



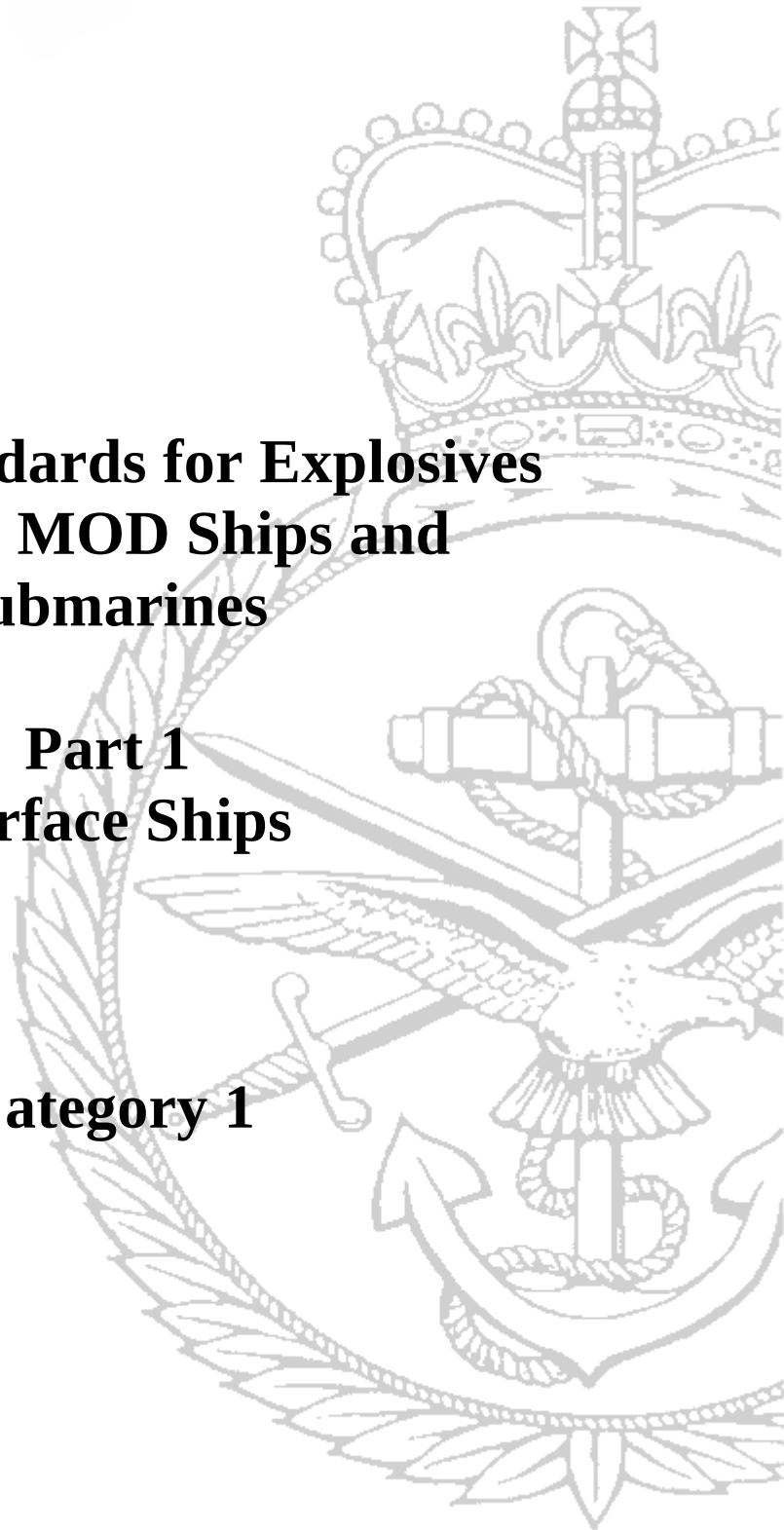
Ministry of Defence Defence Standard 00-101

Issue 2 Publication Date 27 June 2008

Design Standards for Explosives Safety in MOD Ships and Submarines

Part 1 Surface Ships

Category 1



AMENDMENT RECORD

Amd No	Date	Text Affected	Signature and Date

Revision Note

The previous magazine design standards have been protectively marked RESTRICTED, this standard is UNCLASSIFIED. Classified material associated with Response to ATtack on AMmunition (RATTAM) threat levels and mitigation techniques is published separately under classified (NAN) EXP/03 in support of this standard. This document is available from DSS NAExp; it currently is protectively marked RESTRICTED.

Historical Record

This standard supersedes the following:

Defence Standard 00-101 Part 1 Issue 1

(NAN) EXP/05

Defence Standard 08-101 Part 1

Naval Engineering Standard 183

PREFACE

Sponsorship

a. This Defence Standard (Def Stan) 00-101 is sponsored by the Directorate Sea Systems (DSS) Naval Authority Explosives (NAExp), Defence Equipment & Support (DE&S), Ministry of Defence (MOD).

b. The complete standard is titled: Design Standards for Explosives Safety in MOD Ships and Submarines, and comprises:

- Part 1: Surface Ships
- Part 2: Submarines
- Part 3: Electrical Equipment and Installation
- Part 4: Generic Naval Environment
- Part 5: Ship Weapon Dynamic Safety

c. If it is found to be unsuitable for any particular requirement the MOD is to be informed in writing of the circumstances.

d. Any user of this Defence Standard either within MOD or in industry may propose an amendment to it. Proposals for amendments that are not directly applicable to a particular contract are to be made to the publishing authority identified on Page ii, and those directly applicable to a particular contract are to be dealt with using contract procedures.

e. No alteration is to be made to this Defence Standard except by the issue of an authorized amendment.

f. Unless otherwise stated, reference in this Defence Standard to approval, approved, authorised or similar terms, means the MOD in writing.

g. Any significant amendments that may be made to this Defence Standard at a later date will be indicated by a vertical sideline. Deletions will be indicated by 000 appearing at the end of the line interval.

h. Extracts from British Standards within this Defence Standard have been included with the permission of the British Standards Institution.

Conditions of Release

i. This Defence Standard has been devised solely for the use of the MOD, and its contractors in the execution of contracts for the MOD. To the extent permitted by law, the Crown hereby excludes all liability whatsoever and howsoever arising (including but without limitation, liability resulting from negligence) for any loss or damage however caused when the Defence Standard is used for any other purpose.

j. This document is Crown Copyright and the information herein may be subject to Crown or third party rights. It is not to be released, reproduced or published without written permission of the MOD.

k. The Crown reserves the right to amend or modify the contents of this Defence Standard without consulting or informing any holder.

MOD Tender or Contract Process

l. This Defence Standard is the property of the Crown and unless otherwise authorised in writing by the MOD must be returned on completion of the contract or submission of the tender in connection with which it is issued.

m. When this Defence Standard is used in connection with a MOD tender or contract, the user is to ensure that he is in possession of the appropriate version of each document, including related documents, relevant to each particular tender or contract. Enquiries in this connection may be made of the Authority named in the tender or contract.

n. When Defence Standards are incorporated into contracts, users are responsible for their correct application and for complying with contractual and other statutory requirements. Compliance with a Defence Standard does not of itself confer immunity from legal obligations.

Categories of Defence Standard

o. The Category of this Defence Standard has been determined using the following criteria:

a) **Category 1.** If not applied may have a *Critical* affect on the following:

Safety of the vessel, its complement or third parties.

Operational performance of the vessel, its systems or equipment.

b) **Category 2.** If not applied may have a *Significant* affect on the following:

Safety of the vessel, its complement or third parties.

Operational performance of the vessel, its systems or equipment.

Through life costs and support.

c) **Category 3.** If not applied may have a *Minor* affect on the following:

MOD best practise and fleet commonality.

Corporate experience and knowledge.

Current support practise.

Related Documents

p. In the tender and procurement processes the related documents in each Section and Annex A can be obtained as follows:

a) British Standards British Standards Institution,
389 Chiswick High Road,
London, W4 4AL

b) Defence Standards UK Defence Standardization,
Kentigern House
65 Brown Street,
Glasgow, G2 8EX

c) Other documents Tender or Contract Sponsor to advise.

q. All applications to Ministry Establishments for related documents are to quote the relevant MOD Invitation to Tender or Contract Number and date, together with the sponsoring Directorate and the Tender or Contract Sponsor.

r. Prime Contractors are responsible for supplying their subcontractors with relevant documentation, including specifications, standards and drawings.

Health and Safety

Warning

s. This Defence Standard may call for the use of processes, substances and procedures that may be injurious to health if adequate precautions are not taken. It refers only too technical suitability and in no way absolves either the supplier or any user from statutory obligations relating to health and safety at any stage of manufacture or use. Where attention is drawn to hazards, those quoted may not necessarily be exhaustive.

t. This Defence Standard has been written and is to be used taking into account the policy stipulated in Joint Service Publication (JSP) 430: MOD Ship Safety Management System Handbook.

Additional Information

u. This standard provides mandatory Performance Requirements for the design, construction and ship fitting of MOD ships in respect of explosives safety issues arising from stowage, handling and use of explosives onboard. The Performance Requirements are supplemented by Approved Codes of Practice (ACOP) and Guidance, which provide design best practice and corporate knowledge and experience.

v. This standard has been produced by DSS Naval Authority Explosives, Defence Equipment & Support Agency, and Ministry of Defence. The Point of Contact for matters pertaining to the technical content of the standard is (DSS) NAExp, Ash 3c, #3311, MOD Abbey Wood, BRISTOL BS34 8JH.

w. This standard has been agreed by the authorities concerned with its use and is intended to be used whenever relevant in all future designs, contracts etc. and whenever practicable by amendment to those already in existence. If any difficulty arises which prevents application of the Standard, the sponsor shall be informed so that a remedy may be sought.

x. Any enquiries regarding this standard in relation to an invitation to tender or a contract in which it is incorporated are to be addressed to the responsible Platform Duty Holder (PDH), normally the Platform Integrated Project Team (IPT), named in the invitation to tender or contract.

y. Compliance with this Standard shall not in itself relieve any person from any legal obligations imposed upon them.

z. This standard has been devised solely for the use of the MOD and its contractors in the execution of contracts for the MOD. To the extent permitted by law, the MOD hereby excludes all liability whatsoever and howsoever arising (including, but without limitation, liability resulting from negligence) for any loss or damage however caused when the standard is used for any other purpose.

aa. The mandatory requirements and associated guidance in this Standard are intended to meet the policy of the Secretary of State for Defence to put in place regulations that are at least as good as civil requirements, so far as is reasonably practicable, where MOD has exemption from civil legislation. Use of this Standard in maritime platform acquisition programmes is also intended to contribute towards optimisation of capability.

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DESIGN STANDARDS FOR EXPLOSIVES SAFETY IN MOD SHIPS AND SUBMARINES - STANDARDS FOR DEFENCE –

PART 1: SURFACE SHIPS

0. INTRODUCTION

0.1. Defence Standard 00-101 is authorised by the Naval Authority (Explosives) by delegated authority from Controller of the Navy and Chairman of the Ship Safety Board on behalf of the MOD Ship Safety Board, and its use is a mandatory requirement of JSP 430 Part 3, Naval Authority Regulations (NAR) Chapter 8 (Explosives).

0.2. The aim of this Standard is to provide requirements and guidance to assist in providing an acceptably safe integration of Ordnance, Munitions Explosives (OME) into MOD ships and takes precedence over Lloyds Naval Ship rules in regard to design guidance for magazines.

0.3. This Standard has been issued to identify the mandatory Performance Requirements for the design, construction and ship fitting of all JSP 430 applied ships in respect to safety issues arising from stowage, handling and use of explosives. It incorporates the best practice contained in previous magazine standards Naval Engineering Standard (NES) 183 and Def Stan 08-101 but is written to both support the risk based SMS introduced by JSP 430 Pt 3 Chapter 8 (Naval Authority Regulations) and allows prescriptive design features to continue under specified Approved Codes of Practice or Guidance.

0.4. Individual appendices cover specific topics and provide Descriptions, Performance Requirements, Approved Codes of Practice (ACOP) and Guidance for each. This Standard is a component of the Safety Management System process mandated by Naval Authority Regulations Chapter 8 (Explosives) (NAR Ch 8) which defines how Ordnance Munitions and Explosives (OME) should be integrated and used safely in ships. It is essential that Def Stan 00-101 is read in conjunction with Naval Authority Regulations Chapter 8 (Explosives). In addition, Maritime Acquisition Publication (MAP) 01-103, Ship Explosives Safety Case (SESC) – Guidance for Platform Duty Holders, Part 1 provides further guidance on the process for developing a SESC.

0.5. This Standard is to be specified in the User Requirements Documentation and System Requirements for all MOD Ships that embark munitions. Def Stan 00-101 is authorised by the Naval Authority Explosives and its use is a mandatory requirement of the Naval Authority Regulations, Chapter 8 (Explosives).

0.6 The user of this standard is directed to ANNEX C which should be read early in the use of this standard to ensure that the terminology is understood and to avoid misinterpretation.

1. SCOPE

1.1. The MOD Ships to which this standard applies are defined in JSP 430 and JSP 430 Part 3 Naval Authority Regulations, Chapter 8 (Explosives). These include HM Ships and Submarines, Royal Fleet Auxiliaries (RFA), Marine Services, other ships owned by MOD, Government Owned Contractor Operated (GOCO) vessels (where these are owned by MOD), and ships on MOD charter. The term “ship” is intended to include vessels, launches, tenders, lighters and any other craft carrying any explosives. The Naval Authority may determine that a specific platform is not required to comply where no hazard exists but does not issue exemption certificates.

1.2. This Standard applies to the design, construction and ship fitting of all MOD Ships built to MOD or Classification Society constructional standards and operated by the Royal Navy, Army (including Special Forces), Royal Air Force, RFA or Marine Services. The standard also applies to Marine Services vessels supplied as Government Furnished Equipment for contract operations and MOD authorised modifications undertaken to charter vessels.

1.3. It is to be applied to contracts that specify requirements that have any effect upon the explosives safety of the platform. This will include the magazines, adjacent compartments and ammunition routes and handling equipment within MOD ships in which explosives will be embarked, moved, stowed and used. It is also to be applied to all Refits and Repair work affecting any of these including Alterations and Additions and Modifications. It may also include other design issues throughout the platform that impact on explosives safety.

1.4. The complete standard is titled: Design Standards for Explosives Safety in MOD Ships and Submarines, and comprises:

Part 1 – Surface Ships

Part 2 – Submarines

Part 3 – Electrical Equipment and Installation

Part 4 – Generic Naval Environment

Part 5 – Ship Weapon Dynamic Safety

1.5. Classified material associated with threat levels, protection and mitigation techniques is published separately under classified (NAN) EXP/03 in support of this standard. This document is available from DSS NAExp; it is currently protectively marked RESTRICTED.

1.6. This standard has been written primarily to support the risk based shipborne explosives Safety Management System (SMS) introduced by JSP 430 Part 3 NAR Chapter 8 Explosives. Where legacy vessels have been certificated under previous transition procedures, it is not necessary to implement additional work to meet this standard, unless major modifications are undertaken or a new munition added to a magazine or weapon system. Then this Defence Standard must be implemented.

1.7. Supplementary information, information requiring a higher protective marking and temporary instructions will be issued in the form of Naval Authority Notices ((NAN)). (NAN) s relating to explosives safety in MOD ships and submarines are available from Naval Authority System Library website (www.nakmo.co.uk) or the Sponsor of this Standard.

1.8. Regulations governing the safe stowage and handling of explosives in Magazines in RFAs are covered in JSP 862 Chapter 13. Regulations covering the safe stowage and handling of explosives in Charter shipping are included in the IMDG Regulations.

