2 Outside Quantity Distance for Field Storage Areas

9.8 Other Nations' Field Storage Areas

9.8.1 Where another nation plans to build a FSA in the proximity of the UK one, the IQDs at Table 1 may be used for inter-site separation. However, consideration must be given to providing the correct OQDs to the other nations' main offices and other non-explosives exposed sites.

9.9 Allied Ammunition Storage and Transport Publication 5 (AASTP-5)

9.9.1 AASTP-5 contains the NATO guidelines for the storage, maintenance and transport of ammunition on deployed missions and operations. These guidelines include Field Distances (FD) which prevent prompt propagation between adjoining PES and have been determined by trials to provide the same levels of protection as AASTP-1. Where appropriate, the field distances in AASTP-5 may be applied to structures that have been built to the AASTP-5 standard or for vehicles parked with standard loads (previously BLAHA). In these circumstances the Pictograms in Table 3 and their associated FD in Table 4 below may be used.

Matrix for Ammo Field Storage Distances for Deployed Missions or Operations

			PES									
			VEHICLES					STRUCTURES (notes 11 & 12)				
			HEAVY ARMOURED (notes 1 & 5) 	LIGHT ARMOURED 		NON-ARMOURED 		HARDENED (note 5) 	SEMI-HARDENED 		OPEN/LIGHT 	
				BARRICADED	UN-BARRICADED	BARRICADED	UN-BARRICADED		BARRICADED	UN- BARRICADED	BARRICADED	UN-BARRICADED
ES			**APPLICABLE FIELD DISTANCES**									
ES CONTAINING EXPLOSIVES (note 2)	 HEAVY ARMOURED (note 5)		NO FD (note 6)	NO FD (note 6)	NO FD (note 6)	FD1	FD1	FD1	FD1	FD1	FD1	FD1
	 LIGHT ARMOURED (note 5)		NO FD (note 6)	NO FD (note 6)	NO FD (note 6)	FD1	FD1	FD1	FD1	FD1	FD1	FD1
	 NON ARMOURED	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UNBARRICADED	FD1	FD1	FD3	FD1	FD3	FD1	FD1	FD3	FD1	FD3
	 HARDENED (note 5)		FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
	 SEMI-HARDENED	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UNBARRICADED	FD1	FD1	FD2	FD1	FD2	FD1	FD1	FD2	FD1	FD2
	 OPEN/LIGHT STRUCTURE	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UNBARRICADED	FD1	FD1	FD3	FD1	FD3	FD1	FD1	FD3	FD1	FD3
	AMMO WORKSHOP (note 4)	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UNBARRICADED	FD1	FD1	FD3	FD1	FD3	FD1	FD1	FD3	FD1	FD3
EXPOSED SITES WITHOUT EXPLOSIVES (notes 3 and 9)	 HARDENED (notes 5 and 10)		FD10	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4
	 SEMI-HARDENED (note 10)	BARRICADED	FD10	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4
		UNBARRICADED	FD10	FD5	FD6	FD5	FD6	FD5	FD5	FD6	FD5	FD6
	 LIGHT STRUCTURE	BARRICADED	FD10	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)
		UNBARRICADED	FD10	FD8/FD7 (note 7)	FD9	FD8/FD7 (note 7)	FD9	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD9	FD8/FD7 (note 7)	FD9
	 OPEN - PERS MISSION RELATED		FD10	FD8/FD7 (note 12)	FD9	FD8/FD7 (note 12)	FD9	FD8/FD7 (note 12)	FD8/FD7 (note 12)	FD9	FD8/FD7 (note 12)	FD9
	 UNPROTECTED PEOPLE OUTSIDE COMPOUND		FD10	FD9	FD9	FD9/FD8 (note 08)	FD9	FD8	FD9/FD8 (note 08)	FD9	FD9/FD8 (note 08)	FD9

Table 3 AASTP-5 Pictograms

FOOTNOTES

1	It can be assumed that heavy armour will contain fragments and not generate debris for NEQ up to 150kg and is therefore an effective barricade. For NEQ < 150 kg, the FD10-distances are based on blast impulse only. For NEQ > 150kg, the generation of vehicle debris increases and FD10 address the sudden increase above 150 kg NEQ.
2	For these ES the aim is to avoid prompt propagation - one barricade is considered sufficient.
3	For these ES the aim is to ensure personnel protection and structural integrity (survivability).
4	Only ammo related Pers. For Ammo workshop as PES use the relevant PES column . For personnel and facility protection, apply the FD given below for ES without explosives, for the type of structure housing the ammunition workshop.
5	Hardened structures and Heavy Armoured Vehicles are by definition considered barricaded. Light Armoured Vehicles acting as an ES also are considered barricaded.
6	No FD means 0 m; 2 m is recommended in order to allow space for manoeuvring vehicles.
7	If an OHP or the structural integrity protects against free falling fragments then FD7 may be applied.
8	FD9 is to be used except for robust artillery shells stored in a vertically position where FD8 may be applied.
9	The FD do not address fatalities and injuries associated with flying glass.
10	The FD are based on having structures that control blast ingress (through entrances and windows) to limit internal pressures.
11	Non earth covered buildings that can generate debris like structures of concrete or bricks may not be used as PES.
12	Reduced distances may be implemented if the nationally approved structures have been validated.

	FIELD DISTANCES (FD's)									
	PES → ADJACENT PES			PES → ES (NON PES)						
NEQ	**FD1**	**FD2**	**FD3**	**FD4**	**FD5**	**FD6**	**FD7**	**FD8**	**FD9**	**FD10 (note 1)**
25	4	7	14	12	18	23	23	100	130	*13*
50	4	9	18	15	22	30	33	100	212	*21*
75	4	10	20	17	25	34	40	100	260	*27*
100	4	11	22	19	28	37	46	100	294	*32*
150	4	13	26	21	32	43	56	100	342	*42*
250	4	15	30	25	38	51	73	100	400	*400*
500	4	19	38	32	48	64	103	155	400	*400*
750	4	22	44	37	55	73	118	203	400	*400*
1000	4	24	48	40	60	80	130	235	400	*400*
1500	7	28	55	46	69	92	149	283	400	*400*
2000	8	30	61	51	76	101	164	320	400	*400*
2500	8	33	65	54	82	109	177	352	400	*400*
3000	9	35	69	58	87	116	188	381	400	*400*
4000	10	38	76	64	95	127	207	400	400	*400*

Table 4 AASTP-5 Field Distances

10 EXPLOSIVES LICENSING

10.1 Requirement

10.1.1 Once a site for a Field Storage Area has been selected, and the layout of all storage sites confirmed, the following documentation is to be prepared and approved by the appropriate authority, normally the SATO/DArmO or appropriate Inspector of Explosives.

(1) Site Plan.
(2) Explosives Licences for all Storage Sites.
(3) Explosives Safety Case (ESC) (Where necessary)

10.2 The Explosives licences and any backing sheets are to show the distances to the closest of each type of Exposed Site as a minimum (all ES subject to ESC to be included).

11 CLIMATE AND WEATHER

11.1 Introduction

11.1.1 Similar weather patterns throughout the world have been classified into types known as Climatic Categories. Before introduction into the Services, all explosives are subjected to accelerated tests by the DOSG who advise on its safety and suitability for storage and use in each of the different Climatic Categories. The Climatic Categories are laid down in the Joint Service Munitions Control Register (JSMCR).

11.1.2 The effects of weather, large temperature changes and high humidity, can rapidly degrade the performance of explosives. In some cases, the weather may make the explosives unserviceable and dangerous to use within a relatively short space of time. The storage of explosives under field conditions is therefore not normal practice in peacetime and every effort should be made, when on operations, to ensure explosives are stored under cover when covered accommodation is available. The worst condition for storing explosives is where there is a considerable temperature fluctuation from day to night, together with high humidity.

11.2 High Temperatures

11.2.1 Examples of the extremes of the daily range (diurnal cycle) of temperatures which have been experienced on recent operations are:

(1) January/February -7°C to +31°C (diurnal cycle 39°C).
(2) July/August +22°C to +51°C (diurnal cycle 29°C).

11.3 Solar Radiation

11.3.1 The temperatures shown in the example above were the ambient (surrounding) air temperatures and did not necessarily reflect the temperature of the explosives or their internal components. The temperature therein could have been very much higher due to effects of solar radiation. Desert tests carried out by the United States Army indicated that the explosives could experience the following temperatures:

(1) **Exposed to the Sun**. When fully exposed to the sun, the temperature of the explosives could be as much as 50°C higher than the ambient air temperature.
(2) **Tarpaulin Covered**. When covered with a tarpaulin or similar covering, in direct contact with the explosives or ammunition package, the temperature of the explosives could be as much as 52°C higher than the ambient air temperature.
(3) **Shaded**. When shaded, the temperature of the explosives could be up to 27°C higher than the ambient air temperature.

11.4 Explosives Temperatures

11.4.1 Using the examples and taking into account solar radiation, it can be calculated that the highest temperatures that the explosives could be expected to rise to are as follows:

(1) Storage. In shaded well ventilated storage, the temperature of the explosives could be up to 78°C.
(2) On Launcher. Ready use explosives on launchers could be up to 101°C.
(3) Tanks and Armoured Fighting Vehicles (AFVs). In tanks and AFVs, the temperature is normally between that in storage and on a launcher, the temperature of the explosives could be up to 90°C, when the vehicle air-conditioning is not in use.

12 OVERALL EFFECTS

12.1 General

12.1.1 The effects of high temperatures on explosives can be divided into the physical and chemical effects, however, in some cases, these combine to produce an overall effect. In addition, with high temperatures, the effects of moisture are increased and give rise to some deterioration that does not occur at low temperatures.

12.2 Physical Effects

12.2.1 In the explosives, the physical effect of abnormally high temperatures is that a high level of stress occurs between components. The stresses are caused by the different expansion rates of the individual materials used in manufacture of the components, e.g. different metals, alloys, rubbers and plastics all have different expansion rates. The effect, accentuated by large diurnal cycles, causes the early failure of seals, etc. The seals, sealing compositions, paints and varnishes can then be penetrated by wind blown dust and sand particles, some of which may be hygroscopic. This degradation of the seals is completed by moisture being absorbed by osmosis. If the particles of dust or sand are hygroscopic, ingress of moisture is much faster. Degradation of the seals is also faster if the moisture should freeze.

12.2.2 Some particles of airborne dust and sand, as created in sandstorms, become electro-statically charged and thus tend to adhere to metallic surfaces. Melting and exudation of sealing compositions, such as luting, tend to add to the effect. When at its worst, the electro-statically charged particles can interfere with the operation of electronic components. Additionally, the build up of dust and particles can stop working parts moving and cause blockages in flash channels.

12.3 Chemical Effects

12.3.1 Chemical effects are as follows:

(1) Explosive Compositions - The chemical effects may be direct, where the explosive compositions deteriorate and reduced performance becomes apparent, or indirect, where the deterioration leads to the production of gases that cause a propellant motor to crack. Melting and uncontrolled cooling of TNT mixes may result in TNT “needles” which can detonate when broken. Chemical deterioration has a profound effect on the shelf-life of many explosives, but especially on propellants. As a guide for prolonged periods of storage, the rate of chemical deterioration is approximately doubled for every 10°C rise in temperature above 30°C.

(2) Rubber and Plastics - All types of rubber and plastics suffer rapid deterioration from the direct rays of the sun, especially from the ultraviolet rays. They become hard and brittle and any subsequent rough handling or firing may cause complete failure of the components concerned.

13 SPECIFIC EFFECTS - GUN PROPELLANTS

13.1 General Rule

13.1.1 Although not confirmed, the Americans consider that the effect of high temperatures over protracted periods is to halve the shelf-life of gun propellants for every 10°C rise in temperature above 30°C. Thus a propellant with a shelf-life of 20 years would be reduced as follows:

(1) 40°C - The shelf-life is reduced to 10 years.
(2) 50°C - The shelf-life is reduced to 5 years.
(3) 60°C - The shelf-life is reduced to 2.5 years.
(4) 70°C - The shelf-life is reduced to 1.25 years.
(5) 80°C - The shelf-life is reduced to 0.58 years.

13.2 Normal Shelf-Life

13.2.1 Dependent on the design, most propellants have a shelf-life of 15 to 25 years at 30°C, although in temperate climates they can last much longer. At the expiry of the design shelf-life, the propellants must be tested to establish the amount of stabilizer remaining, so that the shelf-life may be extended accordingly. Under very hot conditions they would have to be tested much sooner.

13.3 Shelf-Life Projection

13.3.1 Applying the American theory on ageing of propellants, if the current design of propellants (i.e. shelf-life 15 years to 40 years in temperate zones) were stored at temperatures ranging from 30°C to 90°C, the projected shelf-life according to American criteria would be as shown in Table 5.

Temp in degrees C	**Projected Shelf-Life in years/Months**				**Remarks**
30	15.0	20.0	30.0	40.0	The design shelf-life
40	7.5	10.0	15.0	20.0	
50	3.75	5.0	7.5	10.0	
60	1.83	2.5	3.75	5.0	
70	0.92	1.25	1.87	2.5	
80	0.42	0.62	0.92	1.25	
90	0.21	0.31	0.46	0.62	

Table 5 Projected Shelf-Life Against Temperature

13.4 Guidance/Assistance

13.4.1 Guidance and assistance may be sought from the appropriate Munitions Project Team, who hold all the technical records of the design shelf-life, the age and the history of propellants of the various natures and will give guidance on the natures which are particularly vulnerable to extremely hot temperatures.

13.5 Charge Temperatures in Weapons

13.5.1 Guns that are being fired with a propelling charge that has a raised temperature produce a higher chamber pressure than that produced if the propelling charge is cold. Accordingly, both the artillery and tank regiments take note of the temperature for their computations. However, because they fire to greater distances and in a less direct role, the artillery need to monitor the temperature of the charges more frequently and with greater accuracy for their computations. When firing to extreme distances at exceptionally high temperatures, it is crucial for all guns that the maximum safe pressure for the chamber is not exceeded. Therefore, the type of propellant approved for use in charges for extremely hot climates may differ from the propellant approved and used for extremely cold climates.

14 SPECIFIC EFFECTS - GUIDED MISSILE AND ROCKET PROPELLANTS

14.1 Details

14.1.1 Guided Missile (GM) and Rocket propellants are designed with special properties specific to the missile's performance characteristics. The compounds in the propellants also determine how high temperatures will affect the GM. Since the propellants of different GM are not identical, the propellants will degrade at different rates and do not conform to the rates of deterioration of gun propellants.

15 WHITE PHOSPHORUS

15.1 Liquid Expansion

15.1.1 White Phosphorus (WP) melts at 44°C and on becoming a liquid, increases in volume. Natures that are filled with WP are normally filled using the water displacement process. This usually leaves residual water and an air gap at the top of the filling to allow for a certain amount of expansion. Once liquid, WP continues to expand as the temperature increases, causing the internal pressure to increase correspondingly.

15.2 Thick Cased Munitions

15.2.1 Instances have occurred with thick cased munitions where the expansion of the WP, due to high day time temperatures and the subsequent contraction at night, has led to the failure of seals and joints. This has resulted in spontaneous combustion and explosions.

15.3 Thin Cased Munitions

15.3.1 Thin cased WP munitions are particularly susceptible to the combined action of expansion and contraction prevalent in high temperatures and the abrasive action of any desert sand. This combination gives rise to leakers.

15.4 Upright Storage

15.4.1 Where high temperatures are experienced, WP will melt during the day then reset during the night. If WP ammunition is not stored in an upright attitude in these circumstances, the air gap will become displaced from its correct location and create an imbalance in the ammunition, leading to instability in flight.

15.5 Leaker Management

15.5.1 A suitable container of clean water, large enough to immerse a complete package or item of WP ammunition, must be taken into the field on deployment for immersion of leaking stores if necessary prior to their disposal. The container should be filled with water and sited in the best location near to the WP Storage Sites. Where a suitable container cannot be provided near to a WP Storage Site and there is no facility to completely immerse a container in water, a mound of wet sand or earth should be located near to the site so that a container leaker can be temporarily buried. Further information is given in Chapters 13 and 17.

16 PYROTECHNICS

16.1 Turnover

16.1.1 Pyrotechnic compositions alter more rapidly at high temperatures as the adhesives used in the manufacturing process may melt and migrate within the explosives. Some years ago, migration of adhesive was found to be the cause for the functional failure of Rockets Hand Fired 38 mm when the parachutes failed to open. With the additional effects of moisture caused by large diurnal cycling of temperature, “pouch stocks” of pyrotechnics need to be turned over every three months.

17 SHELL 155 mm How HE L15

17.1 Main Filling Degradation

17.1.1 Shell 155 mm How HE are particularly susceptible to high temperatures and must not be exposed to direct sunlight. The HE main filling will start to degrade after prolonged exposure to temperatures in excess of 63°C. Head end sealing will break down and HE may exude through the degraded head end seal into the fuze cavity. Evidence suggests that exudation through the threads of correctly torqued fuzes is unlikely. Care must be taken when refuzing L15 shells that have been subjected to prolonged exposure to high temperatures. Shells suspected of prolonged exposure to high temperatures are to be inspected and sentenced in accordance with A&ER Vol 3, Pam 41, Part 3 (Click the link for the Pam).