2. WARNING

2.1. The Ministry of Defence (MOD), like its contractors, is subject to both United Kingdom and European laws regarding Health and Safety at Work. All MOD Standards either directly or indirectly invoke the use of processes and procedures that could be injurious to health if adequate precautions are not taken. MoD Standards or their use in no way absolves users from complying with statutory and legal requirements relating to Health and Safety at Work.

2.2. This is a mandatory Category 1 Standard. If not applied it may have a Critical affect on the following:

- a) Safety of the ship, its complement or third parties.
- b) Operational performance of the ship, its systems or equipment.
- c) Through life costs and support.

2.3. If the Platform Duty Holder (PDH) proposes not to apply this mandatory Category 1 Standard, agreement must be obtained from Naval Authority Explosives and the relevant Director of Equipment Capability (DEC). Details of any such agreement is to be formally recorded in the Safety Case. In the event of a MOD enquiry or any prosecution under Health and Safety legislation, if it is proved that the relevant requirements were not followed, the PDH will need to show that he has complied with the Naval Authority Regulations in some other way or an enquiry or court may find him at fault.

2.4. In this standard, Performance Requirements are mandatory (Category 1) requirements. Additionally clauses including the words "shall", "must", "is to", "are to" also are mandatory.

2.5. This standard contains Approved Code of Practice (ACOP), which has been approved by the Naval Authority (Explosives) as good practice. It gives practical advice that may be used to assist in complying with this standard. Alternative methods to those set out in the ACOP may be used providing they are justified in the Ship Explosive Safety Case (SESC).

2.6. This standard also contains other, more general Guidance. This guidance reflects corporate knowledge and experience and is issued by the Naval Authority Explosives to assist duty holders' understanding of the subject area. It may not be exhaustive and all users are recommended to contact DSS NAExp for the latest information.

3. RELATED DOCUMENTS

3.1. The publications listed in Annex A are referred to in the text of this standard.

3.2. Reference in this standard to any related document means that in any invitation to tender or contract the edition and all amendments current at the date of such tender or contract apply unless a specific edition is indicated.

3.3. In consideration of 3.2 above, users shall be fully aware of the issue and amendment status of all related documents, particularly when forming part of an invitation to tender or contract. Responsibility for the correct application of standards rests with users.

3.4. The Directorate of Standardisation (DStan) can advise where related documents are obtained. Requests for such information can be made to the DStan Helpdesk.

4. DEFINITIONS AND ABBREVIATIONS

4.1. For the purpose of this standard the abbreviations and definitions listed in Annex B and Annex C apply. The user of this standard is directed to Annex C that should be read early in the use of this standard to ensure that the terminology is understood and to avoid misinterpretation.

5. AMENDMENT

5.1. If this Standard is found to be unsuitable for any particular requirement, the sponsor is to be informed in writing with a copy to DSS NAExp, Ash 3c #3311, MOD Abbey Wood, BRISTOL BS34 8JH.

5.2. Any user of this Standard either within MOD or in industry may propose an amendment to it. Proposals for amendments that are not directly applicable to a particular contract are to be made to the MOD and those directly applicable to a particular contract are to be dealt with using existing procedures or as specified in the contract.

5.3. No alteration is to be made to this Standard except by the issue of an authorised amendment. Amendments, supplementary information and temporary instructions will be issued in the form of Naval Authority Notices (NAN) by DSS NAExp.

5.4. Unless otherwise stated, reference in this Standard to approval, approved, authorised or similar terms, means by the Ministry of Defence in writing.

6. SPONSORSHIP OF THE REQUIREMENT AND SECURITY

6.1. JSP 430 introduces the concept of Key Hazard Safety Management by MOD Platform Duty Holders (PDH) who are normally the associated Platform Integrated Project Team Leaders (PIPTL). JSP 430 defines a Key Hazard to represent a significant danger to the lives of several persons and whose consequence may cause the loss of the ship or significant damage to the environment. JSP 430 mandates the Regulation of these key hazards by an independent assurance body and for explosives the Naval Authority Explosives (NAExp) in DSS undertakes this role, with delegated authority from the Ships Safety Board. DSS NAExp sponsors this Category 1 mandatory Standard. It is approved by the Naval Authority Explosives Advisory Committee (NAEAC).

6.2. Throughout this document the following convention is used when referring to the Regulatory body or its incumbents. NAExp relates generically to Naval Authority Explosives and its policies, DSS NAExp relates to the Secretariat.

6.3. NAExp has published a suite of documents relating to the use of this Standard, that comprise JSP430 Part 3, Naval Authority Regulations Chapter 8 – Explosives, JSP 862 – MoD Maritime Explosives Regulations (Operator Requirements) and Maritime Acquisition Publication (MAP) 01-103, Ship Explosives Safety Case (SESC) – Guidance For Platform Duty Holders, Part 1. They will be referenced in the Acquisition Management System (AMS) and are available via the Naval Authority System Library website at www.nakmo.co.uk.

7. STATUTORY LEGISLATION AND MOD REGULATION FOR PLATFORM EXPLOSIVE SAFETY

7.1. This standard is authorised by the Naval Authority (Explosives) by delegated authority from Controller of the Navy and Chairman of the Ship Safety Board on behalf of the MOD Ship Safety Board, and its use is a mandatory requirement of JSP 430 Part 3, Naval Authority Regulations (NAR) Chapter 8 (Explosives).

7.2. Various International, European and National legislation exists that is applicable to 'explosives'. European legislation is enacted into UK legislation by Statutory Instruments bringing into force 'Regulations' made under an Act of Parliament. There are several Acts of Parliament in place under which specific legislation is made for the control of the manufacture, storage and use of 'explosives', e.g. The Explosives Act; The Health and Safety at Work etc Act 1974; The Merchant Shipping Act and the Manufacture and Storage of Explosives Regulations (MSER 2005).

7.3. The National regulations may exempt defined groups and personnel from compliance with them in whole or in part. In terms of MOD these exemptions are identified in varying ways throughout statutory legislation, e.g. 'ships', 'master and crew', 'British warships', 'military' and 'armed forces'. However, the Secretary of State for Defence states: "... where MOD has been granted exemption from specific regulations, health and safety standards and arrangements will be, as far as reasonably practicable, at least as good as those required by statute.". In the case of this National legislation the Secretary of State for Defence may invoke at any time the exemptions given in the legislation when there is a National need. These exemptions are explained fully in JSP 375 and JSP 430.

7.4. The Merchant Shipping Act (MSA) 1995 sets out arrangements for registration of ships, safety, health, welfare and discipline of crews, and safety of ships. Section 308 of the Act exempts Her Majesty's ships from the Act, and makes provision for MOD ships to be registered by Order in Council, subject to exceptions and modifications as required. Orders in Council, and the policy statements of the Secretary of State for Defence, have established MOD control and regulation of manufacture, conveyance, storage and use of explosives to standards equal to or more stringent than the provisions of the Explosives Act.

7.5. The Health and Safety at Work etc Act (HSWA) 1974 makes every employer, so far as reasonably practicable, responsible for the health, safety and welfare of all their employees and other persons affected by the “work”. A statutory duty exists under the Health and Safety at Work etc. Act 1974 to assess all hazards and reduce risks to ALARP. However, achievement of compliance with this defence standard for a platform does not necessarily constitute achievement of an ALARP risk state; likewise, this standard is not a “Safety Target”. Activities in ships outside the 12 mile limit and by the Master and crew are exempt from this Act, but subject to the Merchant Shipping Act (see 7.4 above). The effect on MOD of the HSWA is fully explained in JSP 375 Chapter 7. For all MOD Ships, the way the HSWA, and subordinate regulations and guidance, is applied is through the provisions of JSP 430, also from which safety targets are set.

7.6. The Health and Safety at Work etc Act (HSWA) 1974 also confers duties (section 6) on every person who designs, manufactures, imports or supplies any article for use at work. The HSWA should be consulted for the exact extent of these duties.

7.7. The International Maritime Dangerous Goods (IMDG) Code. The IMDG Code applies to cargo ships and provides detailed guidance on the transportation of all materials and substances identified under Dangerous Goods Class 1 (explosives) to Class 9. This includes ship design requirements, safety management, reporting, stowage and packaging of dangerous goods. The provisions of JSP 430 meet the requirements for safety management in MOD ships.

7.8. The regulations in Naval Authority Regulations, JSP 430, Part 3, Chapter 8, Explosives and JSP 862 (MOD Maritime Explosives Regulations (MMERs)) include the directives of the Secretary of State for the conveyance (other than as freight), stowage, handling and use of explosives in HM Ships, Submarines, RFA, Marine Services Vessels, and Charter Ships. In all other respects, the regulations in NAR Chapter 8 (Explosives) and MMERs are intended to conform to the requirements of the HSWA and Statutory Instruments and Regulations made under that Act so far as they apply to the Naval Service and its support agencies and organisations in accordance with JSP 375.

7.9. All Unregistered MOD Ships and submarines are mandated to adhere to NAR Chapter 8 (Explosives)

7.10. All MOD ships that are also registered, or registered under Orders in Council, shall adhere, as a minimum, to Maritime and Coastguard Agency regulations for Safety of Life At Sea (SOLAS). Warships and larger RFAs are provided with additional SOLAS stores in excess of SOLAS requirements and shall adhere to MMERs for carriage, handling and use of SOLAS.

7.11. RFA vessels registered under Orders in Council shall adhere to NAR Chapter 8 (Explosives). NAR Chapter 8 requires the design of magazines to be in accordance with this Standard. Specific exceptions for RFA vessels to the requirements in this standard are stated where appropriate.

7.12. In RFAs and other vessels not manned by Royal Navy (RN) personnel the carriage of packaged explosive stores in bulk, as cargo, for purposes other than own use is to be in accordance with JSP 862 Chapter 13.

7.13. In Charter ships, where MOD authorized modifications have been undertaken for the purposes of carrying and/or handling and using munitions, NAR Chapter 8 and MMERs will apply and an RN or other MOD Officer will be present to be responsible for explosives safety. Carriage of explosive stores in bulk may be in accordance with the IMDG Code, where appropriate. Existing SOLAS stores in Charter vessels will continue to be governed by MCA regulations.

7.14. All existing statutory provisions continue in force until they are amended, repealed or replaced by new legislative provisions. MOD explosives regulation through such documentation as NAR Chapter 8, Def Stan 00-101 and MAP 01-103, only being periodically updated, will not remain concurrent with relevant aspects of statutory legislation. Therefore, it is essential that reviews are conducted at the outset and during the execution of platform design and throughout platform life as a part of the production and subsequent through life review of the SESC. Further information may be obtained from the SSMO Handbook of Maritime Safety Legislation and Regulation (source www.nakmo.co.uk).

8. INTRODUCTION TO PLATFORM EXPLOSIVES SAFETY AND CERTIFICATION

Background

8.1. Platform explosives safety has historically been achieved by following prescriptive rules and standards set by the Naval Magazine Safety Committee (NMSC), now Naval Authority Explosives (NAExp). Safety efforts were targeted at preventing explosives initiation, as it was accepted that there was little that could be done to manage the consequences of an explosive event.

8.2. MOD inclusion in the Health and Safety at Work Etc. (HSAW) Act 1974 and the Secretary of State's statement led to the publication in 1996 of JSP 430 for MOD Ship Safety Management. This introduced the requirement for ship safety cases within which there would be independent regulation of Key Hazards by MOD Naval Authorities. Safety Cases are generally risk based but JSP 430 part 2, issue 3 states "...however prescription can still be useful in certain contexts."

Platform Explosives Safety Management Drivers

8.3. In line with civil statutory authorities the MOD recognised that the fully prescriptive regimes within which explosives hazards were regulated was inappropriate and a change to risk based regulation was made.

8.4. This risk-based approach requires a ship explosives safety case to be produced which demonstrates that the risks posed by explosives on a platform are acceptable. The major aspects of the safety risk that must be considered are:

- a. Operational Loss of Platform
- b. Crew Risk
- c. Societal Risk
- d. Environmental Risk

8.5. Explosives embarked onboard a ship clearly present hazards to the safety of the ship, personnel and the environment. To meet the safety requirements of JSP 430 these hazards must have their risks reduced to levels that are tolerable and ALARP. This means all measures necessary should be adopted to reduce the risk of an incident unless the cost of doing so (in money, time or effort) is shown to be grossly disproportionate to the reduction in risk achieved (further information is presented in JSP 430). The management of explosives safety onboard JSP 430 applied platforms is described in JSP 430 Part 3, Chapter 8. The inherent safety of the OME is defined by the requirements of JSP 520.

Platform Explosives Safety Management Process

8.6. The foundation of the platform explosives safety management process within MOD, for the maritime environment, is the requirement for a Certificate of Safety Explosives (CSE) to be in place before embarking, handling, stowing and using explosives onboard JSP 430 applied platforms.

8.7. The existence of a CSE provides assurance that, for the named platform, the PDH has demonstrated through a safety case that hazards from explosives approved for embarkation, are tolerable and ALARP. For those legacy platforms certified under the requirements based on compliance with prescriptive standards the evidence remains extant.

8.8. Platform explosives safety is achieved through a coherent partnership between design, material state and operator procedures. The PDH is responsible for achieving this coherence and demonstrating it through a risk based safety case, in accordance with JSP 430. However, the safe integration of explosives into a maritime platform can only be achieved after the inherent explosives safety performance and characteristics of the OME have been established through the JSP 520 process.

8.9. Full details of the process for obtaining a Certificate of Safety Explosives are contained within JSP 430 Part 3 Chapter 8. Additional guidance on the process of producing a Ship Explosive Safety Case (SESC) can be found in MAP 01-103 which also provides details of the preferred methodology on how to conduct a Ship Explosive Threat Hazard Assessment (SETHA).

9. DESIGN FOR PLATFORM EXPLOSIVES SAFETY

9.1. The design of the platform is vital to ensuring that the risks from explosives are Tolerable and ALARP. This Defence Standard provides Performance Requirements, Approved Codes of Practice and Guidance for the stowage and handling of explosives. Guidance for explosive safety management and assessment is provided in Maritime Acquisition Publication (MAP) 01-103, Ship Explosives Safety Case (SESC) – Guidance For Platform Duty Holders, Part 1, Edition 1 supporting NAR Chapter 8 by providing fully detailed guidance on practises and methodologies that have been used previously to good effect and how they should be used during the development of a ship explosives safety case. This includes topics such as:

- a. SESC Interfaces, Scope and Planning
- b. Regulatory Standards and Tolerability Principles
- c. Ship Explosive Threat Hazard Assessment (SETHA)
- d. Lines of Defence (LOD)
- e. Dynamic Safety

APPENDIX 1 INTEGRATING ORDNANCE MUNITIONS EXPLOSIVES INTO MOD SHIPS

1.1 Description

1.1.1 This appendix sets out the Performance Requirements, Approved Code of Practice (ACOP) and Guidance that relate to explosive munitions/stores in magazines, and explosives areas in MOD ships. Refer to Chapter 2 “Warning” for the method of identification of mandatory requirement clauses.

1.1.2 The Performance Requirements, ACOP and Guidance below will assist platform duty holders when integrating OME into the platform, in achieving an optimised design for the magazines and associated area within a ship that addresses the hazards produced from credible threats in order to reduce the probability of an explosive event and potential consequences to ALARP and tolerable levels

1.1.3 Definitions of Magazine, Small Magazine, Magazine Locker, RU Magazines, are given at ANNEX C. The term magazine is intended to apply to both Magazines and Small Magazines throughout this standard except where otherwise indicated.

1.1.4 The Performance Requirements, ACOP and Guidance associated with specific detailed explosives safety topics are covered in subsequent appendices.