17.2 Storage

17.2.1 Shells are to be retained in Shell Unit Loads (SUL) or ULC at all times. SULs and ULCs are to be stored at least 10 cm clear of the ground. They are also to be shielded from the effects of solar radiation by screening with tarpaulins or camouflage nets. Additional screening may be provided using empty ammunition containers provided these are separated from the top of the stack by a minimum of 5 cm battening. The following surface temperatures are to be monitored and recorded every 12 hours:

(1) Various parts of the explosives stack including the top layer
(2) Shell from various areas within the stack.

18 EFFECTS OF MOISTURE

18.1 General

18.1.1 The effects of moisture at high temperatures are increased considerably over the effects at low temperatures. For example:

(1) Initiation Systems - Initiator and ignition systems are liable to failure through the ingress of moisture.

(2) Propellant Efficiency - The efficiency of single based propellants is reduced by hydrolysis.

(3) Corrosion. The migration of the products of decomposition of other components with moisture leads to corrosion that may have varying effects on the explosives, ranging from making sensitive components inert to the production of oversensitive salts and crystals.

(4) Chemical Reactions. Chemical reactions between the moisture and the aluminium and magnesium of igniferous compositions, can cause an insulating layer to build up on the surfaces of the compositions, which prevent ignition. They can also cause the production of hydrogen which can cause internal pressures causing swelling of cases.

(5) Diurnal Temperature Cycling. Diurnal temperature cycling can extract moisture from one component and then deposit it on another component that cools faster causing all the moisture problems described already. The moisture arises from:

(a) **Free Moisture.** This is the moisture that is enclosed within the package. This consists of the moisture in the air in the package; that inherently included in the propellant and other explosive compositions; and that which may inherently be included in the packaging (e.g. cardboard and plastics).

(b) **Ingress of Moisture**. Seals and joints, made defective by high temperatures, allow moisture to be sucked in when the air contracts inside an object as a result of a temperature drop.

19 REDUCING THE EFFECTS OF HIGH TEMPERATURES AND MOISTURE

19.1 General

19.1.1 Commensurate with operations, every effort is to be made to reduce the effects of high temperatures and moisture on explosives held by units and in bulk storage locations.

19.2 Storage on the Ground

19.2.1 Explosives are not to be stored on the ground in any situation and this applies more especially in the field. The explosives should be at least 10 cm clear of the ground to ensure ventilation. It is most important that sand, earth, vegetation and scrub should not be allowed to build up around the base of the pallet and prevent the free passage of air. For ventilation purposes, 5 cm is also to be maintained between pallet tiers.

19.3 Tarpaulins and Camouflage Nets

19.3.1 Explosives stored in the open should be shaded with light coloured tarpaulins and camouflage nets in order to reduce the effects of radiant heat. An air gap of 30 cm to 50 cm is to be maintained between the top of the explosives stack and any covering to provide adequate ventilation. Coverings such as tarpaulins and camouflage nets are not to be in direct contact with the stack, as a higher temperature is then created.

19.3.2 Tarpaulins and camouflage nets should be erected so that the explosives can be removed rapidly at night without taking the covering down. This allows replacement explosives to be inserted into the location with a minimum of work. However, the tarpaulins and camouflage nets must be capable of being lowered quickly or be made secure against the possibility of high winds or storms.

19.4 **Improvised Structures**

19.4.1 In some countries, where necessary, local improvised structures and shelters may prove useful for providing cover since the indigenous population may be employed to construct them with minimum supervision. Alternatively, tents, marquees, galvanised iron shelters or ISO containers can be used where available. Explosives stored in iron shelters or ISO containers are to be stacked as far as possible away from roofs.

19.5 **Vital Ammunition**

19.5.1 As GM natures are particularly expensive and are frequently in short supply, they are termed Vital Ammunition. Unless these natures are not susceptible to high temperatures and moisture, they should be given the top priority for protection from the weather.

19.6 **Explosives on Vehicles**

19.6.1 Whenever feasible, all vehicles (including AFVs) carrying explosives in enclosed conditions should be opened to allow for ventilation. This should

be done in such a manner as to prevent rain or the direct rays of the sun falling on the explosives.

19.6.2 Explosives should be carried on load carrying vehicles which have canopies. The explosives should be stacked in such a manner as to allow for ventilation but which prevents rain or the direct rays of the sun falling on them. Providing the safety of personnel working in the area is not violated, vehicles carrying explosives should be parked to take advantage of any shade afforded by buildings, sheds, temporary constructions (including tarpaulin or camouflage netted areas) trees or hills.

19.7 **Explosives on Aircraft**

19.7.1 Armed aircraft, where possible, should be under cover of Sunshades or Rubb Hangars.

19.7.2 Explosives/Weapons downloaded from aircraft are to be moved to licensed explosives storage as soon as practical.

19.8 **Retention in Packages**

19.8.1 Explosives should be retained in their original package for as long as possible, preferably until immediately before use. Propellants, GM natures and rockets are extremely susceptible to humidity and any vapour barriers should remain intact as long as possible. Some munitions have integral humidity indicators which should be checked periodically in accordance with their individual service technical regulations.

19.9 Repacking

19.9.1 Explosives that have been opened should be repacked to their correct configuration at the earliest opportunity. Ideally, such repackaging should be done at the time of day when the humidity is at the lowest; the object being to carry out the procedure when the air is not laden with moisture.

20 PRIORITIES FOR COVERED STORAGE

20.1 Details

20.1.1 When covered storage is not available for all the explosives in operational storage areas, priority should be given to the natures that are likely to deteriorate most rapidly. However, rigid adherence to fixed guidelines may not always be feasible. The priorities may have to be altered to take into account shortages, the vitality accorded to certain natures applied by the staff of the formation, packaging of individual natures and other reasons. For instance, in extremely hot climates, shells containing WP, which are normally fairly robust, may have to be accorded a high priority for covered storage because circumstances do not allow them to be stored in an upright attitude.

20.2 Assuming a normal standard of packaging, with no shortages and no other reasons for allocating high priorities, the following order of priority for covered storage would normally be accorded to the different natures:

(1) Water Activated Explosives.

(2) Guided Weapons, Torpedoes and Rockets.
(3) Anti-Tank, Ranging and Spotting Ammunition. One shot ammunition.
(4) Propelling Charges.
(5) Pyrotechnics.
(6) Mortar Ammunition.
(7) Grenades.
(8) Boxed Shell.
(9) Small Arms Ammunition.
(10) Loose Shell.

21 FIRE PRECAUTIONS

21.1 Introduction

21.1.1 Generally, explosives that have been outloaded into the field are more vulnerable to fire than explosives held in peacetime depots. Therefore, even more importance should be paid to fire precautions and firefighting facilities consistent with the operational situation.

21.2 Implementation

21.1.2 Consistent with the operational situation, the fire precautions, firefighting principles and procedures to be adopted, are those detailed in Chapter 15.

21.3 Map of Storage Sites

21.3.1 A map of the FSA, showing all the Storage Sites, should be maintained for firefighting purposes. It may be held in the Administrative Area, but should not be the map used for directing vehicles to Storage Sites otherwise the map may become dirty and tattered through use.

21.4 Equipment

21.4.1 The unit responsible for the FSA should arrange to deploy with sufficient firefighting equipment of suitable type to deal with fires that may be encountered. However, such equipment should be supplemented by fire-beaters, shovels, machetes, etc to deal with bush and scrub fires not normally encountered in peacetime depots.

21.5 Fire Division Signs

21.5.1 The appropriate Fire Division Signs and Supplementary Fire Signs are to be displayed on posts at the approaches to each Storage Site. However, the firefighting signs must not be put in positions where they are visible from the air. Reflective symbols are ideal as some movement of the explosives may be carried out at night. However, it must be remembered that reflective signs can, under certain conditions, be seen from the air and therefore appropriate measures must be taken to prevent this occurring.

21.6 Grounded Flatracks

21.6.1 Grounded Flatracks loaded with ammunition are to be considered as open stacks for the purposes of firefighting and wherever possible, are to be kept clear of brushwood, bushes, crops, cut and uncut grass.

22 INSPECTION AND REPAIR

22.1 Introduction

22.1.1 Inspection and repair in the field will tend to be tasks that are an operational necessity or concern small tasks only. The majority of tasks undertaken will also tend to be relatively simple ones that do not require complex equipment and the stringently controlled conditions that are available in Ammunition Process Buildings (APB).

22.2 Responsibilities

22.2.1 The Officer Commanding an FSA may not be an ammunition expert. However, in such cases, a person will be nominated as the Technical Explosives Authority, or similar, and will be appointed to be in overall technical control of the explosives.

22.3 The Technical Explosives Authority of an FSA is responsible for:

(1) The inspection, repair and modification of the explosives under his technical control and, in accordance with operational and technical factors, the allocation of priorities for the tasks to be carried out.

(2) The raising of Inspection and Repair Instructions for all processing tasks undertaken to satisfy Safe Systems of Work requirements.

(3) Ensuring that the inspection, repair and modification of explosives are carried out with proper regard for safety and according to current regulations.

(4) The inspection of Storage Sites that have been affected by explosion, fire or enemy action and the separation of the explosives into that which is:

(a) Serviceable and can therefore be issued.

(b) Repairable.

(c) Damaged beyond repair and which must be disposed of or otherwise destroyed.

22.4 **Inspection and Repair Procedures**

22.4.1 The procedures to be used are to be found in A&E R Vol 3 Pam 41 or other single service regulations.

22.5 **Documentation**

22.5.1 The Officer In Charge of Stock Control is to initiate the inspection or repair of explosives by preparing an Order for the Inspection and/or Repair of Ammunition and Explosives AF G942. The AF G942 is to be used by ammunition technical staff to record the details of the inspection or the changes to explosives on repair. Internal Movement Sheets (IMS)

need not be used unless a change in location is required after the work on the explosives has been completed.

22.6 **Returned Ammunition Group (RAG)**

22.6.1 A RAG must be established to cater for munitions that are returned from units. When established, the RAG should be used to receive, sort and inspect explosives before they are put back to stock or reissued. A RAG Storage Site that includes explosives that have not been inspected, or explosives that have been inspected and sentenced unserviceable, is required to be sited at the appropriate QD from storage sites containing serviceable explosives.

22.7 **Demolition Site**

22.7.1 A Demolition Site, see A&ER Vol 3 Pam 21 Part 1 or other single service regulations, need not be established, but should be planned in case there are arisings of explosives that are found to be unserviceable and require to be destroyed.
The location chosen must be a sufficient distance away that the destruction of unserviceable explosives presents no additional danger to other stock in Field Storage Sites/Areas.

22.7.2 Great care must be taken when handling and transporting unserviceable explosives that have been sentenced for destruction. Destruction is to be carried out according to single service regulations. During operations, it is essential that unserviceable explosives are destroyed as soon as possible. Accumulations of unserviceable explosives present an unnecessary and additional danger.

CHAPTER 11

ANNEX C

NON-COMPLIANT STORAGE OF EXPLOSIVES DURING OPERATIONS

CONTENTS

1 BACKGROUND

1.1 The Secretary of State for Defence, through various health and safety legislation is accountable to Parliament for ensuring that all MOD activities are carried out within legal and departmental standards. Through his Health and Safety Policy Statement, the Secretary of State has instructed all staff that safety will, as far as is reasonably practicable, be at least to the standard of the Health and Safety at Work Act 1974. This Act requires all employers to exercise an absolute duty of care to provide the best safety practices within the law and within the bounds of reasonable practicality. This duty of care encompasses all that might be put at risk. Within the MOD it includes personnel, equipment and infrastructures within every employer’s area of responsibility both at home and overseas, whilst training or on operations.

1.2 DSA02/03.OME (the MOD Explosives Regulations) lays down the regulations for the construction and licensing of explosive storage facilities. They also detail how explosives are to be stored and handled in a safe manner. For invariably sound operational reasons, some ammunition is stored in theatres of operations in contravention of these regulations. For example, there will be ammunition stores and vehicles with operational turret stocks that are sited in areas with insufficient real estate to meet the explosive quantity distances required by regulation. This means the levels of protection and safety otherwise provided by the regulations, cannot be achieved.

1.3 On operations, where ammunition storage sites are unable to be licensed in accordance with this document, the requirements of the Secretary of State's Health and Safety Policy Statement are patently not met. In the initial stages of all operations, mission success clearly overrides Health and Safety issues although the latter are always to be complied with where possible. However, as operations become stable, every effort is to be made to normalise these issues and move towards compliance with all Health and Safety requirements, including Explosives Regulations.

2 IMPLEMENTATION

2.1 Authorisation

2.1.1 Storage of explosives under the terms below is to be authorised by the appropriate IE. However, the following information is to be reported to CIE(MOD) as soon as is practicable:

(1) The reasons for using emergency explosives storage.

(2) The estimated duration of the need for such storage.

(3) The types and quantities of explosives involved.

(4) Details of any relaxations of storage already authorised under Chapter 9.

2.2 Siting

2.2.1 Although the choice of site may be restricted due to tactical, technical or other requirements, the provisions of Chapter 5 are to be applied. Should these provisions not be practical, then a Non-Standard Licence is to be sought, in accordance with Chapter 9, from the appropriate IE. The use of undulating terrain as natural traversing should always be considered.

2.3 Relaxations of Quantity Distances

2.3.1 When siting emergency storage, the QDs prescribed in Chapter 10, Section 2 and Section 5 are to be used wherever possible. Prior to consideration being given to the adoption of the reduced criteria within this chapter, deliberation should be given to the utilisation of the Non-Standard Licence procedures detailed in Chapter 9. For overseas deployments, the Host Nation would be required to accept any associated risk to its assets. However, it must be stressed that the strictest set of regulations must be utilised at all times.

2.3.2 The QDs prescribed within Chapter 10, Section 2 provide guidelines that reduce the risks of an explosive event to those accepted as tolerable. Any relaxation of these existing QDs will inevitably increase the risks. Should it be necessary to reduce the Inter-Magazine Distances (IMD) below that prescribed, then practically instantaneous propagation (PIP) must be assumed with the probability of total loss of all explosives assets.bn. Where space is at a premium, inert equipment storage may be permitted to within 2/3 IBD of PES. This only applies to stores that require infrequent access by a minimum number of MOD Personnel e.g. 2 x personnel a day. Personnel are only to visit the store to either collect or deliver equipment/stores. They are not to carry out work within the store or area.

2.4 Quantity Distance Minima

2.4.1 The QD minima to be applied to Emergency Explosives Storage Areas (EESAs) are as follows:

(1) Inter-Magazine Distances. The IMD detailed in Chapter 10, Section 2 are normally to be applied as a minimum. Where these criteria cannot be achieved, consideration should be given to grouping PES, bearing in mind that instantaneous propagation within the group must be assumed.

(2) HD 1.4 Explosives. HD 1.4 may be stored at the separation distances prescribed in Chapter 10, Section 2, provided that the minimum distances in relation to vital installations are adhered to. Furthermore, where other HD are required to be stored in the same site, the HD 1.4 explosives may be stacked so as to provide buffered storage protection between stacks of other HD. Prior to the utilisation of buffered storage, appropriate advice is to be sought from IE staff, as these stocks of HD 1.4 may well be destroyed in the event of the explosion of an adjacent stack.

(3) Considerations for Other QDs. The QDs below may be relaxed to not less than half of that laid down in Chapter 10, Section 2 (e.g.: for HD 1.1, where 22.2Q1/3 would normally be required, 11.1Q1/3 may be used):

(a) Process Building Distances.

(b) Direct and Indirect Support Distances.

(c) Public Traffic Route Distance.

(d) Inhabited Building Distance.

(4) Under exceptional circumstances, and only with the approval of the appropriate Risk Owner[1], further relaxations may be made. However, consideration is to be given to the increased risk to the general public, service personnel and vital facilities. Detailed information regarding this procedure is given at Paras 3 and 4 below.

2.5 Non-Explosive Items

2.5.1 Non-explosive components may be stored between stacks of explosives, in the same manner as HD 1.4, in order to provide additional protection in the event of an explosion. However, should there be an incident; the complete loss of these assets would need to be accepted.

2.6 Stacking Limits

2.6.1 Normal stacking rules are to be applied. However, reduced IMD for the storage of aircraft bombs is permitted in accordance with Chapter 10, Section 2.

[1] The Risk Owner will be CBF for the Army or DDH/ODH (dependant on risk involved) for the RAF

2.7 Mitigation

2.7.1 Mitigating barriers may be provided between stacks of explosives in the same manner as HD 1.4 or non-explosive items in order to provide additional protection in the event of an explosion. Prior to using mitigating techniques of this sort, advice on suitable designs and materials should be sought from the appropriate IE or CIE(MOD) staff. The use of buffers/barriers between stacks is considered in Annex B.

2.8 Covered Storage

2.8.1 With the exception of aircraft HE bombs or stores provided with their own environmental protection, all stores should be kept under cover. Where covered storage is not available, stores should be covered with opaque waterproof, fire resistant, anti-static sheets arranged so as to permit adequate ventilation around the stacks.

2.9 Dispersal of Assets

2.9.1 Stocks of any one item (including non-explosive components) are to be located in a minimum of two locations, which are to be so dispersed as to minimize the risk of total loss of assets due to an explosion or fire.

2.10 Fire Precautions

2.10.1 The provisions of Chapter 15 are, as far as practicable, to be observed. Fire breaks, 2 m wide, are to be maintained around all open stacks. Furthermore, all vegetation within 10 m of stacks is to be strictly controlled. Fire and supplementary hazard symbols are to be displayed. Advice should be sought from DOSR Technical Advisor (Fire) when setting out Field Storage.

2.11 Security

2.11.1 EESAs are to be secured in accordance with Detachment Security Orders. However, as a minimum, they are either to be permanently guarded, protected by means of a secure fence (e.g. Dannart Wire), or protected utilising an electronic/optical/infra-red sensor approved by CIE(MOD) staff.

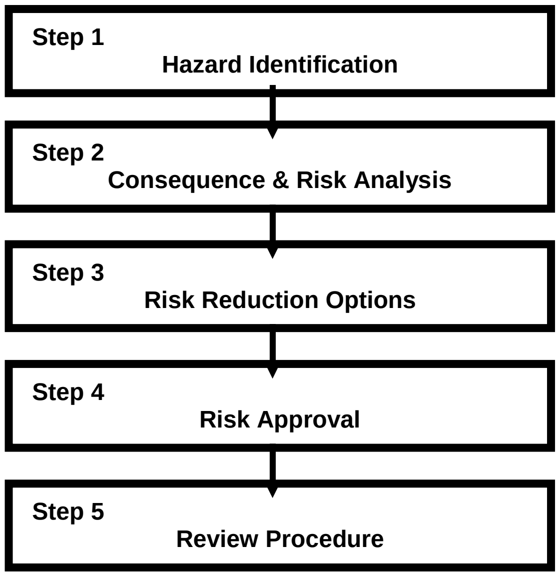
3 THE RISK MANAGEMENT PROCESS

3.1 General

3.1.1 Ammunition is an important combat supply which is vital to the support of operations, but it has always had an inherent risk of damage or loss of personnel and materiel through an undesired explosive event. However, the high tempo of deployed operations can put an increased pressure on the need to maintain accepted safety standards in order to ensure mission success. There can also be an increased pressure to store large quantities of ammunition in small areas that are heavily populated, to expose it to rapidly cycling extremes of climate, to conduct more realistic training using live items, and so on. These pressures may also be exacerbated by the requirement to operate in a Multi-National context. All of these aspects underline the need for an appropriate risk assessment process that will allow commanders to properly accept and authorise situations where operational imperatives cause the compromise of minimum accepted safety standards.

3.1.2 This process is applied in order to enable decision-making in situations where the minimum acceptable safety standards cannot be met. This decision must be well informed and taken by a designated appointment that is authorised to accept the risk should an undesired explosive event occur. This will normally be the Commander British Forces (CBF) or the Delivery Duty Holder/Operational Duty Holder; as agreed in theatre. There will often be instances where more than one risk holder is identified. This will mainly be where the loss of assets significantly reduces operational capability when one risk holder will accept the risk to assets and the second for the impact to operational capability.

3.1.3 The following diagram shows the five steps that are followed in the risk management process:



4 PREPARATION OF SAFETY CASE

4.1 General

4.1.1 When exceptional circumstances, detailed at sub-para 2.4.1(4) above, dictate the requirement for the risk owner to approve relaxations for licensing criteria, a safety case is to be prepared and presented with the submission to the risk owner. This safety case is to be made by the senior Explosives Safety Officer in theatre for the Service concerned, and must show clearly, by maps (where possible) and comment, the risks present and the consequences to personnel (both Service and civilian), materiel assets and infrastructure. The risk owner, on receipt of this safety case, is required to sign a document stating that they have been appraised, in detail, of the circumstances prevailing at a named site, and that:

(1) They have been made aware of the consequences of an explosive event, and,

(2) Operational exigencies take precedence, and,

(3) They accept the risks present.

4.2 Explosives Safety Case

4.2.1 The methodology for preparing an Explosives Safety Case is described in detail at Appendix 1.

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CHAPTER 11 ANNEX C

APPENDIX 1

METHODOLOGY FOR COMPILING AN EXPLOSIVES SAFETY CASE

CONTENTS

Para

5 REVIEW PROCEDURE

5.1 Details

1 METHODOLOGY FOR COMPILING AN EXPLOSIVES SAFETY CASE

1.1 Background

1.1.1 For all operations where full compliance with regulations is not possible, it is essential that an Explosive Safety Case (ESC) is compiled. This is done to ensure that the explosive risk carried is as low as possible, does not jeopardise operational capability and that Health and Safety requirements, and duty of care responsibilities, are properly considered. The Risk Assessment, which is part of the ESC, must be acknowledged by the risk owner. This requirement is satisfied by him signing an Acceptance of Risk (AoR) confirming that the operational imperatives prevent compliance with Explosive Regulations and that the resultant risk to operational capability, and general health and safety, are acceptable under the circumstances.

1.1.2 The IEs have the responsibility, authority and accountability for maintaining explosives safety for Service assets both in the UK, whilst on exercise and on operations. On operations this responsibility is normally discharged on his behalf by the Senior Ammunition Technical Officer (SATO) for the Army or the Detached Armaments Officer (DArmO) for the RAF, through a personal letter of delegation. The methodology used in compiling an ESC is detailed in the following pages and providing that all mitigation measures recommended are implemented, will keep the risk to operational capability at a level that is As Low As is Reasonably Practicable (ALARP).

1.2 Introduction

1.2.1 The methodology for compiling an ESC is a logical one and is based upon a building block model, consisting of the components within the building block at Chap 11, Annex D, Para 3.1.3 i.e. the next component will not necessarily be apparent, or able to be conducted without the previous one being completed. Whereas, for practical reasons, the methodology does not strictly follow the convention for Safety Cases employed elsewhere, the major elements are nevertheless covered in all but name and the same principles applied. The building block process will culminate in the production of a document that accurately assesses all existing risks posed by the storage of explosive natures at a site and the effects on the site should the worst case event occur.

It is imperative that this determined risk and its worst case effects, are explained graphically in terms of loss to operational capability both of personnel and equipment.

1.2.2 For the purpose of explaining the methodology behind compiling an ESC, it can be best explained in terms of the ESC Components. The ESC Components are the individual documents that go together which result in an accurate Hazard Assessment and consequence analysis in the event of an explosion, culminating in the Risk Assessment. The ESC Components are written at each stage **after** considering how **all** of the ESC Factors impinge and impact upon one another.

1.2.3 The preparation and compiling of the ESC requires the assessor to have a complete working knowledge and understanding of the hazards presented before an attempt at compilation is made. If required, further advice and guidance on the requirements and compilation of an ESC should be sought through the appropriate Service IE Staffs.

2 HAZARD IDENTIFICATION

2.1 Introduction

2.1.1 Factors that identify the hazards presented by the explosives at any given site:

(1) The maximum Net Explosive Quantity (NEQ) to be held at the site for operational purposes, by nature/quantity, Hazard Division (HD) and Compatibility Group(CG).
(2) The estimated destructive power of the total NEQ at the site, more commonly referred to as effective NEQ (those natures or components which will contribute to an event).
(3) The geographical layout of the site including natural features which might help reduce hazards.
(4) The accurate positioning of all personnel, equipment and infrastructure permanently exposed to the hazard and located at the site. These are generally known as Exposed Sights (ES). Similarly, those personnel and equipment temporarily exposed to the hazard, or any structure temporarily erected, must be considered.
(5) The operational roles of all personnel, equipment and infrastructure at the site and expected duration of occupancy.
(6) The structural strength of all equipment and infrastructure at the site.
(7) All local Secondary Hazards present which could contribute to or initiate an event.
(8) All extant contingency plans held by Theatre HQ and units at the site for emergency service response times and damage replacement/repair plans.
(9) Occupied dwellings, public utilities/buildings and public traffic routes external to the site which could influence the positioning of stocks. These are also known as ES.

2.1.2 It is imperative for the assessor to have a full knowledge and understanding of each of the factors listed above as each plays a significant part in the overall effects on operational capability. In some cases the assessor may also need to call on expert advice in non-ammunition related subjects.
No one factor can be considered in isolation when assessing the overall effects that a catastrophic explosive event will have at a site on operational capability. As it is the responsibility of the assessor to provide the risk owner with an

accurate Risk Assessment, it is absolutely vital that all of the factors are understood before any attempt is made to compile the ESC.

2.2 Stock Levels (Quantities/NEQ) Held

2.2.1 Knowledge of the specific natures, physical quantities and NEQ required to be held at the site is imperative to the overall Risk Assessment. The Licence Limits are agreed and set in concert by a combination of J2, J3 and J4 Headquarters staff. The J3 elements dictate the quantities at each site based upon the J2 perceived likelihood of the need to fight and win battles. It is not for J4 elements to dictate these quantities but rather to store the requirements in as safe a manner as possible whilst constantly keeping the risk owner appraised of the inherent risk.

2.2.2 At a point when the likely usage of ammunition has fallen to a level that may be perceived as not justifying the associated storage risk, the risk owner must be prompted by the assessor to call for a reduction of ammunition stored at the site. This is a risk reduction measure always to be borne in mind. Constant monitoring must therefore be kept on all sites as the agreed Licence Limits may not be required and this in turn should prompt a reduction in the quantities of ammunition stored.

2.2.3 Due to the explosives properties and characteristics of different ammunition natures, it is important always to know which HDs are being stored at a site. The HDs being stored will influence the explosive safety footprint in the event of an explosive event.

2.3 Destructive Power of the NEQ Held

2.3.1 The assessor should assess accurately the expected destructive power of explosive natures stored at the level for which the site is licensed, in a worst case explosive event. This estimate will be linked intrinsically to an accurate assessment of the effects this has on ES surrounding the storage area.

2.4 Geographical Layout of the Site

2.4.1 The geography of any storage site may assist or hinder the protection of personnel, equipment or infrastructure in and around a storage site. This must be taken into account when analysing the expected effects of explosion of fragmentation, blast, secondary debris and flame. These four effects of explosion must in turn be analysed separately one from another when considering the geography of an area.

2.5 Regular Dispositions of Personnel, Equipment and Infrastructure

2.5.1 For the purposes of compiling the ESC, personnel, equipment and infrastructure are to be regarded as ES as defined in this document. Since many of these ES are mobile, particularly the personnel, it is not possible to draw up an ESC that predicts where everyone or everything will be at all times.

It is therefore necessary to aggregate out where personnel, equipment and infrastructure are most of the time. As a very approximate guide, a figure of 10% occupancy or greater can be used. Knowledge of these locations will assist in determining exactly how much of the explosive effects that any one ES will experience in the case of an explosive event.

2.6 Operational Roles of all Personnel, Equipment and Infrastructure

2.6.1 Injuries to any of the personnel or damage to equipment and infrastructure assets must be expressed in terms of operational capability loss. To this end, it is vital that the assessor understands the operational role of all assets. They must be in a position to advise the risk owner of the consequences of a worst case explosives event and the extent and potential loss of assets. To this end, the assessor should consult with other subject experts as necessary, when advising whether an asset will remain operationally fit for role or otherwise.

2.7 Structural Strength of Exposed Site

2.7.1 A good understanding of the structural strength of all equipment and infrastructure is important for an accurate prediction of the operational capability loss following an explosive event. For example, whilst armoured vehicles may not receive any significant damage to their hulls at a given distance, the same might not be true for their peripherals such as communication aerials. It would then be the responsibility of the assessor to assess this risk and inform the risk owner that whilst his armour could move and fire, the ability to communicate could be lost without the suitable aftermath repairs.

2.8 Secondary Hazards

2.8.1 A Secondary Hazard is something that will enhance the destructive effects of an explosion either immediately or over a protracted period of time. It is important to consider the effects of all potential Secondary Hazards and take these into account when assessing the area that will be affected should an explosive event occur. An obvious example is the storage of fuel.

2.9 Extant Contingency Plans

2.9.1 When making comment on the effects of any expected loss of operational capability due to an explosive event, it is imperative that the assessor has sight of all extant contingency plans that may affect the impact of such an event. These plans will involve a variety of actions. The more common will be:

(1) A replacement for the damaged asset based on a time frame.

(2) The re-orientation of forces to cover any irreplaceable capability loss.

(3) The total repair by a suitable agency of a damaged asset, again based on a time frame.

2.9.2 The state and extent of preparedness of all contingency plans is therefore significant. This will either reduce the overall effect on loss of assets or resources as a result of an explosives event or the reverse situation could arise.

2.10 Exposed Sites

2.10.1 The assessor will need to take account of ES both internal and external to the site. In particular, the proximity and occupancy levels of all on site accommodation, nearby public dwellings, public utilities and public traffic route usage.

It is appreciated that due to the ground limitations of a site and operational considerations, there may be little scope to change the explosives storage arrangements to achieve the higher levels of protection necessary for such ES. Nevertheless, where an alternative and safer solution is feasible, this course of action is to be recommended and pursued. There may be occasions where the proximity and nature of the ES dictates that an alternative solution must be found regardless, especially where heavy loss of life could result. These factors are to be recorded so that a balanced judgement can be made against operational considerations.

3 THE ESC COMPONENTS

3.1 Introduction

3.1.1 Once all of the site background knowledge is known, through a good understanding of the prescribed ESC hazards, it is now important to prepare the ESC document that allows the risk owner to understand quickly all inherent risks posed to operational capability by the storage of the explosives at any given site.

3.1.2 There are three documents that may be common to all ESC from theatre to theatre. These documents are:

(1) ESC Covering Letter.
(2) ESC Brief[2].
(3) Risk owner's Acceptance of Risk letter.

3.1.3 An Annex covering each storage site will also be attached. Each Annex has, in turn, five Appendices which detail all of the required information for the individual storage site to which the Annex relates:
(1) Site Annex front sheet - Explosives Storage Underwrite. Behind this are the five Appendices:

(a) Site Overview and Natures Stored. This will consist of Mission Critical Ammunition Natures (MCAN) and Mission Critical Equipment (MCE) Stored.

(b) Site Secondary Hazards.

(c) Explosive Events Consequence Analysis, consisting of;

(i) Summary of Explosive Event Consequence Analysis.

(ii) Detailed Explosive Event Consequence Analysis.

(d) Risk Assessment Analysis (including Risk Assessment Methodology Instructions).

(e) Available Risk Reduction Options.

3.1.4 In addition, copies of any Explosives Licences issued and any Site Map, aerial photograph or diagram available should be included after the Available Risk Reduction Options Appendix.

3.1.5 Whilst it would be desirable to include an Explosives Safeguarding Map, it is unlikely that such maps/diagrams would be available for most sites. They should be included if possible.

3.1.6 The preparation of all of the documents should be done after studying the existing ESC for that theatre and then using it as an example from which to understand the style in which the document is to be written. If

[2] For ESC with more than one Annex.

improvements to the layout, style or composition can be made, they should be staffed to the IE for authorisation and/or comment.
The following summaries by Component heading are provided below to explain the key data that each Component should address and contain.

3.1.7 An example ESC is at Enclosure 1 to this Annex.

3.2 **ESC Covering Letter**

3.2.1 The ESC Covering Letter provides the following information:

(1) The sponsor of the document.

(2) The title of the document indicating the theatre to which it pertains.

(3) The appointment of the compiler of the document.

(4) The date (at completion) of the document.

3.3 **ESC Brief**[3]

3.3.1 The aim of the ESC Brief is to inform the risk owner of the hazards posed by all non-compliant ammunition storage to his/her operational capability and recommend how the risks of these hazards can be reduced if they cannot be eradicated altogether. The Brief should contain the following sections:

(1) Introduction (providing a reason for the writing of the ESC).

(2) Summary of all non DSA 03.OME compliant ammunition storage in Theatre, by site.

(3) Summary of all explosive hazard mitigation measures, by site.

(4) Recommendations.

(5) List of all required Annexes

(6) Enclosure - Map of the locations of non-compliant sites in Theatre (where possible).

3.4 **Acceptance of Risk Letter**

3.4.1 The Explosive Safety Case, and the risk described within it, must be acknowledged by the risk owner since his responsibilities under Health and Safety Legislation require him to do so. This is satisfied by him signing a letter acknowledging that his military tasks prevent full compliance with Explosive Regulations and that the resultant risk is acceptable under those circumstances. The wording of this letter is exceptionally important and is therefore provided, in generic form by the compiler of the ESC. The compiler is required to amend the detail of the letter so that it is representative of the names of the operation and the risk owner to whom it pertains.

3.5 **Site Annex**

3.5.1 Each Site Annex is broken down into Appendices as laid out in para 3.1.3 of this Instruction.

(1) Site Annex front sheet - Explosives Storage Underwrite. The Site Annex front sheet is a descriptive summary of the ground conditions to be found at the site. It has the following Sections:

(a) Site Title.

(b) Site Location Description. In this paragraph the following summarised information should be provided:

[3] For ESC with more than one Annex

(i) Physical location within Theatre.

(ii) The units located at the site.

(iii) Indication of physical, sectionised parts of the site.

(iv) The total numbers of personnel, MCE and specifically identified infrastructure items at the site.

(c) Site Case File Serial Number.

(d) Explosive Safety Detailed Analysis. This is a series of listed Appendices that are the actual documents produced after the conduct of all pertinent analysis.

3.6 **Appendix 1 - Site Overview and List of MCAN/MCE Stored**

3.6.1 The Site Overview and List of MCAN/MCE Stored contains the following information:

(1) Roles of all major units at the site.

(2) List of all MCAN at the site (MCAN are stipulated by the Permanent Joint Headquarters (PJHQ) Theatre support directive).

(3) List of MCE held at the site, by unit and quantity held.