1.2 Performance Requirement – Generic Design and Constructional Principles in MOD ships.

1.2.1 Magazines shall be designed, constructed and maintained throughout the life of the ship to stow and handle the designated outfit of explosive stores within the environment specified in Part 4 of Def Stan 00-101 - Generic Naval Environment, as far as is reasonable practicable, and justified in the Ship Explosive Safety Case (SESC). Further guidance is given in Part 1 and Part 4 of this standard.

1.2.2 Magazines shall have adequate capacity and space to permit safe stowage and handling of all of the explosive stores specified in the Armament Statement/Requirements document. Arrangements are to be justified in the SESC.

1.2.3 Magazines shall be designed to provide segregation for munitions of incompatible UN Compatibility Groups, or Ship Cats (where utilised) as set out in JSP 862. Inability to meet this requirement shall be fully justified in the SESC.

1.2.4 Magazine, Designated Danger Areas (DDA) and adjacent compartment designs must meet the requirements of the onboard explosives safety management system and safe systems of work specified in JSP 862, and are to be justified in the SESC.

1.2.5 Magazine, DDA and adjacent compartment designs must also meet the requirements of other Safety and Environmental Management Systems (SEMS) and Key Hazard requirements as appropriate, and are to be justified in the SESC. The duty holder shall take measures to ensure all relevant requirements are satisfied.

1.3 ACOP - Safety and Environmental Management Systems (SEMS)

1.3.1 JSP 862 is the onboard document that specifies the explosives safety management system (SMS) to be followed by the ship's company. To ensure consistency of procedures, safe systems of work and training needs across the Fleet and to avoid differences in training needs, all magazine, Designated Danger Area and adjacent compartment designs should be consistent with the operating instructions in JSP 862.

1.3.2 JSP 430 specifies other key hazards that are regulated by Naval Authorities and that require certification (e.g. Fire Certification). The design of magazines, Designated Danger Areas and adjacent compartments should also meet these key hazard requirements and other appropriate SEMS that may specify design requirements for implementation in all ship compartments. Typical examples are Nuclear Biological and Chemical Defence (NBCD) requirements and ship structural, insulation, ventilation, electrical and lighting requirements. This standard identifies where specific requirements unique to explosives safety apply, but specifies that otherwise the general requirements appropriate to a compartment of that type, in a ship of that type, apply.

1.4 ACOP for Stowage of Explosives by UN Hazard Classification Code

1.4.1 The UN Hazard Division (HD) and Compatibility Groups (CG) of explosive stores/munitions are shown in JSP 862, these together forms the Hazard Classification Code (HCC); JSP 862 also shows the requirements for separation by Compatibility Group. Ships are to be fitted out with magazines designed to stow munitions by UN HCC. Where it is practicable to take action retrospectively to separate incompatible groups by repositioning stores this should be undertaken.

1.4.2 Both UN Compatibility Group G and Compatibility Group H stores in general produce large volumes of smoke and intense heat when initiated or in response to initiation events. Such smoke is usually toxic in large quantities in confined spaces and so should not be permitted to spread below decks. Placing magazines containing such stores with access to the upper deck permits easier and safer smoke control and clearance.

1.5 ACOP for Basic Principles of Capacity, Size and Bulk Explosives

1.5.1 The Armament Statement (AS) forms a part of the User Requirements Documentation (URD) and is managed by the PDH. An Entitlement list that encompasses the User requirements will replace the AS shortly and it is likely that requirement change will occur in detail to the Armament Statement during the design and manufacture phase and throughout the in-service period of the platform. The designed capacity of magazines and small magazines should be sufficient to stow the munitions designated in the Armament Statement/Entitlement list and should have some flexibility to accommodate changes through life, as justified in the SESC.

1.5.2 Adequate space and facilities should be provided in the magazines for safe handling of munitions in the magazine, any routine maintenance (e.g. desiccant check) and weapon preparation and test activities. Space should also be allowed for routine maintenance checks of the magazine structure and fittings, and is to be justified in the SESC. The provisions of Def Stan 00-25 should be applied for all Human Factor (HF) aspects associated with the design and use of the magazine.

1.5.3 RFAs shall carry all Class 1 Dangerous Goods explosive stores in accordance with the regulations in JSP 862. Classes 2 to 9 are to be carried by RFAs in accordance with the IMDG code. There may be MOD inspection and storekeeping requirements to access compartments which would not be permitted under the IMDG Code segregation and separation regulations. NOTE: RFA Armament Holds are now referred to as magazines. Refer to JSP 862 Chapter 13 for the requirements for stowage of bulk explosives.

1.5.4 In the case of bulk explosives, the potential consequences from credible explosives events to personnel and operation capability may be catastrophic. It is therefore best practise to locate large magazines containing bulk explosives by at least 6 metres away from High Value compartments and those containing large numbers of personnel (Appendix 3.3). In addition Fire Barrier Insulation (FBI) to A60 bulkhead standard should be fitted. An A60 bulkhead is able to prevent the passage of smoke or fire of a standard test fire for at least one hour. Guidance on FBI is given in Def Stan 07-204 and SOLAS Regulations.

1.6 ACOP for Ready Use Magazines

1.6.1 If reload times for weapon systems cannot be met from the munitions permanent stowage then Ready-Use (RU) Magazines or RU lockers should be provided for temporary stowage of munitions close to the point of use. These RU Magazines should be sited and have adequate capacity to meet weapon reload times, and are to be justified in the SESC. RU Magazines are defined at Annex C.

1.6.2 The capacity in RU Magazines should be additional to the requirements of the Armament Statement/ Entitlement list; actual arrangements are to be justified in the SESC.

1.7 ACOP for Small Quantity Top Up (SQTU) Magazines

1.7.1 Small Quantity Top Up (SQTU) Magazines should be located close to Replenishment in Harbour (RIH) dump areas. This provision is to stow explosive stores/munitions replenished alongside, which cannot be struck-down immediately after embarkation due to the safety restrictions placed on moving munitions whilst alongside. Suitably positioned RU magazine/RU magazine lockers may be used for this purpose. SQTU magazines are defined in Annex C.

1.7.2 The permitted quantity and the compatibility of the explosive stores/munitions shall be taken into account when SQTU magazines are considered, and shall be justified in the SESC. Guidance on the requirements and quantities of SQTU munitions that may be embarked/disembarked is given in JSP 862.

1.8 Guidance - Stowage of Explosives by UN Hazard Classification Code

1.8.1 All packaged explosive stores are allocated a Hazard Classification Code (HCC), however when in the unpackaged state a different HCC may apply that is most likely to be of a higher division, e.g. a Packaged store classified as HD1.2 may show 1.1 tendencies in the unpackaged condition and will be classified HD 1.1 accordingly.

1.8.2 Stowage by Compatibility Group may sometimes be impossible or unworkable in which case the Platform and OME Protection Strategy should justify optimum arrangements applying professional technical judgement. Advice on technical judgements should be sought from DSS NAExp and Subject Matter Experts (SME).

1.8.3 The UN Compatibility Group designation of munitions provides a guide to the potential response to credible initiating event. Separation of incompatible munitions reduces the potential hazard arising from the different responses to initiation events. Further guidance is given below and in JSP 862 Chapter 5 Annex B.

1.9 Guidance - Basic Principles of Capacity, Size and Bulk Explosives

1.9.1 Consideration should also be given to separation between bulk explosives and high value compartments where damage may have a catastrophic effect on operational capability applying vulnerability reduction techniques.

1.9.2 Bulk explosives should be separated from:

- a, Key life saving appliances/area (e.g. marine evacuation points and boats used for lifesaving).
- b, All key 'float' functions (e.g. shaft line, steering gear/rudder, at least one main engine and key auxiliaries /pumps, generators/emergency power, controls and bridge).
- c, Sleeping accommodation, mess decks, living quarters.

d, Operational spaces manned by large numbers of personnel.

1.10 Guidance - Basic Principles for Environmental Hazards

1.10.1 Environmental hazards from the initiation of munitions are generally of short duration apart from the presence of residual toxic materials and metals that must be disposed of through a managed 'clean-up' plan.

1.10.2 In particular, many pyrotechnic / smoke stores produce smoke that is toxic in large concentrations in confined spaces. The Environmental Impact Assessment (EIA) or Control of Substances Hazardous to Health (COSHH) statement within the munition safety case or the Ship Explosive Safety Instruction (SEXSSI) should identify any specific hazards that may need to be considered.

1.10.3 White phosphorus (WP) will combust spontaneously if exposed to air and is classified as a UN Compatibility Group H stores. The risk may be reduced by stowing all WP stores in a magazine or locker within a movable container that can be flooded to a level above the height of the store and its packaging and contained until removed / disposed of. Further guidance including required ventilation for WP stowage is given in Appendix 4.7.6 and 4.17.5.

1.10.4 A number of munitions also contain fuels or batteries that may present an environmental and/or health hazard if the munition skin is breached. These hazards are also described in the munition safety case and SEXSSI.

APPENDIX 2 DESIGNATED DANGER AREAS (DDA)

2.1 Description

2.1.1 Designated Danger Areas (DDAs) are compartments and spaces not fitted out specifically for the stowage of explosive stores/munitions, but in which there is likely to be an increased hazard to ship safety due to their temporary presence. Examples are given at Appendix 2.3.1 below.

2.1.2 Explosives, when present in a ship, are either: in a magazine, small magazine, magazine locker, a weapon system, other launch or ready-use position, or else by definition in a DDA.

2.2 Performance Requirements for DDAs

2.2.1 Appropriate measures are to be taken to reduce risks from munitions to ALARP in DDAs in MOD ships.

2.2.2 The measures taken are to be detailed in the magazine and ammunition handling route designs. Design safety justification for the measures is to be detailed in the DDD. Guidance on appropriate measures and examples of DDAs are given below. The main measures should be justified in the Safety assessment in the SESC.

2.2.3 DDAs must meet the explosive SMS and safe systems of work (SSOW) requirements of JSP 862 and also the requirements of other SEMS and Key Hazard areas as appropriate. The duty holder shall take measures to ensure all relevant requirements are satisfied. See Guidance in Appendix 1.3.

2.2.4 The requirements, best practise and guidance associated with more general explosives safety topics are detailed under specific paragraph headings (see contents). Examples include fire fighting, munitions protection and venting etc. These must be considered in relation to DDAs, addressed in the DDD and justified in the SESC as appropriate.

2.3 ACOP for DDAs (General)

2.3.1 The following spaces are typical DDAs, the list is not exhaustive:

- a) Weapon hoists/trunks.
- b) Weapon lifts.
- c) Areas around gunhouses/turrets/mountings.
- d) Areas around upperdeck weapon launch positions.
- e) Upperdeck weapon and vehicle parks.
- f) Package Examination Room (PER).

- g) Areas for testing, assembling, unpacking, preparing explosive stores/munitions (outside of magazines).
- h) Specific to type weapon facilities as defined in the SRD (e.g. RCMDs hangars).
- i) Ammunition/Weapon Transfer Spaces within a hold/magazine complex.
- j) Clearways
- k) LCVP recesses/sponsons and any sponson housing an armed boat.
- l) Ammunition routes

2.3.2 Other areas such as aircraft/helicopter hangars, vehicle decks, Landing Craft Utility (LCU) cargo deck and Landing Platform Dock (LPD) / Landing Ship Dock (LSD (A)) dock areas are classified as 'Dangerous Areas'. 'Dangerous Areas' are normally accepted as safe for the temporary presence of munitions when these areas meet fully the requirements of BR 1754 – 'Safety Regulations for Storing and Handling Petroleum, Oils and Lubricants and certain other hazardous stores in HM Ships'. The BR 1754 requirements that the ammunition routes rely on to achieve ALARP explosives safety levels shall be summarised in the SESC. Guidance on the requirements of BR1754 may be obtained from its sponsor, DES MPPS SFG216 or DSS NAExp.

2.4 ACOP for Electrical and Fire Fighting Requirements in DDAs

2.4.1 All internal DDAs are to be fitted out electrically in accordance with Def Stan 00-101 Part 3.

2.4.2 DDAs are to meet the fire fighting and fire prevention arrangements set out in this standard.

2.4.3 The following DDAs in particular must be fitted with smoke and heat detectors:

- a. Weapon hoists/trunks that can be entered by personnel.
- b. Weapon lifts.
- c. PERs.
- d. Specific to type weapon facilities as defined in the SRD (e.g. RCMDs hangars).
- e. Weapon transfer and preparation spaces.
- f. Clearways.

2.5 ACOP for Package Examination Room (PER)

2.5.1 The arrangements for PERs shall be assessed and justified in the SESC.

2.5.2 PERs should also comply with the following regulations as described in this standard:

- a. Adjacent Compartment (Appendix 3).
- b. General construction requirements including Preservation and Painting (Appendix 4).
- c. Fire-fighting arrangements (Appendix 8).
- d. Anti-Flash protection (Appendix 13).
- e. Security/Anti-sabotage (Appendix 14).

2.6 ACOP for Marking of Areas around Weapon Systems

2.6.1 The swept arc and/or physical danger area around mountings, launchers, containers, weapon lifts etc should be marked with a black/yellow hazard stripe. Guidance is given in 2.9.2 below.

2.6.2 A means of showing the presence of danger from explosives that may be present in mountings/launchers/torpedo tubes or containers that can be loaded with munitions is to be made available.

2.6.3 The notice is to be positioned so that it cannot be observed from outboard. Guidance is given at 2.9.2 below.

2.7 Guidance – DDAs (Electrical Installations and Fire Fighting Arrangements)

2.7.1 Part 3 of this standard identifies the electrical requirements for internal DDAs.

2.7.2 For Clearways and LCVP/armed boat recesses, the full requirements of Part 3 of this standard are not normally justified. Whilst the general electrical requirements of Def Stan 08-107/NES 501 and Def Stan 08-160 apply to Clearways and LCVP recesses, high fire risk electrical equipment, such as open heaters or dryers etc. should not be sited in these areas.

2.7.3 Guidance on the provision of fire prevention and fire fighting arrangements in DDAs is given in Appendixes 7 & 8.

2.8 Guidance – Package Examination Rooms (PERs)

2.8.1 PERs may be required to have a conducting deck (see Appendix 15). For additional advice contact DSS NAExp.

2.8.2 A PER may also be provided and justified in a large warship or other MOD ship where re-palletisation is required, for examination of damaged packages, or where significant numbers of packages/ammunition containers are refilled from part used or damaged boxes.

2.9 Guidance - Marking of Areas around Weapon Systems

2.9.1 The limit of the physical danger areas from the swept arc, efflux and operational opening of mechanisms or doors, and the noise danger area where relevant, should be marked in accordance with Def Stan 02-784/NES 784.

2.9.2 If the mounting/tube/launcher or canister is not fitted with a loaded indicator mechanism, display or lamp, a portable sign should be provided that can be slotted into position or attached/hung on the mounting/tube/launcher or canister to indicate when it is loaded. It is recommended that the sign is on one side, a black on yellow explosive warning sign in accordance with BS 5499 / Def Stan 02-784/NES 784. The sign may be stowed when not required with the blank reverse side outwards or in a separate stowage position.

2.9.3 Markings and signs associated with munitions should not be visible from outboard so as not to present an aiming point for terrorist attack.

2.10 Guidance - Separation of RAS(L) and RAS(A) Areas

2.10.1 Replenishment at Sea (Liquid) (RAS (L)) and Replenishment at Sea (Ammunition) (RAS (A)) positions should be separated as far as practicable. Best practise is to achieve at least 18 metres separation. Ammunition routes should also be separated by the same distance from fuelling/pumping points unless ship structure or other agreed mitigation is in place to prevent the escalation on of any accident between routes.

APPENDIX 3 ADJACENT COMPARTMENTS

3.1 Description

3.1.1 Adjacent compartments are those that have decks, deckheads or bulkheads in common with a magazine.

3.1.2 Requirements for adjacent compartments also apply in part to compartments that have a contiguous connection to a magazine because they diagonally abut the magazine. Such compartments are described as indirectly adjacent to a magazine.