3.7 **Appendix 2 - Secondary Hazards**

3.7.1 This Appendix lists the individual Secondary Hazards that exist at each site and exactly how each is expected to affect the site in the event of an explosion. In compiling the list of these hazards the compiler must be exhaustive and look deeply at each existing facet of the site. The effects of secondary detonating ordnance and the effects of ejected firebrands must be given close consideration and it is for this reason that knowledge of the HD characteristics and CG of the ammunition natures involved is essential.

3.8 **Appendix 3 - Explosives Events Consequence Analysis**

3.8.1 The Explosive Events Consequence Analysis Appendix is in two parts. It is the actual documentation of the expected effects of an explosive event at the site. A descriptive methodology is provided below for use by ammunition technically qualified personnel.

(1) The first of the two parts is a written Summarised Explosives Event Consequence Analysis. This is a summary of effects that an explosive event at the site will have to the ammunition stored, personnel, equipment and infrastructure at the site. This is in narrative format for the non-ammunition technical personnel that require the information contained therein.

(2) The second part is the Detailed Explosive Event Consequence Analysis of the effects upon personnel, ammunition and equipment and infrastructure at each of six prescribed Explosive Hazard Radii (EHR): $2.4Q^{1/3}$ (D7), $3.6Q^{1/3}$ (D8), $8Q^{1/3}$ (D10), $14.8Q^{1/3}$ (D11), $22.2Q^{1/3}$ (D13) and $44.4Q^{1/3}$ (D14).

3.8.2 The comments made on this analysis should be able to stand-alone and are the basis of all further summarised work. Completion of the second part to this Appendix should be conducted prior to the first. The Summary is only first in the order of the Appendix for quick reference reading by interested, non-technical staff.

3.9 **Technical Methodology for the Conduct of the Detailed Explosives Events Consequence Analysis**

3.9.1 The Technical Methodology for the Conduct of the Detailed Explosive Events Consequence Analysis may be completed using the following suggested method by which a compiler of an ESC may conduct the analysis of explosive effects at a site. This assumes a HD1.1 event or aggregation of HDs contributing to a HD1.1 event:

(1) Step 1. Determine, the Quantity Distance in metres pertinent to each of the HD1.1 D7, D8, D10, D11, D13 and D14 table distances in relation to the site total NEQ being stored.

(2) Step 2. Have these six distances drawn on the Royal Engineer Technical Drawing of the site using the Potential Explosion Site (PES) as the centre of distances for reference. For the most part and practicalities, this will suffice although by convention the corners of the PES nearest to the ES should be used, or the nose wheel for an aircraft. It is recognised that these drawings will not always be available, in which case a hand drawn diagram with the distances between PES' and ES' will have to suffice.

(3) Step 3. Analysing one distance at a time (D7 first, progressing outwards) and starting at a chosen point on the distance line, go around the internal area of the distance and critically note all of the personnel usually found within that distance. Next, write a comment as to what the expected results will be to those personnel under three sub-headings:

(a) Numbers of fatalities and those injured.

(b) Type of Injuries, noting that loss of hearing will be a factor.

(c) Operational Effect.

Note: These estimates are primarily to be made using the Blast Damage/Injury Tables 1, 2 and 3. Tables 4 and 5 provide further guidance on the percentage of fatalities and injuries that may be expected from the effects of blast and fragments. These are only guidelines but give sufficient indication to enable a reasonably accurate estimation. It should be noted that the listed distances in these Tables are the distances from the explosive event at which the listed effects can be expected. As the distance decreases the effects will worsen on a sliding scale until the previous listed distance is reached, at which point the effects listed for that distance may be expected. Conversely, as the distance increases, the effects will lessen on a sliding scale until the next distance is reached and those listed effects may be expected.

(4) Step 4. Repeat the analysis at this distance for equipment. A detailed comment should be made as to the expected effects to the equipment (specific to each type of equipment encountered) found within the distance. This analysis should culminate in a comment under the heading Operational Effect which states the degree of expected loss of operational capability, in the event of an explosion.

(5) Step 5. Repeat Step 4 for the infrastructure found within each distance. No piece of infrastructure within the distance, regardless of the seeming lack of importance, should be discounted for comment.

(6) Step 6. Repeat Steps 1 - 5 for each progressive distance. There is no need to comment further on the effects of the previous distance but a cumulative view should be taken when providing individual comment on the Loss of Operational Capability Statement at each distance e.g.

After quoting the number of fatalities/injured at D8, a comment of 'This is in addition to the 10 fatalities at the previous EHR' will suffice.

3.9.2 During this detailed analysis, maximum use will be made of the assessor's technical knowledge and experience, and of technical documentation, drawn from a wide variety of sources. The seeking of expert advice such as that from Petroleum Experts, Medical Staff, Engineers and a host of other specialities is strongly encouraged and will be vital in the production of a credible ESC document. It is also imperative that the effects of Secondary Hazards are given consideration to the overall effect at each individual distance.

Scaled Distance (a)	Common Name (b)	Blast Overpressure Psi (c)	Kpa (d)	Bar (e)	Structural Damage & Stock Loss (f)	Injuries/Fatalities (g)
$2.4Q^{1/3}$	D7	27	180	1.8	Unstrengthened buildings will suffer complete demolition. Total loss of stocks, as above.	100% fatalities expected.
$3.6Q^{1/3}$	D8	10.5	70	0.7	Unstrengthened buildings will suffer severe structural damage approaching total demolition. Aircraft damaged beyond repair. Propagation to adjacent, untraversed ammunition stocks very likely with their total loss.	Very high incidence of severe injuries or fatalities expected from direct blast effects, building collapse or translation. 100% injuries expected to people in the open from fragment hazard.
$8.0Q^{1/3}$	PBD (D10)	3	21	0.21	Unstrengthened buildings will suffer serious damage (over 30% of total replacement cost). Considerable structural damage to aircraft.	People in the open are not seriously injured from blast effects but there is a significant increase in serious injury from fragment attack, with an increased chance of fatalities. Serious injuries which could result in death, are much more likely for persons in buildings due to debris and fragment hazards, loose translated objects and building collapse.
$14.8Q^{1/3}$	PTRD (D11)	1.35	9	0.09	Unstrengthened buildings will suffer average damage (10% of total replacement cost).	People in the open are not seriously injured from blast effects but there is an increased chance of injury/fatality from fragment and debris attack. People in buildings afforded a higher degree of protection than those in the open except from glass and debris hazard.
$22.2Q^{1/3}$	IBD (D13)	0.7	5	0.05	Unstrengthened buildings will suffer minor damage (to windows, door frames, chimneys).	Unlikely from blast effects. Injuries may occur from glass breakage and falling debris. Small chance of fatality/injury to people in the open from fragment and debris attack.
$44.4Q^{1/3}$	Vulnerable Construction Distance (2 x D13)	0.225	1.5	0.015	Large panes of glass, lightweight cladding - 50% or more may be detached or broken.	Very unlikely from blast effects. Injuries may occur from flying glass and falling cladding/debris hazard.

TABLE 1 – BLAST DAMAGE / INJURIES

Injury Level (a)		Maximum Blast Pressure		
		Psi (b)	**Kpa (c)**	**Bar (d)**
Eardrum Rupture	Threshold 50%	5 15	35 100	0.33 1
Lung Damage	Threshold 50%	10 36	70 250	0.66 2.4
Body Translation (lethality)	Threshold 50%	15 – 22 58 - 110	100 – 150 400 - 750	1 – 1.5 3.9 – 7.33

TABLE 2 – INJURY LEVELS

NEQ (kg)	Injury Due to Blast				Damage to Unstrengthened Buildings					
	No Serious Blast Injury (m)	Small Chance of Serious Injury (m)	Severe Injury (m)	Lethal / Fatal (m)	Large Areas of Glass and Cladding (50%) (m)	Minor (Windows, Door Frames, etc) (m)	Average (10% of Cost) (m)	Serious (30% of Cost) (m)	Severe (Almost Total) (m)	Total Demolition (m)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
5	26	14	7	5	76	38	26	14	7	5
10	32	18	8	6	96	48	32	18	8	6
20	41	22	10	7	121	61	41	22	10	7
25	44	24	11	7	130	65	44	24	11	7
50	55	30	14	9	164	82	55	30	14	9
75	63	34	16	11	188	94	63	34	16	11
100	69	37	17	12	206	103	69	37	17	12
150	79	43	20	13	236	118	79	43	20	13
200	87	47	21	14	260	130	87	47	21	14
250	94	51	23	16	280	140	94	51	23	16
300	99	54	24	16	298	149	99	54	24	16
350	105	57	26	17	313	157	105	57	26	17
400	109	59	27	18	328	164	109	59	27	18
500	118	64	29	19	353	177	118	64	29	19
600	125	68	31	20	375	188	125	68	31	20
750	135	73	33	22	404	202	135	73	33	22
1000	148	80	36	24	444	222	148	80	36	24
1250	160	86	39	26	479	240	160	86	39	26
1500	170	92	42	28	509	255	170	92	42	28
2000	187	101	46	31	560	280	187	101	46	31
3000	214	116	52	35	641	321	214	116	52	35
4000	235	127	58	38	705	353	235	127	58	38
5000	253	127	62	41	760	380	253	137	62	41
10000	319	173	78	52	957	479	319	173	78	52
15000	365	198	89	60	1095	548	365	198	89	60
20000	402	218	98	66	1206	603	402	218	98	66
30000	460	249	112	75	1380	690	460	249	112	75
40000	507	274	124	82	1519	760	407	274	124	82
50000	546	295	133	89	1636	818	546	295	133	89

TABLE 3 – HD 1.1 DAMAGE/DISTANCE FOR UNTRAVERSED STORAGE

NOTES

(1) This table is only a guideline - the distances are only approximate, especially for low NEQs. There will be instances where the injury and/or damage may well be greater of lesser at a given distance (type of ground/explosives stored/storage conditions/weather/structure/body size, etc will obviously vary).

(2) Unstrengthened Buildings are normal domestic local build standards, which are not specially designed to withstand blast.

(3) All distances in the Injuries Section (columns (2) to (5)) only relate to blast effects. No account is taken of injuries from debris or fragment hazards which will occur at greater distances.

(4) Column (2). No Serious Blast Injury, but there will be some injuries from fragment and/or debris hazards. Personnel in a building are offered a high degree of protection except from glass/debris hazards.

(5) Column (3). Although Small Chance of Serious Injury there will obviously be a greater proportion of less serious injuries such as burst eardrums as well as some serious injuries (e.g. lung damage), that could occur.

Event	**SCALED DISTANCES**					
	EHR 6	**EHR 5**	**EHR 4**	**EHR 3**	**EHR 2**	**EHR 1**
(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**
Injuries from:	2 x D13 44.4 $Q^{1/3}$	D13 22.2 $Q^{1/3}$	D11 14.8 $Q^{1/3}$	D10 8.0 $Q^{1/3}$	D8 3.6 $Q^{1/3}$	D7 2.4 $Q^{1/3}$
Fragments to personnel in the open	0%	4%	9%	70%	100%	100%
Fragments to personnel in buildings	0%	0.05%	1%	25%	100%	100%
Blast to personnel in the open	0%	0%	0%	0%	100%	100%
Blast to personnel in buildings	0%	0%	1%	50%	100%	100%

TABLE 4 – FRAGMENT AND BLAST HAZARDS – PROBABILITY OF INJURIES

Event	**SCALED DISTANCES**					
	EHR 6	**EHR 5**	**EHR 4**	**EHR 3**	**EHR 2**	**EHR 1**
(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**
Fatalities from:	2 x D13 44.4 $Q^{1/3}$	D13 22.2 $Q^{1/3}$	D11 14.8 $Q^{1/3}$	D10 8.0 $Q^{1/3}$	D8 3.6 $Q^{1/3}$	D7 2.4 $Q^{1/3}$
Fragments to personnel in the open	0%	1%	1.5%	12%	60%	90%
Fragments to personnel in buildings	0%	0.01%	0.01%	1%	6%	10%
Blast to personnel in the open	0%	0%	0%	0%	0.03%	100%
Blast to personnel in buildings	0%	0%	0%	2%	50%	100%

TABLE 5 – FRAGMENT AND BLAST HAZARDS – PROBABILITY OF FATALITIES

NOTES

(1) These figures are to be used as a guide only and due to the many variables, may or may not be conservative. They should however, be assumed to be the minimum injury/fatality levels expected.

(2) The figures are based on the worst case assumption.

(3) The hazard from fragments does not scale strictly with the blast scaled distances.

(4) Where, for example, there is a 60% chance of fatalities from fragment hazard to personnel in the open, there is a 100% chance of injury to all remaining survivors in the open at this scaled distance.

(5) No one is expected to survive at D7 scaled distances (EHR 1). Any that may survive by pure chance will be very seriously injured and would probably die from injuries subsequently.

3.10 **Appendix 4 - Risk Assessment Analysis**

3.10.1 The Risk Assessment Analysis consists of three steps. Firstly, the measure of severity of an event. Secondly, the assessment of the likelihood of an event. Finally, a combination of these will give a measure of the risk. This is produced as an appendix for each individual site.

3.11 **Risk Assessment Methodology Analysis**

3.11.1 A copy of the Risk Assessment Methodology Instructions are attached to each Annex explaining the process to be followed as each Annex may be read in isolation from the others. A copy of this methodology is detailed below. The Risk Assessment process advocated here follows the principles of Hazard Analysis, Risk Analysis, Risk Assessment, Risk Management and Review.

3.11.2 The method of calculating a Risk Assessment consists of three Parts:

(1) The measurement of the Severity of an event.
(2) The assessment of the Likelihood of an event.
(3) A combination of the factors in sub-paras (1) and (2) will then give a measure of the risk.

3.12 **Severity of an Event**

3.12.1 The data for the Severity of an Event is obtained from the Explosive Event Consequence Analysis. Table 6 shows the factors to be considered and the relevant weighting that should be given to each factor. Scores for infrastructure damage have been afforded less weight than damage to Mission Critical Equipment (MCE) and personnel, since they will have less of an effect on operational capability.

Personnel Fatalities (1)	**Score** (2)	**Equipment Percentage of unit MCE Damaged BLR** (3)	**Score** (4)	**Infrastructure damage** (5)	**Score** (6)
1 – 10	2	Up to 25%	2	Minor	1
11 – 20	5	26 – 50%	5	Major	3
20+	10	50% +	10	Complete Destruction	5

TABLE 6 – SEVERITY OF AN EVENT

3.12.2 Scores for personnel, equipment damage, and infrastructure damage should be summed to give an overall Severity Score. Based on Table 6, this Score could fall between 5-25.

3.13 **Likelihood of an Event**

3.13.1 There are a number of possible causes of an unintentional explosive event and those currently assessed as being relevant are:

(1) Accidental fire - Vehicle or storage container.
(2) Intruder - Deliberate fire.
(3) Intruder - Improvised Explosive Device
(4) Indirect or Direct Fire
(5) Lightning Strike

3.14 **Probability Score**

3.14.1 In Table 7 the Probability Scores are shown:

Probability **(1)**	**Score** **(2)**
Low	1 - 2
Medium	4 - 5
High	7 - 8

TABLE 7 – PROBABILITY SCORES

3.14.2 Table 7 should be used to assign Probability Scores to each of the possible causes of an unintentional explosive event detailed in para 4.3. Assigned Scores are to be based on the current situation and the judgement of the assessor conducting the Risk Assessment. This assessment could be aided by information from outside agencies e.g. The probability of Indirect or Direct Fire from information provided by J2 as to whether the site is in a Low Threat Area.

3.15 **Overall Risk Assessment Score**

3.15.1 The Overall Risk Assessment Scores should then be calculated by multiplying the combined Severity Score by each individual Probability Score. This could result in a score ranging from 5-200, as shown in Table 8.

Severity Score ↓	**Probability Score** →	**1**	**2**	**4**	**5**	**7**	**8**
5		5	10	20	25	35	40
6 – 13		6 – 13	12 – 26	24 – 52	30 – 75	42 – 91	48 - 104
14 - 25		14 – 25	28 – 50	64 – 100	70 – 125	98 – 175	112 - 200

TABLE 8 – OVERALL RISK ASSESSMENT SCORE FOR EACH, INDIVIDUAL, RISK

3.15.2 Scores for each, individual, possible Risk should then be afforded a Risk Rating of:

(1) 1-25: LOW. The Risk is acceptable, but mitigation measures must be taken as soon as practicable.
(2) 26-125: MEDIUM. The Risk is barely acceptable, and mitigation measures must be implemented immediately.
(3) 126-200: HIGH. The Risk is unacceptable, and the ammunition storage plan must be re-worked.

3.15.3 Essentially therefore, if the Risk of any single individual event is assessed as HIGH, the storage plan must be re-worked.

3.16 **Appendix 5 - Risk Reduction Options**

3.16.1 All Risk Reduction Options should be considered, and all levels of these options should be written into this Appendix.

There are usually two levels of Risk Reduction Options – Immediate and planned. An example of an Immediate Option would be the Unitisation of existing stocks, whilst a Planned Option would be the building of a FOBUAS in a less hazardous location. Both should be listed. In exceptional circumstances, there are no apparent measures that can be implemented, advice should be sought from the IE before declaring that this is the case.

3.17 **Explosives Licences**

3.17.1 A copy of any Explosives Licences issued are to be included for reference purposes in the Annex. These Licences are usually a summary of the requirement to store the ammunition, any special circumstances pertaining to the current storage e.g. the reduced distances applied to a FOBUAS, and the Risk Reduction Options.

3.18 **Safeguarding Map**

3.18.1 The Safeguarding Map is a Royal Engineer Site Plan that has drawn upon it the six Quantity Distances as described in para 3.9.1(1) and (2) using the PES as the centre point for all circles. The colours used in the Safeguarding Map, although determined by the compiler of the ESC, should utilise any distance colours where they are already prescribed in DSA 03.OME (Red - MOD Boundary, Yellow – EHR 5 (22.2Q1/3 (IBD)) and Purple – EHR 6 (44.4Q1/3 (VCD)). The colours should also be consistent during any updates of each individual ESC. All changes to the dispositions of personnel, equipment and infrastructure will be displayed in updated Royal Engineer Site Plans and these should be studied at all times with a view as to their effect on the ESC document. The preferred scale is 1:5000 however if a larger scale is available then it should be used. Consideration should also be given to obtaining an aerial photograph of the site where this is practicable, especially for the larger sites.

4 **RISK APPROVAL**

4.1 The steps in the Risk Management Process described at Annex D, Para 3.1.3 show that the next step, after the Risk reduction Options is Risk Approval. This met by the risk owner signing the Letter of Acceptance of risk at Para 3.4 above.

5 **REVIEW PROCEDURE**

5.1 **Details**

5.1.1 All ESC are living documents and will require amendment as and when required. Formal review is essential when there is:

(1) Any significant change in explosive risk carried at any site.
(2) A change in the post-holder of the signatory of the Letter for the Underwrite of Risk.
(3) A routine review of the relevant Risk Register.

5.1.2 Whenever possible, each site should be visited by the assessor, or his representative, at regular intervals. The assessor should take a copy of the appropriate ESC Annex and compare the situation on the ground with the Annex. They should note whether the Immediate Risk Reduction Options have been implemented. If they have, this should be included in the next Revision of the Annex. Any other circumstances that differ from the Annex should also be recorded for inclusion in any Revision. If there are changes, it should be noted that immediate advice may be given to negate, or reduce, any additional or altered risk noted.

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CHAPTER 11 ANNEX C

APPENDIX 2

EXAMPLE - PB ANDOVER EXPLOSIVES STORAGE UNDERWRITE

1. The details listed below provide an overview of the site and its location.

a. **Site Title**. PB ANDOVER, Op LYCOPOD.

b. **Site Description**. PB ANDOVER is located at GR: MGRS 41RPR 29646 07590. The PB is sited amongst farmed rural land, 25km North East of Camp SALISBURY. The nearest occupied buildings, consisting of several small compounds, are located approximately 500m away. The PB currently sits within the CF WILTS AO. The site currently contains 160 ISAF and 11 non ISAF interpreters (terps). There are also 30 ANA, and 30 ANP personnel located on-site.

c. **Ammunition Storage**. Ammunition is stored in 4 areas. Infantry and common user ammunition is stored in two locations, located at the South West edge and Southern edge of the location. Additionally, there is a mortar line, consisting of two base plates (with associated ready use ammunition) and an accompanying Mortar Storage ISO, at the South-East of the PB.

2. **Explosives Safety Detailed Analysis**. The analysis is sub-divided into a number of subjects and the relevant enclosures are attached.

Enclosures:

1. Site Overview and Natures Stored.
2. Secondary Hazards.
3. Explosive Event Consequence Analysis.
4. Risk Assessment.
5. Available Hazard Reduction Measures.

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ENCLOSURE 1

SITE OVERVIEW AND NATURES STORED

1. This Appendix provides an overview of the operational role of the unit, its holdings of Mission Critical Equipment (MCE) and the major ammunition natures held.

a. **PB ANDOVER:** PB ANDOVER is to:

(1) Carry out operations as directed by CF WILTS, in support of the wider Op LYCOPOD mission.

(2) Provide mortar support to surrounding CPs & PBs.

In order to create a stable security environment in Anglostan.

2. **Ammunition Holdings Overview**. Currently the site holds the following quantities of High Explosives and other significant natures of ammunition:

3. **Mortar Ammunition – Ready Use.** 2 x mortar pits, each with one open side facing NE and three sides of 1.25m high HESCO. Each pit contains:

a. Mor Bomb 81mm HE L41A4 - 30

b. Mor Bomb 81mm WP - 30

c. Mor Bomb 81mm IR Illum - 30

d. Mor Bomb 81mm Illum - 30

e. Mor Bomb 81mm HE L41A5 - 30

4. **C Coy ISO - Infantry & Common User Natures.** 2 x ISOs on SW Side of HLS, doors facing HLS. Approx 4m physical separation between ISOs.

a. ASM - 4

b. Rkt 66mm HEAT - 3

c. GM Javelin - 7

d. Rd 40x53mm HEDP - 640

e. Rd 40x46mm HE - 65

f. Gren Hand HE - 25

g. Rkt H/F Para Illum Various - 170

h. Gren hand Smk Scr RP - 12

i. Rkt 84mm AT4 - 3

j. Mor Bomb 60mm Illum - 65

k. Mor Bomb 60mm HE - 15

l. Mor Bomb 60mm IR Illum – 40

5. **A Coy ISO - Infantry & Common User Natures.** 1 x ISO, located adjacent to Ops Room.

a. Rd 40x46mm HE - 200

b. Gren Vis & IR L14 - 390

c. Gren Hd HE L109 - 20

6. **Mortar Ammunition ISO**. 1 x ISO on SE perimeter, doors facing NW – towards Mortar Line.a.Mor Bomb 81mm HE L41A4 - 204.

b. Mor Bomb 81mm HE L41A5 - 100.

c. Mor Bomb 81mm Illum - 324.

d. Mor Bomb 81mm IR Illum - 174.

e. Mor Bomb 81mm Smk WP - 204.

Site Layout

7. The current site layout has the Infantry and Common User storage on the Western side of the PB, split between two locations (A & C Coy). These stores consist of ISO containers, with single depth HESCO traverses, screening three sides.

8. The Mortar ammunition is stored within an ISO container on the South Eastern boundary of the PB, orientated with doors facing North West.

9. The ready use mortar storage consists of 2 raised mortar platforms, surrounded by HESCO on all sides.

10. Ammunition holdings within the two storage sites will be detailed on the Non-Standard Explosives Licences, once endorsed by IE(A), PATO, HQ Land Forces.

Future Development

11. PB ANDOVER has been earmarked to be uplifted to a Level Three site. The work has been sanctioned, but not timetabled as yet. Part of this upgrade will include the build of FOBUAS' in order to store the ammunition on site. Once this work has been completed, this Annex should be reviewed and amended as appropriate.

ENCLOSURE 2

SECONDARY HAZARDS

1. **General**. This Appendix highlights the risks posed to personnel and equipment at PB ANDOVER from secondary hazards that may enhance the effects of an explosive event.

2. **Fuel**.

a. **Bulk Fuel**. 1800 x 20 litre jerry cans (total: 36,000 litres) and 1 x FDR (10,000 litres) of dieso are located at the Westernmost point of the PB. There is no direct line of sight from the fuel to C Coy's ammunition storage, due to a 2.5m HESCO wall separating them. Being a non-volatile hydrocarbon fuel, it is unlikely to be ignited by an explosive event, but fuel will most likely be scattered/splashed around a large area, causing contamination. However, under exceptional circumstances, if it were to be ignited, there would result a significant fire hazard to the immediate surrounding area including the ammunition stores.

b. **Propane Gas**. There are bottles of propane gas for use in the Field Kitchen, located approx 35m from the A Coy ammunition Store.

There is no line of sight and they are protected from the stored ammunition by a single depth 2.5m HESCO wall. However, they may be susceptible to lobbed firebrands or secondary detonating explosives. In the event of the propane tanks exploding, the ammunition would not be affected.

3. **Secondary Detonating Ordnance**. The following hazardous natures are likely to be ejected from the site of a primary explosion if total propagation does not occur:

a. **C Coy ISO Storage**.

(1) Rd 40 x 53mm HEDP.

(2) Rd 40 x 46mm HE.

(3) Gren Hand HE.

(4) Rkt 66m HEAT.

(5) ASM.

(6) GM Javelin HEAT.

(7) Rkt 84mm AT4.

(8) Mor Bomb 60mm HE.

(9) Gren Hd Smk Scr RP

b. **A Coy ISO Storage.**

(1) Rd 40 x 46mm HE.

(2) Gren Hand HE.

c. **Mortar Ammunition ISO**.

(1) Mor Bomb 81mm HE.

(2) Mor Bomb 81mm Smk WP.

d. **Mortar Pit – Ready Use Ammunition.**

(1) Mor Bomb 81mm HE.

(2) Mor Bomb 81mm Smk WP.

4. **Hazard Effects**. The most likely secondary hazard from a catastrophic explosive event will be that of ordnance being ejected by an explosion and detonating in secondary locations. The Mortar Bombs 81mm HE, 60mm HE, Gren Hd HE L109 and Rd 40mm HE/HEDP from ISO storage will produce severe and potentially lethal fragmentation effects. The Mortar Bombs 81mm Smk WP and 60mm Smk WP will produce the normal WP hazards and the Gren Hand Smk Scr RP will produce the normal RP hazards to personnel and infrastructure, also causing WP and RP contamination of the ground. This contamination will persist for a significant period, as traces of WP and RP will linger just under the surface of the ground and will spontaneously combust as the ground is disturbed by vehicles or personnel traversing it. These items could land and function out to 280m from the seat of a primary explosion.

5. **UXO**. All items ejected from the explosion that do not function upon impact will need to be dealt with by EOD teams. This will disable the immediate working environment from the conduct of normal operations, until clearance work is complete.

ENCLOSURE 3

EXPLOSIVE EVENT CONSEQUENCE ANALYSIS

SUMMARISED EXPLOSIVE EVENT CONSEQUENCE ANALYSIS

1. This summary is broken down to cover the effect upon ammunition and the overall damage to personnel and infrastructure in the case of an explosive event, in each of the three locations storing ammunition in the PB. The Detailed Consequence Analysis for these locations follows on from this Summary.

2. The explosives stored are of Hazard Divisions (HDs) 1.1 and 1.2. The individual risks from each site are iterated below under their individual headings.

MORTAR PITS

3. These areas hold ready use 81mm mortar ammunition. It is held in its inner carriers, with lids removed and bombs inserted tail first. Total NEQ per pit is 111kg, of which 56kg is HE. It is assessed that, due to the way it is un-packaged, the ammunition is likely to behave as HD 1.1 during an Explosive Event, but with the added fragmentation of a SsD 1.21 event. It is further assessed that the majority of the ammunition in a stack would be destroyed during an Explosive Event, with a relatively small percentage being expelled from the pit. It is unlikely that the majority of ammunition in any one pit would wholly function, due to the separation of ammunition created by storing mortar bombs on 3 sides of each pit.

MORTAR STORAGE ISO

4. This ISO holds all 81mm Mortar ammunition, less that in the pits. Smk WP is not in separate storage. The total NEQ is 729kg, of which 283kg is HE, 420kg is Illum/IR Illum, and 26kg is WP. It is assessed that a relatively small percentage of the ammunition would be destroyed in an Explosive Event, but there could be significant quantities expelled from the area. Ordnance ejected from any of the sites could, however, cause secondary events at sites close by. Any remaining ammunition would pose a significant disposal risk to the subsequent clean up operation. This task would have to be completed before any salvage of equipment could be conducted.

A Coy ISO

5. This ISO holds various ammunition natures, less mortars, for A Coy. The NEQ of HE natures present is 12kg. Any Explosive Event in the Force Protected ISO storage would be partially contained, with the effects being felt out to approximately 80m.6. The most hazardous explosives stored are primarily of Hazard Division HD 1.1. The range of effects resulting from an explosion in this area would be from mass explosion, fragmentation and fireball, to ammunition being projected into the surrounding area, possibly producing secondary detonation effects.

C Coy ISO

7. This ISO holds various ammunition natures, less mortars, for C Coy. The NEQ of HD 1.1 natures present is 47kg with the remainder as HD1.2, 1.3 & 1.4. Any Explosive Event in the Force Protected ISO storage would be partially contained, with the effects being felt out to approximately 80m.

8. The most hazardous explosives stored are primarily of Hazard Division HD 1.1. The range of effects resulting from an explosion in this area would be from mass explosion, fragmentation and fireball, to ammunition being projected into the surrounding area, possibly producing secondary detonation effects.

PERSONNEL

9. The fatality/injury figures of personnel in the Mortar Pits have been considered part of this Safety Case, even though they would be at risk under normal working conditions anyway, because their loss would have an adverse affect on operational capability.

10. The construction of the ISO storage, force protected by single depth HESCO BASTION will mitigate any HD1.1 Explosive Event, but will not totally contain the effects. Any personnel within the immediate area are likely to be injured by either blast or fragmentation. Personnel not affected by a physical injury are likely to suffer varying degrees of initial shock, which may remain with some individuals for a significant period of time.

11. Because of the lack of adequate overhead protection (OHP) and open fronted bays, any HD1.2 explosive event in any of the ISOs will result in munitions being lobbed from that site. All PB personnel not within the Ops Room (HAB construction) would be at risk of death/injury from debris or secondary detonating ordnance.

12. Approximately 60% of locations that are likely to have personnel in them are individually HB'd. This will help reduce the number of casualties.

EQUIPMENT

13. **Mortars**. Any Explosive Event in the Mortar Pits will destroy that particular mortar and damage any adjacent to it. All mortars will require an inspection prior to use, subsequent to the event.

14. **Communications**. Any antennae may be damaged or destroyed by secondary detonating explosives, or debris from any of the ammunition sites.

INFRASTRUCTURE

15. **Fuel**. Any hot fragment due to secondary detonating munitions may set any fuel at the site on fire, causing the stocks to be destroyed in entirety. There is a possibility of death or injury from the fire itself, depending upon the number of personnel in the vicinity at the time, and substantial damage to the surrounding infrastructure.

If the fuel is ignited it may itself explode, spreading burning fuel around the surrounding area. If it does not explode, the diesel will be scattered, causing contamination to the surrounding area.

16. **Accommodation**. Blast effects to tents will be caused by an event in any storage area. The messing facilities are tented, with no additional protection from an explosive event. Approximately 60% of the tented accommodation is protected by HB walls and physical distance from the Mortar Storage area and Coy Stores; the remainder have no protection from any of the storage areas.

17. **HLS**. Any helicopter on the HLS at the time should be adequately protected from blast damage by multiple HB traverses. Any personnel present may be seriously injured. If no helicopter is present, the HLS will be unusable until after EOD/UXO clearance.

18. **EOD Clearance**. Quantities of unexploded ordnance will be dispersed around the PB. The PB will need to be subject to an EOD clearance before normal operations can resume. This is likely to take several days.

CONCLUSION

19. In the event of a catastrophic explosion it is considered that despite the losses, PB ANDOVER will still be able to conduct framework operations. Whilst the casualties will be moderate, the PB may not have the capacity or facilities to deal with the situation:

a. External assistance will be necessary.

b. The loss of the mortars will not be significant in support of on-going operations, given the location of other indirect fire assets.

c. The loss of packed fuel stocks and lubricants will be significant, although it will not have an adverse effect on the unit’s overall capability. Swift replacement by air should be possible.

d. Potential secondary hazards will be large scale fuel fires (from the F&L compound) and secondary detonating ammunition landing within the camp. The return to normality will be directly affected by the speed with which the secondary hazards are completely dealt with.

ENCLOSURE 3 (Continued)

DETAILED EXPLOSIVE EVENT CONSEQUENCE ANALYSIS MORTAR PITS

PB ANDOVER

1. This detailed analysis investigates the effect at the prescribed radii distances from the Mortar Pits. The Explosive Hazard Radii (EHR) are scaled distances based upon the Net Explosive Quantity (NEQ) of ammunition and explosives stored at a single pit and on Hazard Division (HD) 1.1 damage/distance. HD 1.1 is used because of the storage configuration of the mortar bombs (in inner containers, no lids and fuze forward). It should be noted that if the mortar crews are inside their accommodation at the time of an event, there should not be deaths caused by blast entering the accommodation, but there could be serious injuries.

2. The EHR is the distance from the Explosive Event at which the listed effects can be expected. As the distance decreases the effects will worsen on a sliding scale until the previous EHR is reached, at which point the effects listed for that EHR may be expected. Conversely, as the distance increases, the effects will lessen on a sliding scale until the next EHR is reached and those effects listed may be expected.

3. All technical analysis is based upon a worst case scenario. In this situation, the only deaths due to blast and injuries due to high velocity fragmentation will be the other mortar crews, plus any personnel visiting the pits (numbers can only be estimated). It is further assumed that the propagation of the stored ammunition and explosives is complete and behaves in accordance with normal scientific behaviour.