3.2 Performance Requirements for Adjacent Compartments

3.2.1 Risks to the magazines from adjacent compartments containing petroleum, oils and lubricant (POL) and pressurised bottles/systems are to be reduced to ALARP and justified in the SESC.

3.2.2 Smoke and heat detectors are to be fitted in adjacent compartments where there is a fire risk. To reduce the risk to ALARP the location, configuration and number of smoke and heat detectors is to be assessed and justified in the SESC.

3.3 ACOP for Reduction of Hazards from Adjacent Compartments

3.3.1 The siting of compartments adjacent to magazines, small magazines and magazine lockers should be subject to a SETHA. The risk must be demonstrated in the SESC to be ALARP and tolerable. In general, magazines, small magazines should not be sited directly or indirectly adjacent to the following high risk compartments:

- a. Main Machinery Spaces
- b. Compartments containing Diesel Generators
- c. Compartments containing Gas Turbine Generators
- d. Galleys
- e. Liquid Oxygen (LOX) Compartments
- f. Compartments/spaces containing Gasoline and gasoline pumps
- g. Pressurized/Flammable Gas Cylinder/Bottle Stowages
- h. Switchboard Rooms and Electrical Distribution Centres (EDCs).
- i. Auxiliary Machinery spaces including (not exhaustive): Fuel pump spaces, Shaft tunnels

- j. High Fire Risk Compartments, such as identified in Def Stan 07-204.

3.3.2 Marking of adjacent compartment bulkheads in accordance with Def Stan 07-204 to indicate the presence of a magazine on the other side provides warning to personnel. Markings may also be used to reduce the risk that stores or items are placed against a magazine bulkhead that could result in a threat to a magazine.

3.3.3 Where the magazines, small magazines, contain small quantities of munitions (see guidance below) they may be sited adjacent to those compartments listed above, provided that the common boundary is insulated with Fire Barrier Insulation (FBI) to a minimum of A60 standard. Guidance on FBI is given in Def Stan 07-204 and SOLAS Regulations

NOTE: Mineral Fibre Marine Board (MFMB), where already fitted in existing ships, is acceptable in lieu of fire barrier insulation. New designs should employ the latest MOD SME approved alternatives.

3.3.4 Pressurized cylinder stowage's are not to be sited so as to cause a risk to magazines, small magazines or magazine lockers. Best practise is not to site such stowage's in adjacent compartments. Unless unavoidable pressurized cylinders should not be stowed within 6 metres of a weapon launcher or magazine or magazine locker.

3.3.5 For pressurized gas bottles that serve a magazine i.e. RRSS, bottles may be sited in adjacent compartments but will be dependent on the outcome of a SETHA.

3.3.6 Where electrical equipment is fitted in an adjacent compartment and sited on the common boundary, an air gap of at least 60mm is to be provided between the equipment and the boundary bulkhead, to assist in boundary cooling and minimize heat transfer in the event of fire.

3.3.7 Magazines containing any type of explosive may be sited adjacent to the compartments listed below, provided that adequate FBI (a minimum of A60 standard) is fitted in accordance with Def Stan 07-204/NES 119:

- a, Auxiliary Machinery spaces including (not exhaustive):
 - i Refrigeration machinery compartments
 - ii Hydraulic compartments not using OX40
 - iii Conversion machinery spaces
 - iv Emergency fire pump
 - v Air conditioning plant spaces [ATU/AFU etc]

- b High Value Spaces; (such as those defined in Def Stan 07-204/NES 119)

NOTE: Electrical equipment fitted in high value spaces is to be sited at least 3 metres from the contiguous connection with any diagonally abutting magazines. If this distance cannot be achieved, FBI (minimum A60) is to be fitted appropriately and in accordance with Def Stan 07-204.

- c Laundry
- d Workshops
- e Hangar
- f Vehicle decks and wells
- g Uptakes and downtakes (see guidance Appendix 3.6.9)
- h Acid stores
- i Paint/Flammable stores

3.3.8 In addition maximum practicable segregation between accommodation/operational spaces and bulk explosives stowage complexes should be provided and justified in the SESC.

3.3.9 Exceptionally, some ships including Naval Armament Vessels (NAVs) and powered Naval Armament Lighters (NALs) may be provided with a cofferdam between the Cargo Hold and the Engine Room, where this can be justified as ALARP.

3.3.10 Magazines and magazine lockers containing any type of explosive stores/munitions may normally be sited, without restrictions, adjacent to any other compartment not listed in this Appendix.

3.4 ACOP for POL and Tanks Adjacent to a Magazine

3.4.1 Magazines, small magazines are NOT to be sited adjacent to structural tanks containing Petroleum POL Class I and II products, as defined in BR1754.

3.4.2 The temperature in the magazine should not be allowed to rise due to heating of an adjacent tank to 32⁰C, or those temperatures quoted in Appendix 9.3 Where heated oil or water tanks are sited adjacent to a magazine, risk control or mitigation measures are to be justified in the SESC.

3.4.3 Magazines containing any type of explosive may be sited adjacent to compartments fitted with non-structural tanks containing POL Class I, II and III products, if adequate FBI is fitted in accordance with Def Stan 07-204/NES 119. A minimum of A60 FBI is required. In addition Non-structural tanks containing POL Class I or II products should not be sited on the boundary of a magazine.

3.4.4 Magazines containing any type of explosive stores/munitions may be sited, without restrictions, adjacent to any POL Class III structural tanks.

3.4.5 The risks from any POL systems (e.g. pumps and pipework) adjacent to magazines, or magazine lockers shall be assessed and reduced to ALARP.

3.5 ACOP for Smoke/Heat Detectors in Adjacent Compartments

3.5.1 The assessment of risk will determine the requirement for smoke and heat detectors. It is best practise to install smoke and heat detectors in all adjacent compartments to magazines except as described below.

3.5.2 Detectors are not normally required where adjacent compartments are bathrooms, WCs/heads, watertight compartments (WTCs), passageways, frequently used lobbies, structural tanks and cofferdams.

3.5.3 Smoke and heat detectors should also be installed in compartments with access to small magazines or in compartments containing magazine lockers.

3.5.4 Smoke/Heat Detectors are to operate alarms either in the Ship Control Centre (SCC), or other locations appropriate to the ship's protection organization. In Minor War Vessels and from magazines in RFA and solid support ships detectors are also to alarm on the weatherdeck.

3.5.5 In ships where the SCC or ship's protection organization is not continually manned, additional alarms are to be fitted adjacent to the Officer of the Watch (OOW) position at sea, and adjacent to the Quarter Master's position in harbour. In ships not manned by Naval personnel, including RFAs, NAVs and NALs, the additional smoke/heat detector alarm should be centralized either in the Navigating Bridge area or at any other suitable control station which is provided with direct communication with the Navigating Bridge.

3.6 Guidance - Adjacent Compartments (General)

3.6.1 Magazines containing bulk munitions of HD 1.1 (e.g. air weapons (including bombs), torpedoes, shells, guided weapons, decoy charges (HE), mines or demolition charges) or large quantities of propellant (e.g. rounds/munitions above 57 mm in diameter) should not be sited adjacent to the compartments listed in Appendix 3.1.5 above. Magazines, small magazines and magazine lockers containing small quantities of HD 1.1 munitions (typically less than 25 kg) or munitions of diameter less than 57 mm may be sited adjacent to the compartments listed in Appendix 3.3. Provided that FBI of at least A60 is provided.

3.6.2 A highly effective method of reducing risk to explosive safety is to remove fire hazards by minimising ignition and also removal of any potential sources of explosion to a safe distance e.g. Crank case explosions or HP bottle/cylinder stowages containing flammable gases to a safe distance. Mitigation and control measures in adjacent compartments shall be justified in the SESC.

3.6.3 The risks associated with adjacent compartments have the potential to affect operational capability and should be assessed in the context of reducing the consequences from an explosive incident to tolerable levels. The assessment should consider whether additional hazard in the adjacent compartment could significantly contribute to the explosives incident and present additional risks to explosive safety on the platform and/or affect capability. Further guidance is given at Appendix 10.

3.6.4 A main machinery space includes compartments containing gas turbines or diesel engines for propulsion, generators providing High Voltage (HV) power for electric propulsion and electric propulsion motors, main gearboxes, and steam boilers and turbines.

3.6.5 Advice on vulnerability reduction, protection and mitigation measures between a magazine and an adjacent compartment in a ship may be sought from DSS NAExp.

3.6.6 Typical best practise mitigation design between a magazine and an adjacent compartment include appropriate armour, blast resistant bulkheads/doors and cropped "T" connections with austenitic welds. Water filled cofferdams are also good mitigation and trials to date indicate that these should ideally have a width allowing at least 400 mm of water to be retained. The configuration of explosives in the adjacent magazine needs to be optimised. (Further guidance is given in Appendix 5). This will also help to reduce heat transfer from any fire loading in the adjacent compartment from entering the magazine. Where weight considerations preclude a water fill, a cofferdam with an air gap of approximately 1m will be moderately effective and allow access for maintenance. Further efficiency may be gained by filling the gap with foams or blast absorbing materials. Further advice on blast resistant structure, armour, cofferdams and fill material should be sought from DSS NAExp.

3.6.7 One of the key hazards to munitions from adjacent compartments is fire. Mitigation in the adjacent compartment may be provided by use of:

- a. Fire barrier insulation/fire resistant materials.
- b. Smoke and heat detection.
- c. Surveillance and CCTV systems.
- d. Fire prevention and fire fighting arrangements.

3.6.8 Mitigation within the magazine for fire risks from an adjacent compartment is detailed in Appendix 8.

3.6.9 Bulk explosives should be separated from uptakes and downtakes by an A60 bulkhead and at least 3 metres.

3.6.10 Rounds of adjacent compartments in accordance with JSP 862 are an important control measure to prevent and detect fire.

3.7 Guidance - Adjacent Compartments (POL Products)

3.7.1 Structural tanks containing any liquid with a flash point lower than 57°C should not be placed adjacent to magazines or ammunition routes. The siting of tanks containing liquids with a higher flash point adjacent to magazines and ammunition routes should be justified within the SESC

3.7.2 If it is essential to have a structural tank adjacent to a magazine, consideration should be given to the intended contents i.e. water is preferable to diesel, which in turn is preferable to an Avcat tank. Note: Avcat (F44) has a flash point of 61°C.

3.7.3 The design safety of POL pumps and pipework should be optimised to minimise the threat to magazines and ammunition routes. In particular, Avcat pump spaces should be well separated from magazines by a minimum of 6 meters

3.8 Guidance - Adjacent Compartments (Smoke/Heat Detectors)

3.8.1 Provision of smoke detectors in addition to smoke detectors will improve response time.

3.8.2 Provision of adequate smoke and heat detectors in adjacent compartments, linked to suitable alarms, will help to reduce fire risks to ALARP and tolerable levels and aid in early detection.

APPENDIX 4 GENERAL MAGAZINE CONSTRUCTION REQUIREMENTS

4.1 Description

4.1.2 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the general construction of magazines, small magazines, OME preparation areas and vertical launch silo magazines in ships.

4.2 Performance Requirements for General Magazine Construction

4.2.1 The design and construction of magazines are to be in accordance with these regulations.

4.2.2 The design and construction of magazines is to reduce to ALARP, risks to and from OME contained within.

4.2.3 Magazine construction is to incorporate the requirements for Certificate of Safety Structural Strength with application of appropriate Class Design Rules.

4.3 ACOP for Structural Integrity of Magazines

4.3.1 The structural details of magazine boundaries are to be designed to withstand the required ultimate strength, hydrostatic and determined Quasi-Static (QSP) pressures using appropriate Class Design Rules.

4.3.2 As a minimum, boundaries are to be designed and constructed to meet watertight standards and stability hydrostatic head pressures as defined in the relevant System Requirements Document (SRD). Watertight integrity should be proven by means of an air pressure test conducted in accordance with appropriate Class Design Rules.

4.3.3 In addition, consideration is to be given to “hardening” the boundary to withstand initiation events by, for example,

using blast resistant bulkhead and door designs,

strengthened connection joints including cropped “T”, continuous bulkheads and by using austenitic welding,

incorporating armour into the boundary

and the use of cofferdams or side protection systems.

4.3.4 The use of a SETHA toolset, from which derives the Platform and OME Protection Strategy, will determine potential design options that may be used in the construction of hold, magazine and OME area boundaries. Further guidance is given in Appendix 4.13 and NAN 03 with further advice available from DSS Exp.

4.3.5 The scantlings of magazines and other OME area boundaries below the vertical limit of watertight integrity are to be determined from the general plating and stiffening equations in appropriate Class Design Rules.

4.3.6 In Naval Armament Vessels (NAVs), hold bulkhead boundaries should be proven watertight as a minimum. Watertight integrity should be proven by means of an air pressure test conducted in accordance with appropriate Class Design Rules.

4.3.7 All piped or trunked systems serving a magazine should have isolating valves immediately external to the magazine boundary.

4.3.8 Magazine boundaries should not be constructed of aluminium or any other combustible materials. Where the use of such material is proposed, a SETHA including a structural consequence analysis is required. If essential then Fire Barrier Insulation (FBI) is to be fitted to sides of the boundary facing a fire threat and justified in the SESC.

4.4 ACOP for Painting and Preservation in Magazines

4.4.1 Magazines and Weapon Handling Spaces are to be painted with approved fire retardant paints in accordance with the requirements of the standards stipulated in Warpaint and BR3939. The surface of conducting decks where required are to be left bare steel or painted with an approved conducting paint.

4.4.2 Magazine decks should be fitted with anti-slip measures such as welded studs, fully welded tread strips, anti-slip paint schemes or abrasive self-adhesive tread strips. Adhesive tread strips must not be fitted to conducting decks. Flow-forge stowage systems fitted to magazine decks generally meet anti-slip requirements.

4.5 ACOP for Automatic Air Escapes (AAE)

4.5.1 Automatic Air Escapes (AAE) should be provided for all magazines fitted with spraying arrangements. Variations to this Clause are:

- a. In RFA Magazine, individual magazines within a watertight magazine, which are not themselves watertight, do not require individual AAE.
- b. Package Examination Rooms do not require AAE.

4.5.2 Automatic Air Escapes should be readily accessible for periodic functional testing. A typical AAE drawing is at (Annex K).

4.5.3 Where fitted AEE should operate at approximately 0.013 bar (1.38 kN/m²) (0.2 psi) and terminate above the Red risk Zone in suitable lobbies, passageways or weather decks.

4.5.4 The position of the air escape within the magazine and the terminating position should be indicated by a BLACK arrow and the words 'AIR ESCAPE' in BLACK lettering on a white background in accordance with Def Stan 02-784/NES784.

4.6 ACOP for Air Systems in Magazines

4.6.1 Air systems that do not serve the magazine should NOT pass through magazines, small magazines or silo magazines.

4.6.2 Air operated handling machinery is permitted in magazines. Guidance is given below.

4.6.3 Air systems pipework serving the magazine should be provided with a means of isolation adjacent to the magazine boundary for use in the event of fire.

4.6.4 There should be no fittings or system branches between the magazine boundary and the isolation valve.

4.6.5 In the design of pipework systems, particular care should be taken to reduce vulnerability to damage; mechanical protection is to be provided as necessary.

4.6.6 Adequate access should be provided for inspection and maintenance.

4.7 ACOP for Drainage/Flooding Arrangements in Magazines

4.7.1 Sufficient drainage arrangements should be fitted to ensure magazines can be completely drained or pumped out and to ensure that stability requirements are met.

4.7.2 Additional arrangements should also be made to ensure that water can be drained or pumped out from stowage bins or lockers and from under false floors within magazines – Def Stan 02-712/NES 712 provides guidance.