4. The total NEQ of ammunition and explosives stored at each pit is 111kg, however, of this only 56kg is HE. The majority of the stock falls into SsD 1.21 (sporadically detonating and producing high velocity fragments, with items being projected out of the immediate site) but may behave more like HD 1.1 (mass explosion) due to the configuration in which it is stored. There is also a quantity of WP ammunition, which will cause normal WP hazards in the immediate area of the pits and may cause the ammunition in the other pits to eventually function. If this were to happen, then the results would be the same as the first event, but separated by time. However, the mortar crews of these pits will already be casualties as a result of the first event. These further events will cause casualties amongst the rescue personnel that will inevitably rush to the site after the first event. The effective NEQ of 56Kg has been used to calculate the EHRs below; as it is considered that the illum and WP natures will not contribute significantly to an Explosive Event, other than the aforementioned WP hazards.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
Explosive Hazard Radius (EHR) Number One, to a distance of 10 metres ($2.4Q^{1/3}$)	**Number**: **12** Mortar crew **Type of Injuries**: Death (for anybody within this area). **Operational Effect**: The loss of mortar personnel will have a detrimental effect on operational capability.	The only equipment within this radius should be the mortars, which may be destroyed, as will any other equipment within this EHR. All mortars are to be subject to inspection, prior to further use. **Operational Effect** The loss of a minimum of 50% of the mortars will have a detrimental effect on operational capability.	Structural damage to mortar Pits. There is an Ops tent 9.5m away. This facility would be lost in entirety. **Operational Effect**: Loss of 9 Sqn C2 capabilities.
EHR Number Two to a distance of 14 metres ($3.6Q^{1/3}$)	**Number**: **Nil** As per EHR Number One. **Type of Injuries**: Probable death, severe trauma, burns or laceration injuries. There will be blast and fragmentation injuries. Personnel inside may be injured by the structural failure/partial collapse of the tent. **Operational Effect**: Reduction in effective manpower.	No additional equipment. **Operational Effect**: No additional effect.	The PB Oxfam Tank and Bore Hole are within this Radius. An event would cause the possible loss of these facilities, most definitely loss of operability. **Operational Effect**: Fresh water supply would be lost, though bottled stocks could be used in the interim, until infra could be repaired/replaced.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Three to a distance of 31 metres ($8Q^{1/3}$)	**Number**: **30** 3 x unprotected accommodation tents, housing the ENA contingent. **Type of Injuries**: Possible death, from fragmentation to personnel in unprotected tented accommodation, or transiting in this EHR. It is highly likely that there will be injury from fragmentation. **Operational Effect**: Dependant on numbers, and which personnel are injured, operational capability may be affected for ENA. No additional ISEN forces within this radius.	At least 9 x ISO containers are within this radius, leading to partial destruction of containers and contents. One of these ISOs houses the additional Mortar ammunition. **Operational Effect**: Mortar ammunition will be lost as a result of explosive propagation between the two sites. That ammunition which is not lost will require an inspection prior to further use. Structural integrity of ISOs will need to be inspected, prior to further use.	The tented accommodation housing the ENA will be severely damaged, possibly destroyed. **Operational Effect**: ENA will lose significant operational capability. No further disruption to ISEN forces.
EHR Number Four to a distance of 57 metres ($14.8Q^{1/3}$)	**Number: 40** An additional 4 ENA accommodation tents. **Type of Injuries**: As for EHR Number 3 **Operational Effect:** As for EHR Number 3.	A small part of the vehicle park is within this EHR. **Operational Effect**: Damaged vehicles will need replacing.	No additional infrastructure at this EHR. **Operational Effect**: N/A

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Five to a distance of 85 metres ($22.2Q^{1/3}$)	**Number: 100** There are an additional 7 accom tents, the welfare facility, the med HAB and Ops HAB within this EHR. **Type of Injuries**: There should be no injuries from blast. However some injuries from debris may be expected. **Operational Effect**: There would be minimal additional losses in terms of personnel within this EHR.	The Vehicle Park is within this EHR, as is the POL storage. Damage to the POL at this distance is highly unlikely due to the HESCO FP between the site of the event and the stores. There may, however, be a limited amount of damage to any vehicles parked within the vehicle park. Any Antennae within this EHR will be damaged, requiring repair/replacement. A Coy Ammunition storage is located within this EHR, leading to a possibility of lobbed munitions causing a secondary risk of an additional explosive event. **Operational Effect**: Damage to the antennae and dishes could lead to the unit being without comms until replaced/repaired. Loss of ammunition from within A Coy storage would lead to a loss of operational effectiveness within A Coy, until the ammunition was replenished.	The Ops Room and Med centre are both protected within a HESCO HAB. **Operational Effect**: No additional Operational effect.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Six to a distance of 170m ($44.4Q^{1/3}$)	**Number: 30** The ENA compound is within this EHR. **Type of Injuries**: Very unlikely from blast effects, thrown debris presents a hazard, though is also unlikely. **Operational Effect**: N/A.	The PB HLS is within this EHR. There will be no damage to vehicles unless directly struck by occasional debris/frag – this damage would be minor. An airframe on the HLS would be protected by the HESCO wall and distance involved. Any damage due to frag/debris would be very unlikely to render the airframe U/S, though fire hazard from damaged and ejected WP rounds is a risk. C Coy ammunition storage is within this EHR. Though sympathetic detonations, resulting from lobbed munitions is unlikely. **Operational Effect**: None	Small possibility of UXO or burning WP rounds on the HLS. **Operational Effect**: HLS may become unusable until any fire hazards and/or UXO dealt with.

DETAILED EXPLOSIVE EVENT CONSEQUENCE ANALYSIS

C COY ISOs – PB ANDOVER

1. This detailed analysis investigates the effect at the radii distances from the Ammunition Store. The explosive hazard radii (EHR) are scaled distances, based upon Net Explosive Quantity (NEQ) of ammunition and explosives stored in a single ISO. HD 1.1 is used as it represents the greatest hazard to personnel and infrastructure.

2. The EHR is the distance from the explosive event at which the listed effects can be expected. As the distance decreases the effects will worsen on a sliding scale until the previous EHR is reached, at which point the effects listed for that EHR may be expected. Conversely, as the distance increases, the effects will lessen on a sliding scale until the next EHR is reached and those effects listed may be expected.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
Explosive Hazard Radius (EHR) Number One, to a distance of 9 metres ($2.4Q^{1/3}$)	**Number**: **0** The only personnel likely to be in this EHR are transient individuals, accessing the ISO Containers in the immediate vicinity. **Type of Injuries**: Death (for anybody within this area). **Operational Effect**: Limited, if any operational effect.	Damage to ISO containers within the EHR distance. **Operational Effect** Op effect dependent on stores contained within ISOs.	No additional infrastructure. **Operational Effect**: No additional effect.
EHR Number Two to a distance of 13 metres ($3.6Q^{1/3}$)	**Number: 0** **Type of Injuries**: As per EHR No. 1. **Operational Effect:** As per EHR No. 1.	No additional Equipment. **Operational Effect**: As per EHR No.1.	As per EHR No.1. **Operational Effect**:

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Three to a distance of 29 metres ($8Q^{1/3}$)	Additional ISOs and approximately 10% of the vehicle park are within this EHR. **Number**: **8** Dependant on personnel occupying the vehicle park, or ISO area. **Type of Injuries**: Possible death, severe trauma, burns or laceration injuries. There will be blast and fragmentation injuries. **Operational Effect**: Dependant on numbers and which personnel are injured, operational capability may be affected.	Additional ISOs within storage area. Minor damage likely. **Operational Effect**: Dependant upon stores held.	No additional Infrastructure. **Operational Effect**: No additional effect.
EHR Number Four to a distance of 54 metres ($14.8Q^{1/3}$)	50% of the vehicle park is in this area. **Number: 20** **Type of Injuries**: There should be no serious injury from blast. However, there may be some trauma or laceration injuries from occasional debris. Additionally, shock may affect personnel found within this radius. Those personnel not inside a building may suffer injury by translation of loose objects within. **Operational Effect:** Dependant on numbers and which personnel are injured, operational capability may be affected.	Any equipment in this EHR is likely to suffer damage BLR. **Operational Effect**: None	No additional Infrastructure. **Operational Effect**: No additional effect.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Five to a distance of 81 metres ($22.2Q^{1/3}$)	**Number: 50** Within this area is the ENA compound, the vehicle park in its entirety, the Ops room and Med centre HABs and the ENA vehicle park. **Type of Injuries**: There should be no injuries from blast. However some injuries from debris can be expected. **Operational Effect**: There would be minimal additional losses in terms of personnel within this EHR.	The PB HLS is within this EHR. The POL storage is Within this EHR, as are two sangars and several more ISO storage containers. Damage to the POL at this distance is highly unlikely due to the physical distance between the site of the event and the holdings. There may, however, be a limited amount of damage to any vehicles parked within the vehicle park. Any Antennae within this EHR will be damaged, requiring repair/replacement. **Operational Effect**: Damage to the Antennae and dishes could lead to the unit being without comms until replaced/repaired. An airframe on the HLS would be protected by the HESCO wall and distance involved. Any damage due to frag/debris would be very unlikely to render the airframe U/S, though fire hazard from damaged and ejected WP rounds is a risk.	The Ops Room and Med centre are both protected within a HESCO HAB. Small possibility of UXO or burning WP rounds on the HLS. **Operational Effect**: HLS may become unusable until any fire hazards and/or UXO dealt with.

Damage Area	Personnel	Equipment	Infrastructure
EHR Number Six to a distance of 161m (44.4$Q^{1/3}$)	**Number: 130** The entire PB is encompassed within this EHR. **Type of Injuries**: Very unlikely from blast effects, thrown debris presents a hazard, though is also unlikely. **Operational Effect**: N/A.	There will be no damage to vehicles unless directly struck by occasional debris/frag – this damage would be minor. A Coy Ammunition storage is located within this EHR, leading to a possibility of lobbed munitions causing a secondary risk of an additional explosive event. **Operational Effect**: Any loss of ammunition from within A Coy storage would lead to a loss of operational effectiveness within A Coy, until the ammunition was replenished.	**Operational Effect**: No additional Operational effect.

3. All technical analysis is based upon a worst case scenario. It is assumed that the propagation of the stored ammunition and explosives is complete and behaves in accordance with expected scientific norms.

4. The largest, effective, NEQ of ammunition and explosives that will contribute to a mass detonation is 47kg. This will constitute the HE mortars, GM Javelin, 40x46mm HE, 40x53mm HEDP, Gren Hd HE L109s, Rkt 66mm HEAT, ASM and Rkt 84mm AT4 ammunition stored within the C Coy ISO storage area. There are other HDs present, but their NEQ will not contribute significantly to the HE explosive event, it is for these reasons that the aggregate of ammunition likely to mass detonate has been used to estimate the likely damage in a catastrophic event.

DETAILED EXPLOSIVE EVENT CONSEQUENCE ANALYSIS

A COY ISO – PB ANDOVER

1. This detailed analysis investigates the effect at the radii distances from the Ammunition Store. The explosive hazard radii (EHR) are scaled distances, based upon Net Explosive Quantity (NEQ) of ammunition and explosives stored in a single ISO. HD 1.1 is used as it represents the greatest hazard to personnel and infrastructure.

2. The EHR is the distance from the explosive event at which the listed effects can be expected. As the distance decreases the effects will worsen on a sliding scale until the previous EHR is reached, at which point the effects listed for that EHR may be expected. Conversely, as the distance increases, the effects will lessen on a sliding scale until the next EHR is reached and those effects listed may be expected.

3. All technical analysis is based upon a worst-case scenario. It is assumed that the propagation of the stored ammunition and explosives is complete and behaves in accordance with expected scientific norms.

4. The largest, effective, NEQ of ammunition and explosives that will contribute to a mass detonation is 12kg. This will constitute the 40x46mm HE and Gren Hd HE L109 ammunition stored within the A Coy ISO storage area. There are other HDs present, but their NEQ will not contribute significantly to the HE explosive event, it is for these reasons that the aggregate of ammunition likely to mass detonate has been used to estimate the likely damage in a catastrophic event.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
Explosive Hazard Radius (EHR) Number One, to a distance of 6 metres ($2.4Q^{1/3}$)	**Number**: **0-2** The only personnel likely to be in this EHR are those directly accessing the A Coy ammunition ISO. **Type of Injuries**: Death (for anybody within this area). **Operational Effect**: Limited, if any operational effect.	Damage to single ISO container within the EHR distance. **Operational Effect** Loss of ammunition held within A Coy's ISO store.	No infrastructure other than the ammo ISO. **Operational Effect**: No additional effect.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Two to a distance of 9 metres ($3.6Q^{1/3}$)	**Number: 0** As per EHR No.1. **Type of Injuries**: As per EHR No.1. **Operational Effect:** No additional effect.	No additional equipment.. **Operational Effect**: No additional effect.	No additional infrastructure. **Operational Effect**: No additional effect.
EHR Number Three to a distance of 19 metres ($8Q^{1/3}$)	**Number**: **8** Tented transit accommodation is located within this EHR, which presents a risk to transitory personnel. **Type of Injuries**: Possible death, severe trauma, burns or laceration injuries. There will be blast and fragmentation injuries. **Operational Effect**: Loss of accommodated personnel.	Additional ISOs within storage area. Minor damage likely. **Operational Effect**: Dependant upon stores held.	No additional Infrastructure. **Operational Effect**: No additional effect.

Damage Area	Personnel	Equipment	Infrastructure
EHR Number Four to a distance of 34 metres ($14.8Q^{1/3}$)	Approx 30% of the vehicle park is in this area. **Number: 20** **Type of Injuries**: There should be no serious injury from blast. However, there may be some trauma or laceration injuries from occasional debris. Additionally, shock may affect personnel found within this radius. Those personnel not inside a building may suffer injury by translation of loose objects within. **Operational Effect:** Dependant on numbers and which personnel are injured, operational capability may be affected.	Any equipment in this EHR is likely to suffer damage BLR. **Operational Effect**: None	No additional Infrastructure. **Operational Effect**: No additional effect.

Damage Area	**Personnel**	**Equipment**	**Infrastructure**
EHR Number Five to a distance of 51 metres (22.2$Q^{1/3}$)	**Number: 50** Within this area is 80% of the vehicle park, the Ops room and Med centre HABs, the majority of A Coy accommodation and the welfare tent. **Type of Injuries**: There should be no injuries from blast. However some injuries from debris can be expected. **Operational Effect**: There would be minimal additional losses in terms of personnel within this EHR.	Some tented accommodation within this EHR would be damaged or destroyed. There will be a limited amount of damage to any vehicles parked within the vehicle park. Any Antennae within this EHR may be damaged, requiring repair/replacement. **Operational Effect**: Damage to the Antennae and dishes could lead to the unit being without comms until replaced/repaired.	The Ops Room and Med centre are both protected within a HESCO HAB. **Operational Effect**: Tented accommodation may need to be repaired/ replaced.

Damage Area	Personnel	Equipment	Infrastructure
EHR Number Six to a distance of 102m ($44.4Q^{1/3}$)	**Number: 120** The majority of the PB is encompassed within this EHR, completely encompassing occupied areas. **Type of Injuries**: Very unlikely from blast effects, thrown debris presents a hazard, though is also unlikely. **Operational Effect**: N/A.	There will be no damage to vehicles unless directly struck by occasional debris/frag – this damage would be minor. C Coy Ammunition storage, the mortar line and mortar storage ISO are located within this EHR, leading to a possibility of lobbed munitions causing a secondary risk of an additional explosive event. **Operational Effect**: Any loss of ammunition from within any of the other storage would lead to a loss of operational effectiveness within A Coy, until the ammunition was replenished.	**Operational Effect**: No additional Operational effect.

MORTAR BOMB AMMUNITION STORE – PB ANDOVER

1. The entire holdings of ammunition within the Mortar Bomb Storage area are HD 1.2. Therefore, the consequences of an event in this area will not result in a mass explosion hazard, but result in the contents of the store exploding progressively, a few items at a time. Munitions will be lobbed from the site, some of which may explode on impact. Others will remain as UXO and require clearance by qualified personnel. Illumination bombs that function on impact will cause fires in the event of landing amongst stored fuel or other combustible materials.

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ENCLOSURE 4

RISK ASSESSMENT
MORTAR PITS - SEVERITY

1. The data used is based on the IE(A) information contained in this document. Severity scores assigned are based on those specified in Table 1 (attached).

2. **Severity Ratings**.

a. Personnel: Total fatalities = 9. Score from Table 1 = **2.**

b. MCE % of damaged BLR = 26-50% Score from Table 1 = **5.**

c. Damage to infrastructure = Minor Damage. Score from Table 1 = **1.**

Total severity rating = 2 + 5 + 1 = 8.

PROBABILITY

3. Probability figures assigned are based on those specified in Table 2 attached.

a. Accidental Fire: Score = **1 (Other than spontaneous combustion, the only source of a fire would be the Mortar Crews).**

b. Intruder – Deliberate fire: Score = **1 (Based on the pits being permanently manned).**

c. Intruder – IED: Score = **1 (Based on the pits being permanently manned).**

d. Indirect or Direct Fire: Score = **2 (Based on the J2 classification of this as a Low Threat Area).**

e. Lightning Strike: Score = **1 (Based on the low incidence of strike).**

OVERALL RISK SCORES

4. Overall risk scores are calculated as the product of the total severity scores and the individual probability scores.

a. Accidental fire: 8 x 1 = **8**

b. Intruder – deliberate fire: 8 x 1 = **8**

c. Intruder – IED: 8 x 1 = **8**

d. Indirect or Direct fire: 8 x 2 = **16**

e. Lightning Strike: 8 x 1 = **8**

5. **Risk Assessment**. Based on the risk assessment scores in Table 3 (attached), the overall risk in all cases is assessed as **LOW**.

6. **Remedial Actions**. There is nothing, other than protective roofs, that can offer further protection from incoming fire and this would prevent the all round arc of fire that the mortars require.

MORTAR STORE - SEVERITY

7. The data used is based on the regulatory information contained in this document. Severity scores assigned are based on those specified in Table 1 attached.