4.7.3 Magazines drains are not to be shared with drains likely to contain flammable liquids.

4.7.4 Magazine drainage arrangements, which may be subject to contamination from magazine contents, should be separate from all other drainage systems. Such systems should be able to contain the contents or discharge directly overboard. When designing the arrangements the Environmental Impact Assessment and MARPOL requirements must be included.

4.7.5 Drainage arrangements should be fitted with lockable opening and closing arrangements, immediately adjacent to the magazine.

4.7.6 Magazines, small magazines, or magazine lockers containing White Phosphorus (WP) munitions are to be arranged such that either the whole magazine or locker can be flooded to above the level of the stowages or that the WP natures are in a tank or bin that can be separately, manually flooded. See guidance at (4.17.5).

4.7.7 Flood sensors should be fitted in magazines where a pressurized fluid system (other than the magazine spray system) passes through or serves the magazine.

4.7.8 Small magazines, RU Magazines/Magazine Lockers do not normally require flood sensors.

4.8 ACOP for Access to Magazines

4.8.1 Access doors and hatches to magazines should be of steel, or a composite material with specified suitable protective and structural properties. These should be watertight and constructed using the guidance of Def Stan 02-127/NES 127. Access doors and hatches should be provided with door/hatch hold open arrangements.

4.8.2 The SETHA will help in determining whether blast resistant doors are to be fitted. Where this type of door is to be used it should have the same level of blast, fragmentation protection and fire resistance as the bulkhead it is fitted within.

4.8.3 In NAVs, a watertight hatch and fixed ladder should be fitted to give alternative access to the Cargo Hold to facilitate inspection of the cargo at sea.

4.8.4 "Out-to-in" fish eye viewing (f-e-v) devices are to be fitted at each access point to the magazine to allow an assessment of the magazine.

4.8.5 An "in-to-out" f-e-v should also be fitted to magazine doors that open directly into the hangar/flight deck to allow assessment of any fuel danger hazards, additionally, a notice stating 'DO NOT OPEN DOOR IN FUEL DANGER STATE'. The notice should be BLACK text on a WHITE background... Should be affixed to the inside of the door.

4.9 ACOP for Cupboards and Drawers

4.9.1 Cupboards and drawers should be constructed from non-flammable materials and fitted with locks and label plates or card holders.

4.10 ACOP for Portable Emergency Lighting

4.10.1 Magazines capable of being entered should be provided with portable emergency lighting. Emergency lighting is not normally required in NAVs and Naval Armament Lighters (NALs).

4.10.2 A dedicated stowage box should be provided for the emergency lighting outfit, and stood off from the bulkhead to allow boundary cooling. Where the method chosen is Cyalume Chemical Illuminators (CCI) the stowage box should hold a full outfit of CCI including their associated Magnetic Base Holders and Combat Light Devices (light shields). See JSP 862 for guidance.

4.10.3 The emergency lighting stowage box should be sited adjacent to the magazine access on the outside for inboard magazines and the inside for weatherdeck magazines.

4.11 ACOP for Magazine Hazard Warning/Safety Signs & Notices

4.11.1 Magazines sited within the ship should have an explosives warning sign affixed to their access door/hatch, in accordance with Def Stan 02-784/NES 784.

4.11.2 Where magazine doors open onto the weatherdeck, the deck, in front of the access should be marked 'DANGER EXPLOSIVES' in RED TEXT.

4.11.3 All pipes passing through magazines should be identified with the correct colour coding and DC identification tape in accordance with Def Stan 02-853/NES 853 Part 1.

4.11.4 Other Hazard Warning/Safety Signs and notices are to be in accordance with Def Stan 02-784/NES784, unless otherwise specified within individual sections of this standard.

4.12 ACOP for Protection from Efflux

4.12.1 Adequate protection should be provided to prevent efflux from burning through the magazine boundaries, adjacent stowage's and internal magazine structures and to prevent efflux from impacting into adjacent munitions and adjacent high value compartments.

4.12.2 External doors, hatches, hoists or other openings in the ships structure that may be subject to burning efflux emitted from a missile during or after launch should be flameproof, as well as flashtight, when closed.

4.12.3 Combustible material should not be used as a seal in the path of efflux.

4.12.4 On Guided Weapon (GW) a flashtight barrier is to be provided between the launchers, hoist and magazine stowage to protect other missiles from efflux if a missile on the launcher is fired.

4.12.5 Guidance is available from DSS NAExp on calculating the need for over-pressure venting

4.13 Guidance – Structural Integrity of Magazines

4.13.1 Whether the boundary structure will withstand explosive loadings and whether its failure, elastically, plastically or total, will cause intolerable consequences upon the safety and capability of the platform, on personnel and to the environment is to be determined. When assessing the structural design, in this context, distinction should be made between the effectiveness of Service Life of Structure (SLS) and Ultimate Life of Structure (ULS) built into the magazine boundaries as part of the whole hull girder

structural design and the level to which this will contribute to withstanding an initiation event from magazine contents.

4.13.2 Boundary structure may be designed to withstand Quasi Static over-pressures or in combination with pressure relief venting/blast structurally weak routes will provide a level of structural withstand to initiation events of munitions stowed in the magazine, in particular from Explosion Type III, Deflagration Type IV, Burning Type V reactions and propulsive burning reactions (See ANNEX C definitions).

4.13.3 Boundary structure may incorporate a filled cofferdam, where the SETHA indicates that barrier separation is required from other compartments. This should have a width of at least 400 mm of water to reduce the blast effects and fragment velocity (assessment of this is required) from threats or initiation events to levels that will prevent propagation of explosion. (The configuration of explosives in the adjacent magazine needs to be optimised. Seek guidance from DSS NAExp). This will also help to reduce heat transfer from any fire loading in the adjacent compartment from entering the magazine. Where weight considerations preclude a water fill, a cofferdam with an air gap of approximately 1m will be effective for lower ENEQ events and allow access for maintenance. Further efficiency may be gained by filling the gap with blast absorbing fill including foams or pulverised mineral ash. Further advice on blast resistant structure, armour, cofferdams and fill material should be sought from DSS NAExp.

4.13.4 For Lloyds Naval Ship Rules the scantlings are to be calculated according to Volume 1, Part 6, Chapter 3 Section 3.12 including Table 3.3.15. Alternative arrangements should be proven by direct calculation/testing.

4.13.5 As a minimum compartments within the red risk zone must meet the ship construction requirements in full. The requirement is to keep flood water out of the magazine and keep smoke and gasses generated by explosives incidents within the magazine. For Lloyds Naval Ship Rules Volume 1, Part 5, Chapter 3, Section 5.8 apply for deep tank or watertight bulkheads or the equivalent quasi-static over-pressure caused by the postulate credible incident, whichever is greater.

4.13.6 Magazines above the red risk zone need to meet the minimum structural requirements to achieve the air pressure test. This is required to keep smoke and gasses generated by explosives incidents within the magazine.

4.13.7 Watertight integrity should be proven by means of an air pressure test conducted in accordance with appropriate Class Design Rules. For Lloyds Naval Ship Rules refer to Volume 1, Part 6, Chapter 6, Section 6) for guidance.

4.13.8 The magazine and explosives preparation areas should be constructed to the standard chosen for the ship construction and meet the watertight requirements of the compartment location.

4.13.9 Within the magazine structure, fire fighting and spraying arrangements may cause local flooding and free surface water. The impact on stability will require assessing. The watertight construction of the magazine should prevent unintentional escape of water and casualty explosives products. Drainage arrangements will be required (see 4.17).

4.13.10 Guidance on the structural requirements for a floodable magazine, magazine locker or tank may be obtained from appropriate Class Design rules.

4.13.11 The magazine structural boundary also forms the first line of defence against risks arising in adjacent compartments. In particular, fire in an adjacent compartment may cause structural failure thus exposing munitions to heat hazards. Operation CORPORATE lessons learned showed that magazines in aluminium structure were prone to structural failure in fire. Lessons learned from the USS STARK incident in 1987 showed that magazine bulkheads were prone to failure at the bulkhead to deckhead junction when subjected to high heat loads.

4.13.12 Where aluminium or GRP is used in the boundaries of magazines, fire barrier insulation is required on both sides of the boundary. The protection provided is to be assessed to ensure that the response of the structure to the thermal effects of credible incidents within the magazine or in adjacent compartments does not exceed that which will cause significant reduction in the strength properties of the material. Further advice is available through DSS NAExp.

4.14 Guidance - Painting and Preservation

4.14.1 Guidance on anti static requirements and conducting decks is captured at Appendix 15.

4.15 Guidance - AAEs

4.15.1 AAEs are provided in magazines to prevent pressurization as a result of spray system activation. Lack of an AAE will result in a build up of pressure that may reduce the flow of water into the compartment and potentially cause plastic deformation of the magazine structure. The number of relief valves is to be assessed to ensure that the elastic design capability of the magazine is not exceeded.

4.15.2 The size of an AAE is too limited to act as an effective over- pressure vent to relieve the pressure caused by inadvertent initiation of explosives propellant (see Appendix 12).

4.16 Guidance - Air Systems in Magazines

4.16.1 Air operated handling machinery may be used. They should be designed to minimise the probability of feeding air into a fire. Guidance on system pressure and types of connector is available from MESH IPT.

4.17 Guidance - Drainage for Magazines

4.17.1 Drainage arrangements are required to allow water from fire fighting and spraying arrangements to be drained and to prevent local flooding and build up of free surface water.

4.17.2 Control of drains by lockable opening and closing arrangements is required for the following purposes:

- a. To allow deliberate water covering of the deck as a mitigation aid to reduce explosion and blast effects.
- b. To control the drainage of explosive compositions from casualty weapons. This may be of solid particles in water or of a mixture of liquid explosives fuel and water. Either of these mixtures could be potentially flammable, or even explosive.
- c. To permit the deliberate flooding of the magazine deck as an aid to boundary cooling (e.g. in the event of a fire in the compartment below).

4.17.3 Magazine drains are normally locked open. However, where munitions carrying liquid fuel are present in a magazine, it may be considered more appropriate that the drain is normally locked shut. This will depend upon the free-surface presented by a magazine or OME area and operating environment restrictions. Environmental Impact Assessment (EIA) and International Marine Pollution (MARPOL) requirements are to be assessed and considered in the design of arrangements.

4.17.4 The entry point to a drain in a magazine is normally designed with a low lip (approximately 15 – 25 mm) to allow a water film to develop on the deck of the magazine. This is sufficient to be effective for boundary cooling, but sufficiently small to avoid free surface issues. In a larger magazine (e.g. greater than 10 m²) a drain may be required on each side of the magazine to avoid the build up of a significant volume of water in a list condition.

4.17.5 Compatibility Group H munitions contain white phosphorus (WP). WP will ignite spontaneously when exposed to air and generate large volumes of smoke that is toxic in a confined space. The objective of a tank or floodable magazine for WP munitions is to enable the munitions to be immersed in water as a precaution in the event of an adjacent fire or of damage or potential damage to the munitions.

4.18 Guidance - Access to Magazines

Security requirements for magazine access are covered in Appendix 14.

4.19 Guidance - Safety Signs and Notices

4.19.1 Explosives warning signs are intended to alert personnel to the presence of explosive stores in a compartment and reduce the potential for accident near the magazine/access. The Fire Division warning sign will assist shore fire brigade personnel in deciding how to tackle a fire in the vicinity. This duplicates arrangements at military and civil shore explosive storehouses.

4.19.2 Other signs and Damage Control (DC) markings should use the normal convention of other RN and MOD ships. This aids the actions of personnel and permits common training for emergency and contingency arrangements.

4.20 Guidance - Protection from Rocket Motor Efflux

4.20.1 Adequate protection should be provided to prevent efflux from burning through the magazine boundary. Guidance on use of mitigating materials to protect stowages and structure from efflux is given in (NAN) EXP/03 (Advice should be sought from DSS NAExp). The orientation of the munitions will require consideration when designing magazine layout configurations to take into account the effects from an initiation event and how they impact adjacent munitions, stowages or structure.

4.20.2 When designing efflux protection arrangements consideration should be given to the propellant mass and burn times, the thrust pressures generated and the temperature of the burn. Further advice should be sought from DSS NAExp or the OME SME.

4.20.3 Combustible materials may not withstand the flame torching when a missile is fired and should therefore not be used or fitted in the path of efflux.

APPENDIX 5 MUNITION STOWAGES AND FITTINGS

5.1 Description

5.1.2 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the general configuration and construction of munition stowage's and fittings in magazines and magazine lockers in MOD ships. These provisions are also relevant to stowage's for bulk explosives, as appropriate. In addition, the requirements for stowage of bulk explosives in JSP862 Part 1 Chapter 13 – Stowage Plans apply.

5.1.3 The intention is to achieve optimum stowage of ordnance/munitions/explosive stores to provide protection and reduce the probability of an initiation event and to reduce consequences, as assessed by conducting a SETHA, together with providing a stowage configuration that gives appropriate logistics with a secure stowage design to prevent movement by ship manoeuvre, in a seaway or by adjacent underwater shocks.

5.2 Performance Requirements for Munition Stowages and Fittings

5.2.1 Appropriate stowages shall be provided to safely stow the required quantities of munitions, in accordance with Armament Statement requirements, within magazines and magazine lockers in MOD ships. Flow forge or multi purpose stowages shall provide means to safely restrain munitions in their transit packaging (see Annex N).

5.2.2 The permitted contents of a magazine or magazine locker shall be clearly displayed inside the magazine using RN Form S285K (see Annex D).

5.2.3 In magazines that are wholly or partially special-to-type, designated stowage positions shall be identified and the safe stowage capacity suitably marked .

5.2.4 For multi-purpose magazines stowing bulk-packed/palletised munitions, where the quantities vary, a stowage plan (see example in figure 2 at the end of this appendix) shall be used in lieu of RN Form S285K.

5.2.5 The stowage racks and any supporting structure and plinths should meet the shock requirements (including associated whipping components) of Def Stan 08-120/NES 814, BR 3021, BR 8470 and CB 8469 when munitions are in place within the racks.

5.3 ACOP for General Munition Stowage Requirements

5.3.1 Explosive stores should be safely stowed and restrained to meet the assessed conditions of ships movement and required shock levels. Guidance is given below and in the GNE, Part 4 of this standard. Methods of stowing explosive stores/munitions in RFA Magazines, NAVs and NALs should be in accordance with the Platform and OME Protection Strategy (See MAP 01-103 Ship Explosive Threat Hazard Assessment). Further guidance should be sought from DSS NAExp.

5.3.2 Stowage's and fittings should be constructed from non-flammable materials see Guidance below at 5.8.

5.3.3 Munitions in magazines and magazine lockers that are vulnerable to underwater shock will require suitable protection in their stowage's from non-contact underwater shock. Detailed guidance for methods of including shock protection in stowage arrangements is given in BR 8470 and CB 8469 [previously BR 3021 and CB 5012]. The maximum safe shock load that can be tolerated by each munition should be specified in the Weapon Installation Specification for a Naval weapon or in the safety case for an Embarked Extraordinary Explosives (E3). Bulk explosives in their transit packaging should be restrained to prevent movement in the event of non-contact underwater shock.

5.3.4 All portable fittings should be restrained when in use and also restrained in a stowage position when not required for use. Such restraint should be designed to ensure that the fittings do not rattle in use or when stowed, or jump out under shock conditions.

5.3.5. Every effort shall be made to reduce rattles in stowages and fittings that may contribute to the acoustic noise signature of the ship. Further guidance is given in Def Stan 02-703.

5.3.6 Stowages and fittings and restraint arrangements should be free of projections that may damage stores or hazard personnel.

5.3.7 Separate stowages should be provided for each type of explosive store and should be adjustable to allow alterations in box sizes. Where alternative packages are specified in the Armament Statement for the same explosive store, additional portable restraints/battens are to be provided.