8. Severity Ratings.

a. Personnel: Total fatalities = 0. Score from Table 1 = **0.**

b. MCE % of damaged BLR = N/A Score from Table 1 = **0.**

c. Damage to infrastructure = Minor Score from Table 1 = **1.**

Total severity rating = 0 + 0 + 1 = 1.

PROBABILITY

9. Probability figures assigned are based on those specified in Table 2 attached.

a. Accidental Fire: Score = **1 (Based on there being no combustibles in the area).**

b. Intruder – Deliberate fire: Score = **1 (Based on this being a secure FOB).**

c. Intruder – IED: Score = **1 (Based on this being a secure FOB).**

d. Indirect or Direct Fire: Score = **2 (Based on the J2 classification of this as a Low Threat Area).**

e. Lightning Strike: Score =**2 (Based on there being no earthing but low incidence of strikes).**

OVERALL RISK SCORES

10. Overall risk scores are calculated as the product of the total severity scores and the individual probability scores.

a. Accidental fire: 1 x 1 = **1**

b. Intruder – deliberate fire: 1 x 1 = **1**

c. Intruder – IED: 1 x 1 = **1**

d. Indirect or Direct fire: 1 x 2 = **2**

e. Lightning Strike: 1 x 2 = **2**

11. **Risk Assessment**. Based on the risk assessment scores in Table 3 (attached), the overall risk is assessed as **LOW.**

Remedial Actions. Measures to mitigate the risks above are quantified at Appendix 5

A COY ISO - SEVERITY

12. The data used is based on the regulatory information contained in this document. Severity scores assigned are based on those specified in Table 1 attached.

13. Severity Ratings.

a. Personnel: Total fatalities = 2-8. Score from Table 1 = **2.**

b. MCE % of damaged BLR = up to 25% Score from Table 1 = **2.**

c. Damage to infrastructure = Minor Score from Table 1 = **1.**

Total severity rating = 2 + 2 + 1 = 5.

PROBABILITY

14. Probability figures assigned are based on those specified in Table 2 attached.

a. Accidental Fire: Score =**1 (Based on there being no combustibles in the area).**

b. Intruder – Deliberate fire: Score = **1 (Based on this being a secure FOB).**

c. Intruder – IED: Score = **1 (Based on this being a secure FOB).**

d. Indirect or Direct Fire: Score = **2 (Based on frequency and inaccuracy of attacks)**

e. Lightning Strike: Score = **2 (Based on there being no earthing but low incidence of strikes).**

OVERALL RISK SCORES

15. Overall risk scores are calculated as the product of the total severity scores and the individual probability scores.

a. Accidental fire: 5 x 1 = **5**

b. Intruder – deliberate fire: 5 x 1 = **5**

c. Intruder – IED: 5 x 1 = **5**

d. Indirect or Direct fire: 5 x 2 = **10**

e. Lightning Strike: 5 x 2 = **10**

16. **Risk Assessment**. Based on the risk assessment scores in Table 3 (attached), the overall risk in all cases is assessed as **LOW**.

17. **Remedial Actions**. Measures to mitigate the risks above are quantified at Appendix 5.

C COY ISO - SEVERITY

18. The data used is based on the regulatory information contained in this document. Severity scores assigned are based on those specified in Table 1 attached.

19. Severity Ratings.

a. Personnel: Total fatalities = 0-8. Score from Table 1 = **2.**

b. MCE % of damaged BLR = up to 25% Score from Table 1 = **2.**

c. Damage to infrastructure = Minor Score from Table 1 = **1.**

Total severity rating = 2 + 2 + 1 = 5.

PROBABILITY

20. Probability figures assigned are based on those specified in Table 2 attached.

a. Accidental Fire: Score = **1 (Based on there being no combustibles in the area).**

b. Intruder – Deliberate fire: Score = **1 (Based on this being a secure FOB).**

c. Intruder – IED: Score = **1 (Based on this being a secure FOB).**

d. Indirect or Direct Fire: Score = **2 (Based on frequency and inaccuracy of attacks)**

e. Lightning Strike: Score = **2 (Based on there being no earthing but low incidence of strikes).**

OVERALL RISK SCORES

21. Overall risk scores are calculated as the product of the total severity scores and the individual probability scores.

a. Accidental fire: 5 x 1 = **5**

b. Intruder – deliberate fire: 5 x 1 = **5**

c. Intruder – IED: 5 x 1 = **5**

d. Indirect or Direct fire: 5 x 2 = **10**

e. Lightning Strike: 5 x 2 = **10**

22. **Risk Assessment**. Based on the risk assessment scores in Table 3 (attached), the overall risk in all cases is assessed as **LOW**.

23. **Remedial Actions**. Measures to mitigate the risks above are quantified at Appendix 5.

24. **METHOD OF CALCULATION OF RISK ASSESSMENT (TO BE INCLUDED IN ALL ANNEXES SO THAT THEY MAY BE READ INDIVIDUALLY)**

1. **Introduction.** The risk assessment consists of 3 parts. Firstly, the measurement of the severity of an event. Secondly, the assessment of the likelihood of an event. Finally, a combination of these will give a measure of the risk. The proposed methodology is shown below.

2. **Severity of an Event**.

a. The data for the severity of an event is obtained from the Explosive Event Consequence Analysis. The table below shows the factors to be considered and the relevant weighting that should be given to each factor. Scores for infrastructure damage have been afforded less weight than damage to mission critical equipment (MCE) and personnel, since they will have less of an effect on operational capability.

Personnel – Fatalities	Score	Equipment - %age of unit MCE damage BLR	Score	Infrastructure Damage	Score
1-10	2	Up to 25%	2	Minor	1
11-20	5	26-50%	5	Major	3
20+	10	50% +	10	Complete destruction	5

Table 1

Scores for personnel, equipment damage, and infrastructure damage should be totalled (summed) to give an overall Severity Score. Based on Table 1, this score could fall between 5-25.

3. **Likelihood of an Event**.

a. **Possible Causes of an Unintentional Explosive Event**. There are currently 5 assessed possible causes of an explosive event:

(1) Accidental fire – vehicle or ISO.

(2) Intruder – deliberate fire.

(3) Intruder – IED.

(4) Indirect or Direct Fire.

(5) Lightning Strike.

b. **Probability Scores**.

Probability	Score
Low	1-2
Medium	4-5
High	7-8

Table 2

Table 2 should be used to assign probability scores to each of the possible causes of an unintentional explosive event detailed at paragraph 4b above. Assigned scores are to be based on the current situation and the judgement of the ATO/AT conducting the risk assessment.

4. **Overall Risk Assessment Score**.

a. Overall risk assessment scores should then be calculated by multiplying the combined severity score by the probability score. This could result in a score ranging from 5-200, as shown below:

Severity Score	Probability Score	1	2	4	5	7	8
5		5	10	20	25	35	40
6-13		6-13	12-26	24-52	30-75	42-91	48-104
14-25		14-25	28-50	64-100	70-125	98-175	112-200

Table 3

b. Scores for each possible risk should then be afforded a risk rating of:

1-25: **LOW**. The risk is acceptable, but mitigation measures must be taken as soon as is practical.

26-125: **MEDIUM**. The risk is barely acceptable, and mitigation measures must be implemented immediately.

126-200: **HIGH**. The risk is unacceptable, and the ammunition storage plan must be re-worked.

Essentially therefore, if the risk of any single individual event is assessed as HIGH, the storage plan must be re-worked.

ENCLOSURE 5

AVAILABLE HAZARD REDUCTION MEASURES

GENERAL

1. The storage conditions at PB ANDOVER are currently considered to be in the LOW explosive risk category.

AMMUNITION STOCKS

2. **Mortar Pits.** At present the two mortar pits are holding an excessive amount of ammunition for the usage levels experienced. It is suggested that stock levels within the ready use mortar ammunition are reduced to as low a level as is reasonably practicable, whilst suitable for operational requirements.

METHOD OF REDUCING THE CURRENT HAZARD

3. **PB Expansion.** There is an intention to increase the size of PB ANDOVER by approximately 150%, subsequent to proposed "land-grabs" around the site. As part of this planned upgrade, there is an intention to incorporate FOBUAS ammunition storage for the various locations around the site.

4. **Unitisation**. In order to reduce the explosive hazard in the A & C Coy stores, the HD 1.1 items should be unitised from the HD 1.2 HE items, in order to negate the need to aggregate them, thus lowering the effective HD 1.1 NEQ.

5. **Planning Process.** The planned upgrade also brings with it greater ammunition scaling for the additional troops that would be based at the location. It is essential that J4 Ammo – JFSp(A) are involved with all proposed building works from as early in the process as possible.

SUMMARY

6. There will always be a risk to Health and Safety when ammunition and explosives are handled in the immediate proximity to personnel, equipment and infrastructure. The only way to achieve total safety is to remove all ammunition and explosives from the site. Clearly this is not operationally viable; therefore, measures to mitigate the existing risk should be made in order to bring this safety risk to a level that is as low as is reasonably practicable (ALARP). It has been accepted that the continued handling of a determined quantity of ammunition and explosives is an acceptable operational risk within the confines of PB ANDOVER.

RECOMMENDATIONS

7. It is recommended that once the proposed infrastructure and manning changes have been made, that a re-visit to the site and the ESC Annex are made by SATO HERRICK.

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CHAPTER 11

ANNEX D

OPERATIONAL STORAGE OF DOSR UNCLASSIFIED MUNITIONS IN MOD EXPLOSIVES STORAGE AREAS

CONTENTS

Para

1 STORAGE OF DOSR UNCLASSIFIED MUNITIONS IN MOD EXPLOSIVES STORAGE AREAS

1.1 Background

1.1.1 MOD Explosives Regulations do not permit the storage of explosives on MOD property unless they have been classified by the DOSR . In the operational environment the requirement may arise, for information gathering reasons, to store DOSR unclassified munitions in a MOD explosives storage area pending their transportation to the UK in contravention of Explosives Regulations. The Sponsor in all instances will be DSTL.

1.2 Aim

1.2.1 The aim of this regulation is to lay down the procedure to be followed when the storage of DOSR unclassified explosives in a MOD explosives storage area is an operational requirement. This procedure complies with the principles of this document, and will combine elements of other existing regulations to ensure that any risk is ALARP.

2 POLICY

2.1 Outline

2.1.1 In operational theatres, DOSR unclassified munitions may be stored in MOD explosives storage areas for 60 days under the existing regulations for the management of EOD arisings. During this 60 day period, the munitions sponsor is to apply for, and obtain, DOSR clearance for storage beyond this period. Once DOSR classification is received, storage will be permitted until the sponsor has the items removed under the appropriate arrangements.

2.2 Detail

2.2.1 All stages of the policy detailed below are mandatory and no deviation whatsoever is to be permitted.

(1) Safe to Move. All items for information gathering are to be certified "Safe to Move" by a Competent Ammunition Person prior to being transported to a theatre storage location as EOD arisings. All such moves are to be in accordance with DSA03.DLSR.LSSR Movement and Transport Safety Regulations, Dangerous Goods Manual (DGM) and MOD Form 1663 is to be fully completed.

(2) EOD Classification. Immediately upon arrival at a theatre storage location all items must then be "EOD classified".

(3) Safety Certification. Following EOD Classification, every item must undergo Safety Certification. MOD Forms 1661, must be fully completed.

(4) Packaging and Marking. All items stored under this procedure are to be packaged and marked correctly.

(5) DOSR Classification. The storage of EOD arisings under the procedure detailed above is strictly limited to 60 days. Within that period, the sponsors of the items being stored are to seek DOSR provisional classification. All DOSR classifications are to be staffed through the relevant Service IE to CIE(MOD) and must include MOD Forms 1656 complete with photographs of all items, their packages and method of pack.

(6) Storage. The management of items classified either under the EOD or DOSR provisional classification route is to be strictly in accordance with Chapter 13, Paras 8.8 or extant TEB. Such items must not be stored or processed in any PES that contains MoD explosives.

(7) Disposal. The disposal of items that have been awarded a DOSR provisional classification will be the responsibility of the sponsor of the items. In practice, items so classified shall be removed from MOD explosives storage areas within 6 months. Should DOSR provisional classification not be obtained within the 60 day period, the relevant Service IE will direct that all affected items are immediately destroyed locally.

2.3 Technical Assistance

2.3.1 Ammunition technical staff in operational theatres are to continue to provide the necessary assistance with all aspects of technical management for DOSR unclassified munitions and explosives. Direct liaison between theatre ammunition technical staff and the MOD Sponsor is essential for the safe and effective management of DOSR unclassified munitions. As far as practicable, liaison shall be at working level whilst keeping the relevant Service IE staff fully informed at all times.

CHAPTER 11

ANNEX E

TREATMENT OF ORDNANCE, MUNITIONS AND EXPLOSIVES EXPOSED TO CHEMICAL WARFARE AGENT CONTAMINATION

CONTENTS

Para

Appendix

1 TREATMENT OF ORDNANCE, MUNITIONS AND EXPLOSIVES THAT HAVE BEEN EXPOSED TO CHEMICAL WARFARE AGENT CONTAMINATION

1.1 General

1.1.1 The contamination of Ordnance, Munitions and Explosives (OME) or their packages by Chemical Warfare (CW) agent(s), and in particular any persistent liquid CW agents, may render stores unfit for normal use until they have been effectively decontaminated. Additionally, contamination of exposed energetic fillings by liquid CW agents or decontaminating solutions, may give rise to explosion or fire. Every precaution is therefore to be taken to protect OME stocks in buildings and in the open. Doors, windows and ventilators of storage buildings are to be well fitting and kept in good repair and, if a warning is received that a CW attack is expected, they are to be closed, and kept closed, for the duration of any attack threat. Stocks in the open are to be kept covered, ideally with Chemical Agent Resistant Material (CARM).
Personnel employed in the handling and destruction of contaminated OME and the associated packaging, are to be conversant with the risks attached to CW agent contamination and with the precautions to be taken. Appendix 1 provides a comprehensive list of CW agents showing their type and persistency.

1.2 Contamination of materials by CW agent

1.2.1 Persistent CW agents are generally liquids with a relatively high boiling point. These agents will remain on hard non absorbent materials for extended periods of time and will only dissipate slowly. Persistent liquid CW agents can also be readily absorbed into materials such as paint, foam, wood, fibreboard, some plastics, cloth and leather. Once a persistent CW agent is entrapped in these matrixes it will continue to present a vapour hazard by off-gassing for a considerable period of time, even after the initial source of contamination has been removed. It is therefore difficult to decontaminate porous materials that have been contaminated with a persistent CW agent.

1.2.2 Persistent CW agents can be removed from hard non-absorbent surfaces, such as metals, however, consideration needs to be given to finishes such as paint. In addition many of these agents exhibit a low surface tension and they can therefore ingress into cracks, crevices and screw threads, from where they will continue to produce both a contact and an off-gassing hazard. The term ‘non-persistent’ CW agents has been widely used to describe those CW agents with low boiling points which volatilise easily from hard non absorbent surfaces. However, it has been shown that non-persistent liquid CW agents may also ingress into cracks, crevices and screw threads or be absorbed into absorbent materials. Therefore, non-persistent liquid CW agents can still present a long term off-gassing hazard in the same way as the more persistent CW agents.
Some CW agents, such as phosgene (CG) and cyanogen chloride (CK), have very low boiling points and will only be observed as gases in normal climatic conditions. These agents will not ingress into cracks, crevices or screw threads and they will not be retained in absorbent materials.

1.3 Levels of decontamination

1.3.1 The ability to decontaminate materials is determined by a number of factors including the ambient conditions (hot, cold, precipitation etc), the material from which the item is made and the persistency of the CW agent making the challenge.

1.3.2 Decontamination can be split into 3 stages:

(1) Immediate: Decontamination sufficient to save life, minimise casualties, prevent fire or explosion.

(2) Operational: Decontamination sufficient to maintain operations, reduce the contact hazard of the CW Agent and limit the spread of the contamination.

(3) Thorough: Decontamination to eliminate, or reduce, the requirement for IPE or to remove contamination so items can be re-used.

1.3.3 Because of the reasons cited earlier, ‘Thorough decontamination’ of items contaminated with liquid CW agent, whether classified as either persistent or non-persistent, may be difficult to achieve. There are also long term human health and safety issues associated with exposure to very low concentrations of CW agent which present technical problems in deciding what level of decontamination is required, and the what sampling regime is required to demonstrate complete decontamination. For these reasons a ‘clearance plan’ would need to be devised to support thorough decontamination operations.

Therefore, the likely maximum level of decontamination that can be achieved without specialist equipment or assistance is Operational decontamination.

1.4 Decontamination materials

1.4.1 Chemical Agent Decontaminant (CAD) should be used for all liquid CW agent contamination. OME and associated packaging can be scrubbed using hot soapy and water for immediate decontamination only (only if CAD is not available), that is to save life, minimise casualties, prevent fire or explosion.

Personnel handling items 'decontaminated' in this way will be required to wear full Personal Protective Equipment (PPE).

1.4.2 Highly volatile agents, such as phosgene and cyanogen chloride, do not require decontamination using CAD. Weathering of the contaminated items by exposing them to the elements with free air flow should be sufficient to ensure decontamination.

1.5 Emergency decontaminating materials

1.5.1 Several materials have historically been used as emergency decontaminants. Appendix B details the materials which can be used. Dry bleach powder is not to be used as it can react with certain agents (mustard agent in particular) and cause spontaneous ignition. It is only to be used diluted with water (5 - 10% of water volume) and then only for immediate or operational use.