5.3.8 The stowage and restraint arrangements should be designed in such a manner that removal of restraint to gain access to other stores will not leave a tier or part of a tier to topple.

5.3.9 The maximum stowage height of ammunition boxes when stowed separately (i.e. not palletised) is to take account of the size and weight of individual boxes and be commensurate with the health and safety requirements of the explosive store, the handler and the ship/magazine layout. Guidance on human factor (HF) requirements is given in Def Stan 00-25.

5.3.10 Where shelves are an integral part of the stowage, they should be constructed with an upstand and provided with drainage holes.

5.3.11 Where flow forge arrangements are fitted, provision should be made for removable access above and under the grid where appropriate for the purpose of maintenance and cleaning.

5.3.12 Where non-explosive stores (e.g. Flight in Air Materials (FIAM)) are required to be stowed in the magazine, non-flammable lockers with adjustable stowages should be provided.

5.3.13 Handling equipment to be stowed in the magazine should be provided with a stowage position with suitable restraint arrangements and included on the S285K

5.3.14 In determining the amount of space required for stowage of munitions, consideration also needs to be given for stowage of empty munition containers or ACAs, especially where munitions are moved to a weapons preparation areas.

5.4 ACOP for Munition Layout in Magazines

5.4.1 Layout of stowage's, configuration and orientation of munitions within stowage's should be optimised for both protection and operability. Guidance is given below and in Appendix 1.1.1. The aim is to prevent sympathetic reaction or reduce consequences to ALARP and tolerable levels. This must be considered along with the requirements for safely operating the weapon system and providing adequate restraint.

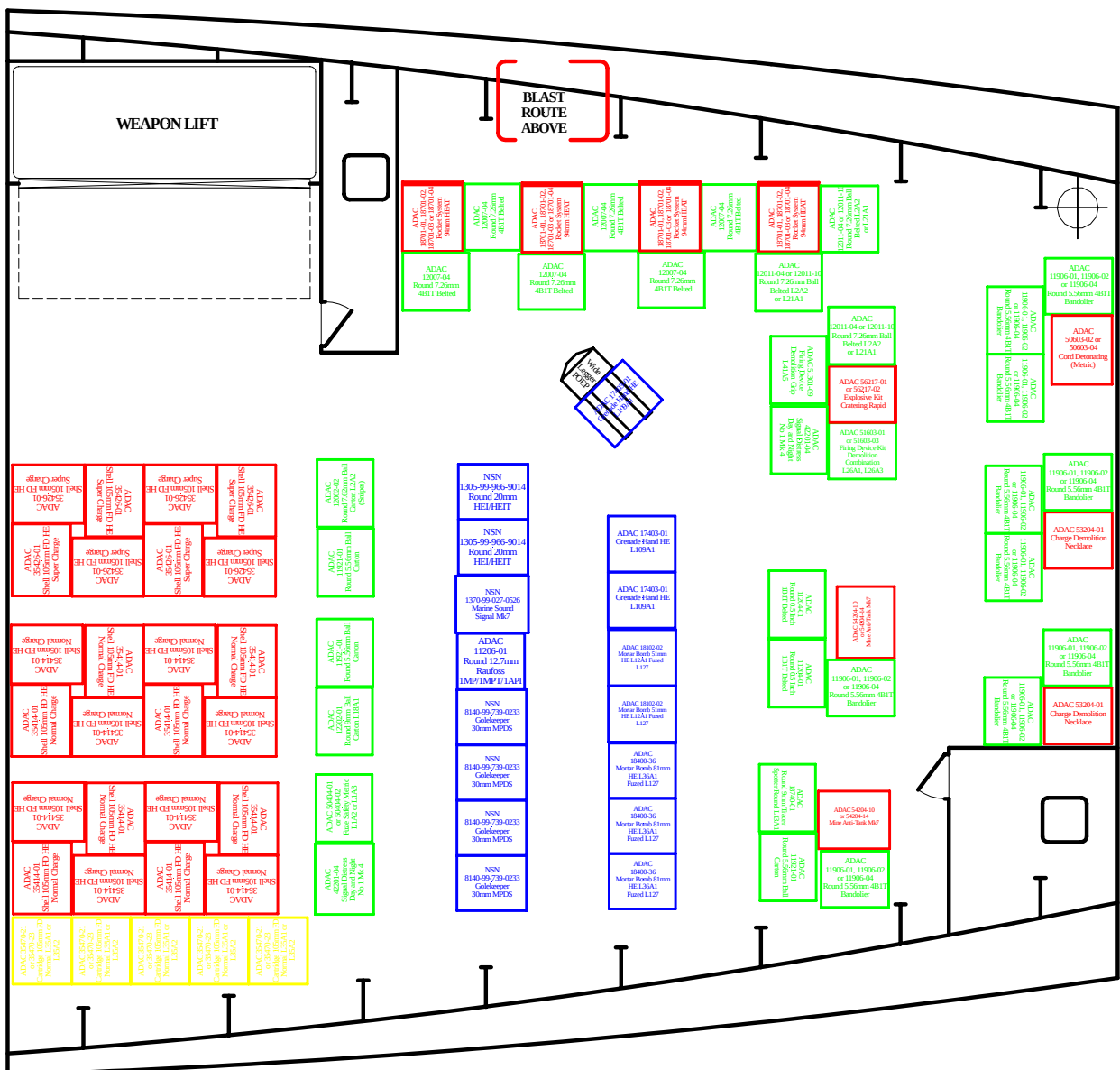
5.4.2 External threats to the ship, on the munitions to be stowed in each magazine, are to be reviewed as part the SETHA. The susceptibility, HCC and ENEQ of the munitions to be stowed, the results of munition safety trials detailed in the SEXSSI and OME Safety Instruction and the munition packaging configuration will be three major inputs to the THA. This will identify munitions which require protection and measures to reduce the probability of sympathetic reaction and intolerable consequences. All RFA stowage plans for UN Class 1 munitions and explosives carried for whatever purpose, will now be fully covered by JSP 862 and RFAs will no longer use the International Maritime Dangerous Goods (IMDG) code for explosives stowage plans. For the requirements for bulk stowage plans refer to JSP 862 Chapter 13 Stowage Plans.

5.4.3 For magazines with specific-to-type stowage arrangements, have been optimised for explosive safety during the design process.

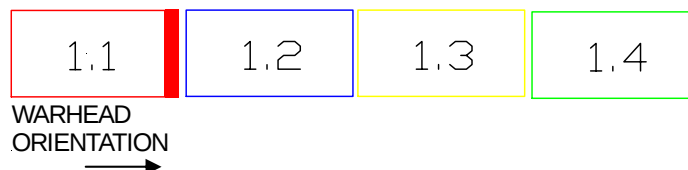
5.4.4 For multi-purpose magazines, where explosive outfits are predictable, optimised stowage plans are to be provided by the PDH, and these should be kept in JSP 862 Addendum. Predictable outfits will include those defined for declared ship roles.

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Fig 1 below shows a typical stowage plan.



Hazard Classification Code
COLOUR CODING



5.4.5 To assist the development of stowage plans a validated software “Stowage Planning Tool”, complete with a guidance manual, is available from DSS NAExp. See Fig 1 above .

5.4.6 To achieve optimisation of the stowage plan, from an explosive safety perspective, the plan should seek to comply, as far as is reasonably practicable, with the following principles. They are generically listed in order of application but for a particular circumstance this order may not be valid and adjustment must then be made.

No.	Principle
1	The maximum Effective NEQ (ENEQ) of HD 1.1 munitions placed in a 'unit' should be less than the quantity that could cause intolerable damage. (This principle is generally called 'unitisation'.) The tolerable level of damage is measured by the Effective NEQ and is to be determined from the THA.
2	UN Hazard Classification Codes are to be applied. Compatibility Groups (CG) of explosive stores/munitions are to be separated by Group unless mixing by Group is authorised.
3	Munitions that are less susceptible to Sympathetic Reaction, Bullet or Fragment Attack should be used as barriers between more susceptible munitions (i.e. pallets of HD 1.4S munitions between units of HD 1.1). Other inert barrier materials should be used if there are insufficient pallets of munitions with lower susceptibility.
4	Spatial relationships with other adjacent magazines (above, below, forward and aft) are to be considered when positioning units of HD 1.1. Pallets of HD 1.1 should not be positioned 'adjacent' to other pallets of susceptible munitions.
5	Susceptible munitions are to be protected from RATTAM and fragment threats by placing them in protected magazines/holds within the Platform e.g. behind armour, under the waterline.
6	Where possible, ship's structure should be utilised to provide shielding for susceptible HD 1.1 munitions.
7	Consideration must be given to stowing HD 1.1 munitions the maximum distance inboard from ships side plating.
8	Munitions should be stowed with the maximum available separation between units of HD 1.1.
9	Lashings and securing arrangements are to be sufficient to prevent movement of the pallets or loads, and should take into account the possibility of underwater shock.
10	Consideration must be given to the heights of pallets when arranging barriers between susceptible munitions to avoid line of sight communication from fragments.
11	A minimum clearance of 300 mm below the level of magazine spray heads is to be maintained

12	The risk of heat transfer through bulkheads must be considered and hence a minimum clearance of 60 mm from bulkheads is to be maintained.
13	Munitions should be oriented so that the non-explosive components are placed to act as a buffer between the susceptible compositions of adjacent munitions.
14	Munitions should be oriented to present the least susceptible area to the threat (i.e. directing the nose/base of a susceptible munition towards the threat or adjacent munition).
15	Hard cased munitions should be oriented so that their nose is at 90° to adjacent munitions e.g. 105mm HE Shell pallets should be placed at 90° to each other.
16	Stow rocket motors adjacent to over-pressure venting arrangements.
17	Directed energy weapons should be oriented such that the high velocity jet or fragments are aimed away from vulnerable munitions/high value compartments/external infrastructure – ideally not within 1 metre of the ship structure.
18	Rocket propelled munitions must be secured such that they remain constrained if they initiate propulsively.
19	Rocket propelled munitions should be oriented to prevent the efflux from playing on susceptible munitions and structures and a barrier placed to deflect the efflux.
20	The positioning of munitions is to be such that access to ship fittings (e.g. fire-fighting equipment) within the magazine for operation, maintenance and inspection is to be maintained i.e. clearways are to be maintained.
21	Due cognizance of the regulations for the Stowage and Segregation of Dangerous Goods UN Classes 2 through 9 in relation to UN Class 1 are to be applied.
22	When explosives in different compatibility groups are transported on a weather deck, they shall be stowed not less than 6 m apart unless their mixed stowage is allowed according to JSP 862 Chap 5 Annex A Table 2.
23	Containers carrying different UN Class 1 goods do not require segregation if the mixing of the compatibility groups is authorised. Where this is not permitted, containers shall be in separate magazines or compartments if below deck or separated by a solid intervening deck if containers are both on deck and below deck. For containers on deck principles 21 and 22 apply.

5.5 ACOP for Clearance between Stowages and Adjacent Boundaries

5.5.1 Heat transfer from an adjacent compartment fire or tank heating may be reduced to tolerable levels by a free air space of at least 60mm being maintained between bulkheads and stowage's and between the lowest tier of stowage's and the deck. This space also serves to permit boundary cooling of the bulkhead/deck to be carried out.

5.5.2 Clearance is not required where the bulkhead is the hull or the outer superstructure of the vessel. Clearance is also not required for minor stowage of fittings or portable items. Clearance may be required for FIAM stowages and other larger non-munition stowages to enable effective boundary cooling.

5.5.3 Clearance is also required in Glass Fibre Reinforced Plastic (GRP) vessels.

5.5.4 In RFA Magazines, NAVs and NALs clearance between the deck and stowages/transit boxes is not required. Normally where flow forge stowage is used, the grating is raised off the deck sufficiently to provide adequate heat dissipation. This, however, should be assessed on a case by case basis.

5.5.5 When determining the optimum stowage configurations using a SETHA methodology, should identify separation distances required between susceptible munitions and the clearance required to fit any mitigation barrier or system to reduce consequences to ALARP and tolerable levels.

5.6 ACOP for Identification of Stowages and Stowage Capacity

5.6.1 Where stowage racks are fitted, identification letters should be painted in BLACK over each bay in magazines and the tiers are to be numbered commencing with the lowest tier to enable the different explosive store stowage's to be uniquely identified.

5.6.2 Each stowage should also be fitted with a label plate or card holder, showing the nature of the contents and the maximum number of boxes/munitions.

5.6.3 Where appropriate, stowage racks should be marked with a BLACK line to denote the maximum permissible height of munitions. The line should take into account the spray head clearances.

5.7 ACOP for permitted magazine contents

5.7.1 An aluminium or steel Magazine Contents Board should be fitted in a prominent position near to the access of each magazine to carry the items specified in Annex E. A typical suitable size for the board is 550 mm x 450 mm. This ACOP applies to magazines in RFAs and Ships Taken Up From Trade (STUFT) vessels.

5.7.2 A Magazine Contents Board is not required in NAVs and NALs - BR1029 covers equipment requirements, temperature measurement etc. in NAVs and NALs.

5.7.3 The board should be positioned clear of the bulkhead using at least 20 mm spacers.

5.7.4 Where the space precludes the fitting of a full 'Contents Board', an A4 size holder should be provided to take RN Form S285K.

5.7.5 RN Form S285K - "The Magazine Designed Capacity List" - is authorised by the IPT/TL and should list all explosive and non-explosive stores listed in the Armament Statement, for stowage in the magazine. It is to include e.g. portable fittings, lifting equipment and portable electrical equipment. A typical RN Form S285K is shown at Annex D.

5.7.6 The RN Form S285K is to be updated by the PIPT throughout the life of the ship to reflect any changes.

5.7.7 For bulk explosive stowages in warships and RFAs stowage plans are to be prepared for each outload in accordance with JSP 862 Chapter 13. For palletised stowages in warships a set of stowage plans is required for the most common likely types of outload. Magazines that use palletised type stowages will be provided with stowage plans that complement the RN Form S285K as appropriate.

5.7.8 A chalkboard or white plastic laminate board is to be provided, suitably sized to list the primary munition contents of the magazine.

5.8 Guidance - Safe and Secure Stowage

5.8.1 The design of stowages should reflect the need for restraint of movement as well as ship expenditure of ammunition. Guidance on expected movement is given in Part 4 of this standard. As the ship expends ammunition or moves munitions to RU stowages, the number of boxes in a stowage configuration may decrease. The stowages may need to be re-arranged to re-stow empty boxes. Likewise the contents of bulk stowages (e.g. the operational load in an RFA magazines) may alter as munitions are outloaded or supplied to other ships and other munitions or empty containers are returned. To ensure the stores are safely stowed and restrained to meet these conditions, "flow forge/binpole", conventional steel stowage racks/shelving with restraints/battens, or other suitable restraint arrangements that can be adjusted to suit a variable number of boxes/ULCs/containers, should be used.

5.8.2 Stowages, shelves, racks and associated fittings should generally be made of steel rather than a lower melting point metal to withstand a fire or heat generated by a credible incident to a munition. Guidance is given in Def Stan 02-791/NES 791, Part 1. Where significant quantities of Insensitive Munitions (IM) are present in a magazine, their response to enemy action may be an intense fire generating large thermal energy.

5.8.3 Portable restraints/battens should be fitted with retention arrangements to prevent "jumping out" under shock conditions. Precautions should be taken to ensure that portable restraints/battens do not rattle when in position. Neoprene pads or similar materials are suitable for this purpose.

5.8.4 Fixed stowages should be provided for portable stowage restraints/battens, chocks, and wedges etc. when not in use. Precautions should also be taken to ensure that all portable restraints/battens, chocks, wedges etc. do not rattle when in their stowage position.