1.6 Use of Fullers Earth

1.6.1 Fullers Earth does not neutralise CW agent. It can, however, be used to absorb and immobilise liquid CW agent, thereby preventing the spread of contamination. Once CW agent has been absorbed onto Fullers Earth it can be removed from the contaminated surface. The surface, however, has not been decontaminated and further treatment will be required. The Fullers Earth will be contaminated with the absorbed CW agent and must be disposed of using suitable precautions.

1.7 Decontamination of OME and its associated packaging

1.7.1 Absorbent materials - These materials may be present at all levels within the packaging hierarchy. They may also be present either attached to or as part of OME. Examples, although far from exhaustive, include:

(1) Cloth, leather – In adhesive tapes used to secure packaging, carrying bags and straps, charges bags containing propellant etc.

(2) Paper, cardboard, fibreboard – Packaging fitments, internal packages, wrapping of demolition explosives etc.

(3) Polystyrene, plastic – Internal packaging fitments, internal packages, OME components such as handles, triggers, sights, fuze covers, end caps etc.

(4) Wood – Pallet furniture and bases, outer packages, internal packaging fitments etc.

1.7.2 Absorbent materials contaminated with liquid CW agent (persistent or non persistent) cannot be easily decontaminated. Therefore, such materials

should be discarded and destroyed at the earliest opportunity. OME held in packages made from these materials can be repacked as long as it can be shown that the items were not themselves contaminated.

1.7.3 Where absorbent materials have been exposed to highly volatile CW agents, such as phosgene or cyanogen chloride, it is unlikely that they will become contaminated to an extent whereby they will provide a long term hazard. However, it is prudent to ensure that items exposed to these agents should be segregated and exposed to the elements to weather. They should then be used at the earliest opportunity in preference to items that have not been contaminated.

1.7.4 Non-absorbent materials: This category of materials is primarily represented by metals which may be present at all levels within the packaging hierarchy, as well as either attached to or as part of OME. Examples, although far from exhaustive, include: tensile steel strapping, ULC construction, outer or inner packages, packing fitments, munition bodies etc.

1.7.5 Non-absorbent materials, such as boxes and shell bodies, contaminated with liquid CW agent (persistent or non persistent) can be decontaminated to an operational level using service or improvised decontaminants. However, absorption of CW agent into protective paints and ingress into cracks, crevices and screw threads may seriously hinder the decontamination process. Where non-absorbent materials have been exposed to highly volatile CW agents, such as phosgene or cyanogen chloride, it is unlikely that they will become contaminated. However, it is prudent to ensure that items exposed to these agents should be segregated and exposed to the elements to weather. They should then be used at the earliest opportunity.

1.7.6 Other materials: Modern OME may contain many materials, such as hard plastics, fibreglass and carbon fibre, which may not appear to fall neatly into the two categories described above. In addition, many materials may have been treated by the manufacturer to enhance their resistance to contamination by CW agent. The range of materials falling into this category is too large to give specific advice, therefore, assistance should be sought from the Force SCIAD/Project Team as required in instances where these materials are encountered.

1.7.7 Energetic materials: Energetic materials should not become directly exposed to CW agent as they are generally contained within munition bodies. However, there are instance where exposure of energetics can occur such as:

(1) Damaged munitions.
(2) Unwrapped demolitions charges such as PE4, PE7 and SX2.
(3) Cut ends of demolition accessories such as detonating cord and safety fuze.
(4) Absorbed through cloth bags used on propelling charges.

1.7.8 There are many types of energetic materials, most of which have not been tested for compatibility against a full range of CW agents. However, historically it has been shown that some energetic materials will spontaneously combust when exposed to CW agents. Therefore, until evidence shows otherwise, the possibility of spontaneous combustion must be assumed, and affected items must be segregated and destroyed at the earliest opportunity.

1.7.9 No attempt should be made to decontaminate energetic materials as the decontaminating solutions will likely present a far greater spontaneous combustion hazard than CW agent. CW agent contamination may be immobilised with fuller’s earth, or covered in gas proof polythene to reduce the risk from CW agent off-gassing.

1.8 Storage, transportation and disposal of OME and associated packages that have been contaminated with CW agent

1.8.1 OME or associated packaging that has been contaminated with liquid CW agent should not be transported in a closed load carrying compartment or returned into a closed explosive store house (ESH). Where this is unavoidable management and safe entry procedures must be established.

1.8.2 OME or associated packaging that has been contaminated with liquid CW agent, and then decontaminated, should not be transported in a closed load carrying compartment or returned into a closed ESH until thorough decontamination can be proven. Where this is unavoidable management and safe entry procedures must be established.

1.8.3 The methods used for the destruction of CW agent contaminated OME or packaging need to be planned so that receptors, such as humans and animals, are not exposed (as would happen with uncontrolled, open burning); and no long term detrimental effect of the environment occurs. Destruction should only be carried out after consultation with the force Scientific Advisor (SCIAD). Where contaminated items cannot be immediately destroyed they are to be packaged in gas proof bags and segregated until disposal can be arranged.

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CHAPTER 11

ANNNEX E

APPENDIX 1

LIST OF CHEMICAL WARFARE AGENTS

Agent Group	**Agent**	**Code Letters**	**Persistency***
Lethal (Nerve)	Tabun	GA	Fairly P
	Sarin	GB	NP
	Soman	GD	NP or P
		VX	Very P
Lethal (Blood)	Hydrogen Cyanide	AC	NP
	Cyanogen Chloride	CK	NP
Lethal (Choking)	Phosgene	CG	NP
Damaging (Blister)	Sulphur Mustard	H or HD	P
	Mustard-T Mixture	HT	P
	Lewisite	L	P
	Nitrogen Mustard	HN	P
	Phosgene Oxime	CX	P
	Mustard Lewisite	HL	P
Incapacitating	Quinuclidinyl Benzilate	BZ	NP

*P = Persistent, NP = Non Persistent

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CHAPTER 11

ANNEX E

APPENDIX 2

DECONTAMINANTS – ALTERNATIVES IN EMERGENCY SITUATIONS

Decontaminant	Mixing	Agent	Remarks
Supertropical Bleach (STB)	50 / 50 mix with water	GA, GB, GD, VX, H, HN, HT, HL, L	Preferred option. Fire Hazard in contact with certain materials and CW agents. Extremely toxic. Add STB to water and **NOT** the reverse.
HTH – HTB (Calcium Hypochlorite)	10% HTH to water volume	GA, GB, GD, VX, H, HN, HT, HL, L	Add HTH-HTB to water and **NOT** the reverse.
Household Bleach (Sodium Hypochlorite)	Use Neat	GA, GB, GD, VX, H, HN, HT, HL, L	
Caustic Soda (Sodium Hydroxide)	10% Soda to water volume	GA, GB, VX, CG, AC, CK	Not preferred. Allow to cool before use. Do not use on wood.
Washing Soda (Sodium Carbonate)	10% Soda to water volume	GA, GB, GD, CX	
Caustic Soda in Alcohol	10% Soda to water volume then double the volume with Alcohol	BZ, GA, GB, GD, CX	Add Alcohol after Caustic Soda/water mix has cooled. Do not use on wood.
Hot Soapy Water		GA, GB,	To remove CW agent only.

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CHAPTER 11

ANNEX F

ROYAL ENGINEERS TECHNICAL REPORT

CONTENTS

1 EXPLOSIVES STORAGE FACILITIES IN SUPPORT OF OPERATIONS

1.1 Introduction

1.1.1 The Royal Engineers Technical Report is intended to highlight points to be considered for the construction of Explosives Facilities by RE in support to operations. In addition, it provides direction to the relevant publications and SMEs. DSA 03.OME Planning and Siting Considerations for explosives facilities.

1.1.2 Because of the scale of the earthworks involved in constructing the roads, hard-standings and traverses, it may well be quicker to employ specialist civil contractors to carry out all or some of the works under RE supervision. The ground conditions of the site selected will have a major impact on the level of construction and drainage works required. Where speed of construction is essential, it is recommended that the site with the best ground conditions be selected wherever possible.

1.2 **Requirements**

1.2.1 The aim of this report is to explore the technical aspects of designing and constructing explosives storage facilities to clarify areas of responsibility. The report deals principally with the areas of RE responsibility:

(1) Road and hard-standing construction.

(2) Traverse construction.

(3) Provision of emergency water supplies for fire fighting.

(4) Provision of lightning protection.

(5) Basic perimeter security.

2 **EXPLOSIVES STORAGE FACILITIES COMPONENTS**

2.1 **Introduction**

2.1.1 A typical explosives storage facility comprises of the following main components:

(1) **Roads and Hard-standings**. Roads and hard-standings would most likely have to be constructed to provide an access to and from the ESA, priorities would include the need for substantial junctions and bends/curves. A traffic circuit around the site will need to be established and prepared areas suitable for storing the munitions and supporting temporary structures. Considering the time frame for construction, these roads and hard-standings would probably be constructed from crushed stone laid and compacted with a basic surface drainage system. DSA 03.OMEdetails road considerations.

(2) **Traverses**. Traverses should to be designed to meet the requirements of the quantity and type of munitions deployed. DSA03.OMEPart 1 Chapter 7 details traverse classification and construction.

(3) **Storage/Process Buildings**. These buildings can be of a prefabricated nature, designed to be quickly erected on the site on a very basic surface. The buildings may be protected by traverses. Nationally approved structures such as the FOBUAS should also be considered.

(4) **Emergency Water Supply**. For fire fighting purposes, a suitable hydrant system or series of emergency water storage tanks may be provided.

(5) **Perimeter Security**. The explosives storage facilities may require a basic barbed-wire perimeter fence for security and this could be enhanced as required to meet any particular threat. This may also include the provision of defensive positions, a guard-house and controlled access points. JSP 440 details minimum security standards for storage of explosives.

(6) **Lightning Protection**. Depending on the nature and type of munitions to be stored and the likelihood of lightning strikes, it may be necessary to provide lightning protection.

(7) **Environmental Protection**. In certain environments, it may be

necessary to provide a degree of solar radiation protection to some or all of the storage facilities. This protection should be designed to meet specific theatre conditions. Climatic control may be required for some climatic zones and/or munitions.

2.2 **Site Selection Factors**

2.2.1 The following factors must be considered when selecting a site for explosives storage facilities:

(1) **Physical space**. Dependent on nature and quantity of munitions

(2) **Safety distances**. Distances from inhabited buildings, public travel routes and valued assets, e.g. Radars, MSRs, BFIs, etc.

(3) **Ground drainage conditions**. Low lying areas susceptible to flooding should be avoided. Ideally, a site without drainage problems requiring the minimum of drainage works should be selected.

(4) **Soil type**. Certain soil types are less suitable for construction. Where possible, the area with the best soil conditions should be selected as this will significantly reduce the engineering work required to produce roads and hard standings.

(5) **Water Source**. A large quantity of water may be needed for fire-Fighting purposes. Where possible, explosives storage facilities should therefore be sited close to a suitable water source (such as a lake or buried water main).

(6) **Access**. Consideration should be given to access requirements. Where possible, explosives storage facilities should have a least two points of access. On airfields, explosives storage facilities should be located with good access to the areas where the aircraft will be operated.

(7) **Security Considerations**. Where possible, the explosives storage facilities should be located within a protected area otherwise the perimeter security requirement will increase.

(8) **Force Protection**.

3 **AREAS OF RESPONSIBILITY**

3.1 **RE Responsibilities**

3.1.1 RE are responsible for the following:

(1) Road and hard-standing design and construction.

(2) Traverse construction.

(3) Emergency Water Storage facilities (if required).

(4) Lightning Protection System (LPS).

(5) Basic Perimeter Security.

(6) Electrical Installations.

(7) Lighting.

(8) Storage/Process Buildings.

(9) Maintenance.

(10) Testing – LPS and Electrical Installations

3.2 **IE Responsibilities**

3.2.1 The relevant IE is responsible for the following :

(1) Provision of the quantities of munitions to be stored.

(2) Determination of NEQs.

(3) Confirmation of safety or other distances for Licensing.

(4) Statement of Requirement and Technical Design approval.

3.3 **SATO/Deployed Armament Officer (DArmO) RAF Responsibilities**.

3.3.1 SATO, or the DArmO, is responsible for the general location and siting of Field Storage Areas, Field Storage Sites and Bomb Dumps.

3.4 **Safety Distances and Terms**

3.4.1 RE personnel involved in explosives storage facility construction/delivery require a basic understanding of the following safety distances and terms which are used in this Annex[1]:

(1) **Net Explosive Quantity (NEQ).** The total explosives content present in a munition or stack of munitions etc.

(2) **Hazard Divisions (HD).** A division of the UN Dangerous Goods Class 1 (explosives). Each munition is categorised according to the particular hazard, these categories are known as Hazard Divisions, brief definitions for the divisions for explosives are as follows:

(a) HD 1.1 - Mass Explosion Hazard.

(b) HD 1.2 - Projection Hazard.

(c) HD 1.3 - Fire and Radiant Heat Hazard.

(d) HD 1.4 – Moderate Fire Hazard.

(e) HD 1.5 – Mass Explosion Hazard, but so insensitive there is very little probability of initiation.

(f) HD 1.6 – Extremely insensitive articles that do not have a mass explosion hazard.

(3) **Potential Explosion Site (PES).** An open bay, stack, storehouse, etc, that contains, or is intended to contain munitions/explosives.

(4) **Exposed Site (ES)**. Any building, storehouse, road, etc, which is exposed to the effects of an explosion at a PES.

(5) **Inhabited Building Distance (IBD)**. IBD is the minimum permissible distance between a PES and any inhabited building or place of assembly. This distance is such that an explosive event at a PES will not cause severe structural damage to, or unduly hazard the occupants of, the inhabited building.

(6) **Inter-Magazine Distance (IMD)**. IMD is the distance between buildings or stacks containing explosives. This distance is intended to prevent the direct propagation of any explosive event from one building or stack to the next.

(7) Process Building Distance (PBD). PBD is the distance from a building or stack containing explosives to a Process Building, or from a Process Building to another Process Building which will provide a reasonable degree of immunity for the operatives within the Process building(s), and a high degree of protection against propagation of explosions.

(8) Public Traffic Route Distance (PTRD). PTRD is the minimum permissible distance between a PES and public traffic routes, which is such that an explosives event at a PES will not cause intolerable danger to occupants of vehicles. PTRD are variable and dependant on the volume of

[1] See also DSA 03.OME Preliminary Pages.

traffic.

4 ROADS AND HARD-STANDINGS

4.1 Roads

4.1.1 Roads will be required at explosives storage facilities to provide:

(1) Access and egress to/from the storage areas.

(2) A traffic circuit around the storage areas.

4.2 Hard-Standings

4.2.1 Hard-standings and Prepared Bases will be required:

(1) For loading/unloading of vehicles.

(2) Storage areas.

(3) Working areas in front of each storage area to allow traffic to pass whilst munitions are being handled.

(4) Marshalling Areas.

4.3 Road Design

4.3.1 Road design is to be in accordance with DIO documents related to Design of All Weather Roads.

5 DRAINAGE

5.1 The importance of drainage in explosives storage facilities construction and maintenance cannot be over-emphasised. Lack of attention to this important factor can slow down or even prevent the completion of construction and render work already carried out unusable. For explosives storage facilities to be effective, the access roads and hard standings must remain in a workable condition throughout all weather conditions, and this can only be achieved by good drainage. The drainage of all sites should be given careful consideration at the site selection stage. Some sites may require very little work whilst others may require a great deal of time, effort and materials to provide a suitably well drained site. A balance must be struck, taking into account all of the other factors to be considered in selecting a site.

6 TRAVERSES

6.1 Traverse design is to be in accordance with this document.

7 EMERGENCY WATER SUPPLY

7.1 There may be a requirement to provide an Emergency Water Supply (EWS) for firefighting purposes. Guidance on EWS can be found in this document, and by liaison with Defence Fire staff and ammunition technical staff.

8 OTHER CONSIDERATIONS

8.1 Electrical Installations and Equipment

8.1.1 Special considerations need to be applied when designing or installing electrical systems in buildings and areas that may be used for explosive processing or storage. Electrical installations in buildings or areas containing explosives are categorised according to the proposed usage of those areas. It is the responsibility of the user, on advice from the Inspector of Explosives to specify the required electrical category of any electrical installation or equipment for any explosives building, and to confirm that the required standards are obtained. These are detailed in Chapter 8.

8.2 **Lightning Protection Systems**

8.2.1 Where required, lightning protection systems (LPS) are an integral part of explosive buildings and storage areas installation. The principal components and basic layout of a range of LPS are defined in this document.

8.3 **LPS Standards and Publications**

8.3.1 The following publications are to be consulted prior to design, installation, refurbishment or testing of LPS/electrical installations in explosive storage facilities:

(1) BS 7671:1992 (as amended) – Requirements for Electrical Installations IEE Wiring Regulations 17th Edition.

(2) BS 62305:1999 – Code of Practice for Protection of Structures Against Lightning.

(3) ESTC Standard No 6 Part 1.

8.4 **Perimeter Security**

8.4.1 There is a requirement to provide basic perimeter fencing to explosives storage facilities both to demarcate the boundaries of the site and to offer some degree of security. The explosives storage facilities location and the particular threat will dictate the level of security required