5.8.5 Shelves require upstands both to assist in retaining the stores on the shelf and also to allow spray water to thoroughly wet the boxes in the stowages and keep the shelves wet. Drainage holes in the shelves should be designed to enable spray water to drain evenly to lower levels to ensure boxes on lower shelves are also wetted thoroughly.

NOTE: Detonator Magazines - where “pigeon hole” arrangements are provided for the stowage of Detonators, the provision of upstands and drainage holes is not required. (Drainage holes would infringe the mitigation effect of the 8mm thick partitions). Appropriate retention arrangements e.g. keep battens, should be fitted.

5.9 Guidance - Munition Layout in Magazines.

5.9.1 Guidance on the stowage principles in Appendix 5. is as follows:

No.	Guidance
1	Unitisation of munitions to limit their combined ENEQ, by stowing together in a group with allowance for boundaries or barriers to segregate from other groups of munitions, will contribute to achieving ALARP solutions to intolerable consequences. A balance is to be achieved between space for barriers, stand-off and stowage density. Unitised ENEQ levels are to be determined from the THA with guidance to be provided in CB8844. Where unitised levels cannot be achieved, the strategy to apply, is to protect susceptible munitions and prevent initiation.
2	The UN Hazard Division (HD) and Compatibility Groups (CG) of explosive stores/munitions are contained in JSP 862 Volume 1 Chapter 5 Annex B.
3	Munitions and ULCs classified as HCC 1.4S may be used as buffers between HD 1.1 and 1.2 allocated munitions and ULCs to reduce or prevent propagation between similar classified munitions and ULCs. The 1.4S items will provide both separation and some shielding and blast absorption/deflection from the effects of higher classification items reducing the potential for Practically Instantaneous Propagation (PIP) and sympathetic reaction. See also Item 8 below.

4	Consideration is to be given to the standoff of munitions from crucial structure and to the position of munitions in adjacent magazines. For example, placing HD 1.1 munitions close to the deck directly above other HD 1.1 munitions in an adjacent compartment could lead to direct shock holing of the deck and propagation of an explosive event within the magazine below.
5	Protection of all RATTAM and fragment susceptible munitions against the RATTAM and fragment threats should be optimised. Refer to Appendix 11
6	Increasing the amount of ship's structure between susceptible 1.1 munitions and a threat (e.g. bullet or fragment attack) will reduce the likelihood of munition initiation; c.f. RATTAM protection Refer to Appendix 11
7	Distance from side plating reduces the consequence to ship survivability in the event of initiation and improves the protection from an asymmetric attack on the ship's hull and from collisions and grounding impacts
8	Maximising the separation between units of HD1.1 munitions will reduce the risks associated with PIP of an explosion, given that one unit is initiated. Blast decreases as an inverse cube law and so distance is critical in reduction of blast overpressure to below the threshold level that will cause initiation in adjacent "units" of munitions. A balance is to be achieved between space for barriers and standoff and stowage density. Recommended minimum separation distances based on preventing only peak reflected over-pressure PIP are: Small Units >200Kg – 1.0m minimum separation Medium Units between 200Kg and 400Kg – 1.5m minimum separation Large Units >400Kg to 700Kg – 2.0m minimum separation Barriers will be required to prevent fragment impact and to reduce lobbing effects. Refer to Appendices 10 and 11
9	Bin poles and chocking arrangements will be required to secure packages. Stowage of Individual ACA's arranged into stacks will require consideration and securing arrangements will need to be derived. Every effort shall be made to reduce rattles in stowages and fittings that may contribute to the acoustic noise signature of the ship.
11	In general, munitions should be stowed below the level at which the spray system will develop an even spray coverage. The aim is to ensure that spray water would flow over the top, sides and ends of munition containers/ACAs and to achieve optimum boundary cooling. Where this is not practicable, the best compromise should be chosen that ensures that the sides and top facing the next 'unit' would be wetted Appendix 8 refers.

12	Heat transfer from an adjacent compartment fire or tank heating may be reduced to tolerable levels by a free air space of 60 mm being maintained between bulkheads and stowages and between the lowest tier of stowages and the deck. Trials have shown a tenfold reduction in temperature at this distance from 700°C to 70°C. This space also serves to permit boundary cooling of the bulkhead/deck to be carried out. Refer to Appendix 8.
13	Place munitions in stowage so that warheads are placed next to non-explosive elements or motors rather than other warheads (i.e. nose to tail) or other similar orientation options. This increases the warhead to warhead distance to the diagonal distance Refer to Appendix 10 .
14	Worst case is where enemy or secondary fragments can strike a munition normal to the casing containing the explosive composition. Presenting a smaller target (base) or a tangential target (nose) is better. Best is to present a part of the munition that does not contain an explosive component Refer to Appendix 10.
15	Orientate hard case munitions with the nose or base pointing at 90° to adjacent munitions or in the direction of the base or tail of the adjacent munition with maximum separation. This places the munitions in the arcs of least energy emanating from a detonation and reduces probabilities of propagation. See also Item 4 above. E.g. Trials have demonstrated propagation is prevented when applying this principle to pallets of 105mm HE Shell and 4.5 Inch IA HE Shell.
16	See Appendix 12 for over-pressure venting arrangements.
17	The orientation of shaped charges, in their stowages, should be arranged to reduce the risk to other munitions and the ship to levels that are ALARP and tolerable. Stowage positions for munitions with shaped charge warheads should be chosen so that the warhead is directed away from other adjacent munitions. If possible these munitions should be placed facing ship structure, ideally not within 1.0 m of packaging, so that the shaped charge effect is dispersed and scattered. Account is to be taken of compartments or the environment on the other side of the warhead direction and the consequences of high velocity jets escaping to these areas. Refer to Appendix 10.1.32 .
18	Missiles (and sub-munitions) must be prevented from flight, which can arm their fuzing systems. Refer to Appendix 10.1.30.
19	Missile efflux can initiate other munitions by torching if allowed to play on other weapons and torching through structure releasing effects into adjacent compartments. Combustible materials may not withstand the flame torching when a missile is fired and should therefore not be used or fitted in the path of efflux Refer to Appendix 10.1.30.

20	Movement of munitions should be minimised and space allowed for safe use of tools, test equipment and personnel access.
21	Dangerous Goods UN Classes 2 - 9 present a significant risk to explosives. Adequate segregation between other dangerous goods and explosives is essential to ensure that in the event of an accident there is no adverse effect on the explosives. Such segregation can be achieved by maintaining certain distances between the incompatible Dangerous Goods or by the use of separate compartments.
22	Compatibility groups and their permitted mixing are defined in order to reduce overall risk thus these principles of collocation should also be applied to the upper deck situation.
23	See Guidance Item 21 and 22 above

5.10 Guidance - Clearances between Stowages and Adjacent Boundaries

5.10.1 Heat transfer experiments [78] show that a clearance/stand off from the bulkhead/deck reduces the heat measured at a munition stowage to a tolerable level (prior to magazine spray or boundary cooling) even in the severe case of a large (1 MW) adjacent compartment fire - see Figure). Electrical equipment stood off from the bulkhead will also benefit, although heat will be conducted by the mounting arrangement.

5.10.2 A clearance of at least 60mm should be achieved to allow boundary cooling by first aid appliances or from magazine sprays to thoroughly wet the bulkhead. In the case of a large stowage (e.g. width >2 m), and where boundary cooling requires the use of a fire hose, a clearance of at least 60mm should be provided but preferably greater to allow access for typical RN centre fed hose reel or main fire hose nozzles (see also guidance at 0 and BR2170). Electrical equipment should also be 'stood off' to allow boundary cooling and spray water to flow down the bulkhead.

5.10.3 Where the clearance between bulkhead/deck and stowage is variable due to the shape of the bulkhead, a minimum of 20 mm clearance is to be achieved at all positions, with an accessible area where there is at least 60mm clearance to allow first aid boundary cooling.

5.10.4 Clearance from the hull or outer superstructure to assist heat dissipation is not specifically required because there is already a good insulating medium present (i.e. sea or air). If assessed as necessary, cooling can be applied externally by hose on the exposed boundary above the waterline or in accordance with normal BR2170 fire fighting boundary cooling practise, to adjacent bulkheads/decks/deckheads.

5.10.5 Clearance from the deck is not required in RFAs, NAVs and NALs because in general these vessels carry unit loads, either of pallet type or special to type containers. Such loads in general have a gap underneath to allow fork access. Furthermore, in most cases the working “deck” in an RFA magazine is the flow forge deck, which is itself raised off the compartment deck, thus allowing plenty of room for water flow underneath.

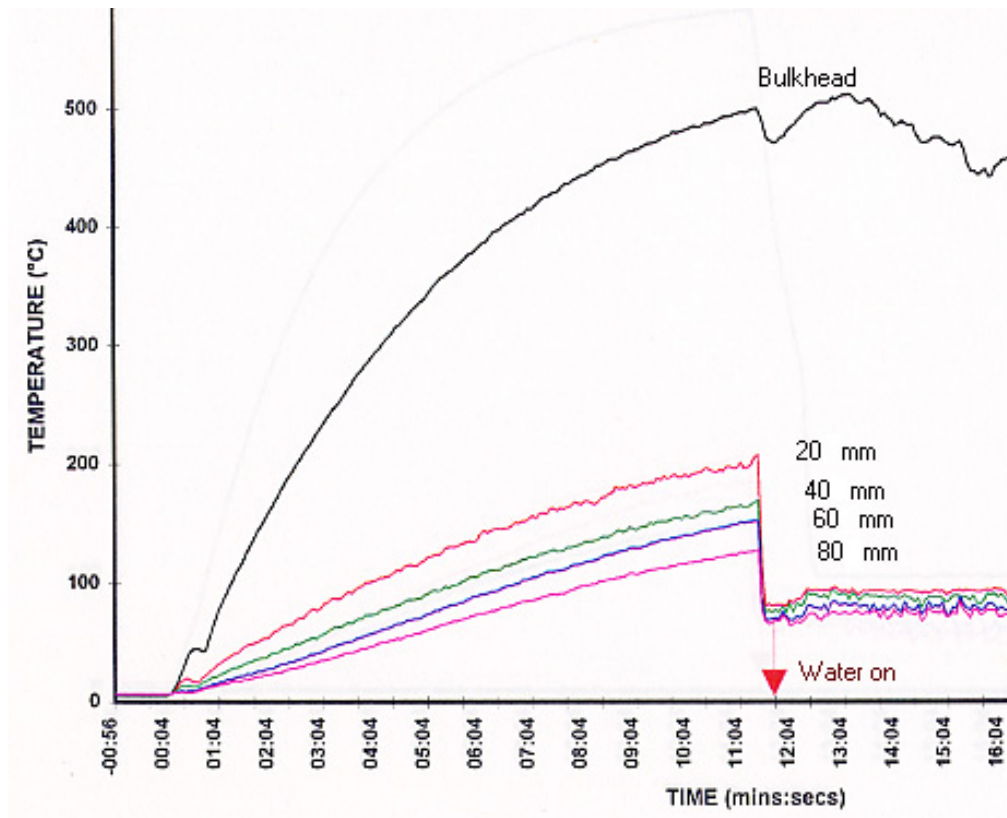


Figure 2 - Temperature at the Magazine Bulkhead and at Distances from the Bulkhead in the Magazine when Subject to a 1 MW Fire in the Adjacent Compartment.

5.11 Guidance - Identification of Stowages and Stowage Capacity

5.11.1 Identification of stowages is intended to assist in location of stores for operational purposes and in audit and accounting.

5.11.2 The position of lines marking maximum permissible capacity is to take into account sprayhead clearances and the manual handling limits specified in Def Stan 00-25.

5.12 Guidance - Permitted Magazine Contents

5.12.1 The safety case provides justification for a specific number of particular munitions (and other equipment) in a given magazine. A list of magazine contents is to be prepared for each magazine and magazine locker. RN Form S285K is to be used to list the permitted contents of magazines and magazine lockers.

5.12.2 The primary purpose of the RN Form S285K is to ensure that the Officer of the Quarter (OOQ) complies with the design intent by stowing only the number and type of munitions (and other equipment) cleared by the safety case.

5.12.3 An A4 sized holder for RN Form S285K is appropriate in Small Magazines and Magazine Lockers.

5.12.4 Minor variations between the total number of munitions specified for the Class/Batch in the Armament Statement/Entitlement List and the maximum number that may actually be stowed safely should be identified in the RN Form S285K.

5.12.5 For palletised stowages in warships, a set of stowage plans is required for the most common likely types of outload. Further guidance is given in JSP 862. For bulk explosives stowages in warships and RFAs, stowage plans are to be prepared for each outload in accordance with JSP 862.

5.12.6 The chalkboard or laminated board is used to enable operational movements to be recorded in Action and Defence States. It is only necessary to list the major munition types likely to be expended in operations, together with a small space for messages. It will be used to keep a running total of usage for later ledger action.

APPENDIX 6 MAGAZINE LOCKERS

6.1 Description

6.1.2 Magazine Lockers are lockers designed and constructed for the safe stowage of explosive stores for which specific or 'built in' magazine compartment facilities have not been provided. They are free standing and should be surrounded by an air gap, but may be recessed into the ship's structure. A locker does not normally have an 'adjacent compartment' because of this air gap. Each locker is considered to be a separate stowage.

6.1.3 Ready Use (RU) Magazine Lockers or 'RU Lockers' are used for the temporary stowage of small quantities of explosives for immediate use and because of reduced time at risk have slightly different requirements to permanent stowage Magazine lockers (see below).

6.1.4 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the design safety and installation of magazine lockers in MOD ships.

6.2 Performance Requirements for Magazine Lockers - General

6.2.1 See Def Stan 02-179 for performance requirements.

6.2.2 Ready use Stowages including lockers for Safety Of Life At Sea (SOLAS) and explosive stores for immediate use in all MOD ships shall be compliant with Maritime and Coastguard Agency (MCA) regulations as a minimum.

6.3 Performance Requirements for Magazine Locker Flooding Arrangements

6.3.1 Appropriate measures are to be taken to permit the flooding of magazine lockers in the event of a fire (except where justified in the SESC, lockers containing only: HCC 1.4S munitions RU lockers, depth charge fuze and detonator RU lockers).

6.4 Performance Requirements for Siting and Installation of Magazine Lockers

6.4.1 Sufficient magazine lockers are to be provided to permit the stowage of munitions to meet the requirements for separation of Compatibility Groups as detailed in JSP 862.

6.4.2 Magazine Lockers shall not normally be sited in any of the compartments listed in Appendix 3.1.5 or 3.1.9. above

6.5 ACOP for Magazine Locker Design

6.5.1 The following code of practise for safe design of magazine lockers should be followed in addition to the design requirements of Def Stan 02-179/NES 179:

- a. Locker doors and lids should be rigid enough to withstand distortion/cracking in operation and, with the exception of Detonator Lockers and RU lockers, capable of achieving a good watertight seal.
- b. Clips and closing arrangements should not be distorted or able to rotate freely or spring open under the influence of ship motion, vibration or shock.
- c. Racks, sections and shelves within the locker should be clearly marked for instant recognition. Each item should be provided with adequate supports and restraints, consistent with rapid removal.
- d. Unless the vessel operates solely within UK waters, Magazine Lockers sited on weather decks should be fitted with solar cladding to form a 25 mm (tolerance - 3 mm) air gap.
- e. The use of composite materials in the locker carcass may remove the requirement for solar cladding - see guidance below and Def Stan 02-179.
- f. Magazine Lockers should be capable of withstanding full flooding from the ship's fire main and maintain watertightness and structural integrity.
- g. Response Force Lockers are to meet the requirements of RU Magazine Lockers (see guidance section).
- h. RU 7.62 mm General Purpose Machine Gun (GPMG)/12.7mm Calibre machine gun ammunition should be stowed either in a secure locker or a 'pigeon hole' type of stowage fitted with locking arrangements.
- i. Ventilation arrangements should be provided to the locker; these are to incorporate anti-sabotage arrangements.

6.5.2 The environment within Magazine Lockers should meet the environment specified for the specified munitions Part 4 of this standard (the GNE) and the applicable SRD.

6.5.3 Fixed stowages should be provided for portable stowage restraints/battens, chocks, and wedges etc., when not in use. Precautions should be taken to ensure that all portable battens, chocks, wedges etc do not rattle when placed in their stowage position.

6.5.4 MCA requirements for stowage of SOLAS stores for immediate use are given in Merchant Shipping Life Saving Appliances Regulations SI 1986/1066. In summary they must be retained in a cupboard or box unless their size precludes this (e.g. Marker Man Overboard). In NAVs, NALs, GoCo vessels, STUFT, and all other minor vessels including MOD yachts, ships' boats, LCVPs and other tenders and boats this will generally be the only SOLAS store stowage. In warships, RFA vessels and LCUs, separate stowage in appropriate magazines/magazine lockers should be provided for spare SOLAS stores to replenish stores used and to stow safely the whole SOLAS outfit when in harbour. Warships and RFAs will generally carry additional or more effective safety of life explosive stores than the minimum SOLAS requirement.

6.5.5 Magazine lockers containing RATTAM susceptible munitions should be RATTAM protected in accordance with Appendix 11.

6.5.6 RATTAM protection may be fitted in lieu of solar cladding subject to the air gap of 25 mm being maintained.

6.6 ACOP for Magazine Locker Flooding Arrangements

6.6.1 Magazine Lockers (except RU Lockers, Depth Charge fuse RU lockers, and Detonator Lockers) should be provided with individual manual flooding arrangements. Lockers containing only HCC 1.4S munitions may not require a flooding arrangement but this shall be justified in the SESC.

NOTE: Magazine Lockers with spraying arrangements may retain these facilities.

6.6.2 The seawater system branch pipe for flooding Magazine Lockers should be capable of isolation to facilitate maintenance of the flood-operating valve. Inadvertent operation of the isolation facility must be prevented by suitable means.

6.6.3 The Magazine Locker flood valve operating position should be sited either in a protected position, i.e. screened from the locker, and at least 3 metres from the locker, or greater than 5 metres away from the locker in an unprotected position.

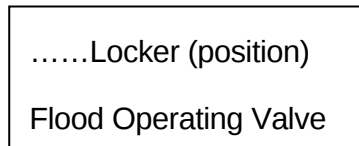
6.6.4 A suitable facility should be fitted in the branch pipe immediately down stream of the flood isolating valve to indicate readily if the valve is passing.

6.6.5 Pressurised parts of flood (or spray) pipe systems exposed to atmosphere should be lagged and/or trace heated in accordance with the electrical requirements of Part 3 of this standard, to prevent freezing.

6.6.6 Special requirements apply to Magazine Lockers containing White Phosphorus stores. Are to be found in Appendix 1 and 4.

6.6.7 Each flood operating and isolating valve should have a clearly visible sign adjacent to it that identifies the magazine locker served, position/location, the purpose of the valve and the normal system valve line-up position, e.g. "locked closed" to identify valve function. Operating instructions should also be provided adjacent to these positions.

6.6.8 Valve identification signs are to be in WHITE text on a RED background in accordance with the requirements of Def Stan 02-784/NES784 e.g.,



6.6.9 Anti-sabotage drainage arrangements should be provided to the locker to meet requirement of JSP 440.

6.6.10 Drain facilities should be identified by a notice, displayed in a prominent position, with the words 'DRAIN' in BLACK text on a WHITE background together with a BLACK arrow.

6.6.11 All locking arrangements should be in accordance with Def Stan 07-207/NES 142.

6.7 ACOP for Siting and Installation of Magazine Lockers

6.7.1 The following design guidance for siting of magazine lockers should be taken into account:

- a. Magazine Lockers are not normally sited within ship's structure. In particular, Lloyds Naval Rules specifies that Magazine Lockers are not to be sited in compartments listed in Appendix 3.1.5 and 3.1.9.
- b. Magazine Lockers should be sited clear of structure, on all sides, to allow adequate cooling and ship husbandry activities.
- c. Magazine Lockers should not to be welded directly to the deck.
- d. Where appropriate door/lid 'hold open' arrangements should be provided.
- e. Magazine Lockers should be sited so that their contents cannot be damaged by gun blast, and are clear of any rocket/missile launcher. The efflux from the rocket or missile at launch, or in flight, should not pass over or infringe the lockers.
- f. Magazine Lockers should be sited so as to be screened from RATTAM type attack where possible

6.7.2 Physical protection against unauthorised access and sabotage is to be achieved.

6.8 ACOP for Detonator Locker Requirements

6.8.1 Detonator Lockers may be sited in either, the Torpedo and Anti-Submarine (TAS) store, Gunners Store or any MOD approved dry secure storeroom provided the total Net Explosive Quantity (NEQ) of the detonators does not exceed 1 kg per storeroom. The storeroom is to be locked in accordance with the requirements of JSP 440.

6.8.2 Detonator Lockers should not be sited in compartments subject to: temperatures above 32°C, excessive vibration or which contain flammable liquids, solvents, mixed paints, acids in bulk, or any material liable to spontaneous combustion.

6.8.3 Where the total NEQ of the detonators to be embarked exceeds 1 kg, stowage should be provided either by siting Detonator Lockers in a dedicated Detonator Magazine, sited below the waterline, or in a number of dry secure storerooms. See guidance below in Appendix 6.13.

6.8.4 Detonator Lockers should be sited at least 60 mm from the compartment boundary and should not be secured to the ship's side.

6.8.5 Where up to 4 in number Detonator Lockers for Compatibility Group B class stores are sited in the same compartment, they may be bolted together provided that an 8 mm (minimum) mild steel plate is fitted between each locker. The 60mm minimum air distance should be provided between the lockers and the compartment boundary. See guidance below at Appendix 6.13.

6.8.6 To facilitate handling of detonators, sloping ladders should be fitted to compartments/Detonator Magazines/ammunition routes. Where vertical ladders are provided, haversacks should be provided to carry the detonators.

6.9 ACOP for Depth Charge Fuze RU Magazine Lockers

6.9.1 A Depth Charge Fuze RU Magazine Locker, containing up to 4 kg NEQ, may be fitted in the Air Weapons Magazine. Where more than one locker is required, they should all be sited on the weatherdeck, near the depth charge fuze area.

6.9.2 When fitted in the Air Weapons Magazine, a 100 mm minimum air distance should be provided between the locker and the compartment boundary - measured from the bulkhead plating.

6.10 ACOP for General Locker Notices and Notice Boards

6.10.1 Upperdeck Magazine Lockers should be painted with the colour of the ship's side or adjacent superstructure.

6.10.2 Warning notices should also be painted on the locker in 50 mm high 'RED' lettering. Lettering should be as follows:

- a. Magazine Locker lettering to read 'DANGER EXPLOSIVES'.
- b. RU Magazine Locker lettering to read 'READY USE ONLY'.
- c. For RU Lockers a notice board marked 'DANGER EXPLOSIVES' is also to be provided for display when the locker contains explosives.

6.10.3 Markings should be visible across the front or top of each locker, or in the case of lockers over 1.5 m in height, on the deck immediately in front of the locker.

6.10.4 Internal Magazine Lockers (including Detonator Lockers and Response Force Lockers) are to be fitted with an explosives warning sign in accordance with Def Stan 02-784/NES 784.

6.10.5 Detonator Lockers should be painted RED with the word 'DETONATORS' painted in 20 mm high WHITE letters across the front of the locker.

6.11 ACOP for Magazine Locker Contents

6.11.1 Magazine lockers should be provided with the following items:

- a. Magazine Designed Capacity List (RN Form S285K) and holder;
- b. Temperature record card (RN Form S285C) stowage;
- c. Maximum/minimum thermometer stowage.

6.12 ACOP for Small Quantity Top Up (SQTU) Magazines

6.12.1 Small Quantity Top Up (SQTU) Magazines should be located close to Replenishment in Harbour (RIH) dump areas. This provision is to stow explosive stores/munitions replenished alongside, which cannot be struck-down immediately after embarkation due to the safety restrictions placed on moving munitions whilst alongside. Suitably positioned RU magazine/RU magazine lockers may be used for this purpose. SQTU magazines are defined in Annex C.

6.12.2 The permitted quantity and the compatibility of the explosive stores/munitions shall be taken into account when SQTU magazines are considered. Guidance on the requirements and quantities of SQTU munitions that may be embarked/disembarked is given in JSP 862.

6.13 Guidance - Safety of Magazine Lockers and Detonator Lockers

6.13.1 Lockers containing CG B detonators, should only contain a limited NEQ and should not have a volume greater than 3 m³. The provision of upper deck lockers for the stowage of explosive stores/munitions should be kept to a minimum to reduce Radar Cross Section (RCS) ship vulnerability. Where larger quantities of munitions or significant quantities of UN HD 1.1 munitions are required to be stowed, a small magazine or magazine should be provided. Application of the design requirements specified in Part 3 of this standard should eliminate any risks from electrical equipment. Design to meet the appropriate fire prevention and fire fighting provisions of this standard and of the Fire Safety Management System requirements will help to reduce fire risks.

6.13.2 The SRD should specify the environment within Magazine Lockers. The environment specified in the GNE in Part 4 of this standard may be used as a template. To achieve this in non-UK waters, solar cladding will be required for steel lockers. Due to the low thermal conductivity of GRP and similar materials, solar cladding may not be required depending on the design of the locker. However, other considerations such as humidity, Radar Cross Section and the need for RATTAM protection may influence the choice of locker construction materials.

6.13.3 GRP may be used to construct Magazine Lockers. It has some advantages over steel.

6.13.4 Material placed within a GRP locker will be protected from elevated external temperatures for longer period of time as GRP is generally a poorer conductor of heat than steel.

6.13.5 It is generally true that a GRP structure, of equivalent weight to a steel structure, would be more able to arrest or mitigate the effects of fragments generated from a detonating munition.

6.13.6 The GRP carcass may be moulded with RCS attenuating material embedded onto or within the composite itself.

6.14 Guidance - Flooding of Magazine Lockers

6.14.1 Where appropriate, a float-operated valve may be fitted that turns off the supply once the locker is completely flooded

6.14.2 Where appropriate, a sealed key safe with a transparent frangible front containing the key to the operating valve may be fitted adjacent to the valve operating position. This is likely to be required where the flood valve is a deck valve requiring a special key.

6.14.3 It is generally assumed that the small quantity of explosives in a RU magazine/locker and the limited time at risk will result in an assessment that flooding is not required for RU magazines/lockers. In the particular case of Response Force lockers, the consequences of any potential incident to the small quantity of HCC 1.4S stores inside are very unlikely to justify a requirement for flooding. The same argument is likely to apply to any Magazine Locker containing only HCC 1.4 S munitions.

6.15 Guidance - Detonator Lockers

6.15.1 Hazards arising from adjacent equipment/stores should be considered for detonator lockers. Where more than one detonator locker is required, mitigation between lockers may be achieved by appropriate use of intervening stores/equipment and by placing the lockers at least 1 m apart.

6.15.2 Where only small quantities of detonators are required, it is recommended that they be supplied in special purpose-designed and lined H83 boxes such that they can be Classified as UN HCC 1.4S. Such boxes may be safely stowed with other stores.

6.15.3 Where Detonators are required to be stowed in bulk on ships not manned by RN personnel, a separate secure compartment, within or outside a magazine, should be provided. Detonator lockers to hold less than 1 kg NEQ in RFAs should comply with Appendix 6.8.1 above.

6.15.4 The separate secure compartment is to be sited at least 2.5 m from ship's side and surrounded by steel bulkheads of a minimum of 8 mm mild steel plate.

6.15.5 Detonator stowages are to consist of either a lined system of pigeon hole stowages with a maximum of 2 boxes per pigeon hole or Detonator Lockers.

6.15.6 Adjacent Detonator Lockers are to be separated by a minimum of 8 mm mild steel plate. Pigeon hole stowages are to be made of a minimum of 8 mm mild steel plate.

APPENDIX 7 FIRE PREVENTION

7.1 Description

7.1.2 Fire Prevention measures in magazines, magazine lockers and DDAs are designed to reduce the probability of a fire incident involving munitions to ALARP. As one of the primary risks to explosives, magazine and DDA Fire Safety is uniquely regulated by NAExp, however an important interface exists with whole ship Fire Safety, the Key Hazard regulated by NA Fire (MESH FS) under NAR Chapter 7. MESH FS are also the sponsors of the Damage Control and whole ship fire fighting Defence Standards, BR's are Subject Matter Experts and equipment sponsor for many system components used within magazine spray systems.

7.1.3 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the design safety requirements for fire prevention relating to munitions in MOD ships.

7.1.4 Knowledge of the munitions' reaction to various heating regimes (as described in Part 4 of this standard, STANAG 4439, STANAG 4240, and STANAG 4382), and the operational environment is required to determine the nature of the fire prevention measures required.

7.1.5 Munitions may spend 95% of their time or more in a platform in a quiescent state in the magazine. The explosives SMS should address the fire prevention precautions required to provide assurance that the munitions remain safe. This includes rounds of magazines and adjacent compartments in accordance with JSP 862. The specific procedures that personnel undertaking rounds carry out related to fire prevention are detailed in JSP 862.

7.1.6 For the small proportion of time onboard that munitions are being handled for embarkation/disembarkation, testing/maintenance/preparation and use, the physical precautions identified in this standard are designed to reduce the risk of fire. These precautions are set out in appendix 16 (Ammunition handling – embarking, stowing and supply), Appendix 15 (Static control requirements and conducting decks), appendix 2 (DDAs) and Appendix 4,5 and 6 (design of magazines, stowages and lockers). Further procedural precautions are given in JSP 862.

7.2 Performance Requirements for Fire Prevention

7.2.1 The design of magazines and DDAs in MoD ships is to ensure that the risk of initiating or sustaining a fire is ALARP and tolerable.

7.2.2 The measures taken are to be detailed in the design. Design safety justification for the fire prevention measures are to be detailed in the DDD. Guidance on procedural fire prevention measures and the safe system of work (SSOW) are given in JSP 862.

7.2.3 Fire Prevention measures must meet the explosives SMS and Safe System Of Work (SSOW) requirements of JSP 862, other SEMS and Key Hazards area as appropriate. The duty holder shall take measures to ensure that all relevant requirements are satisfied.

7.3 Fire Prevention Through Design

7.3.1 In addition to the general design guidance for DDAs, Adjacent Compartments and Magazines given in this standard, there are a number of specific measures that can be taken in the design of the magazine to reduce the risk of fire. Examples that should be considered in magazine and DDA design are:

- a. Pipes conveying or venting flammable liquids or gases (including engine/generator exhaust gases) should not to be routed through magazines.
- b. Hydraulic pressure systems, HP air systems and exhaust pipes should not be taken into, or led through magazines, except where they serve equipment in the magazines.
- c. Flammable gas bottle stowage's should not be sited either in a position to cause risk to a magazine or within 6m of a weapon launcher or magazine locker
See Appendix 3.3.5
- d. The relevant authority (MESH FS) should approve pipework couplings for fire fighting spray systems, hydraulic and pneumatic systems as suitable to minimise fire risk.
- e. The use of wood in magazines and magazine furniture and fittings should be kept to a minimum. Where necessary, hardwood is to be used. Generally, wood should not be flame retarded but left clean and unpainted unless specifically being used as a part of an DSS NAExp approved mitigation system where fuel fire is considered a credible hazard.

7.3.2 Where the protection afforded by adjacent compartments is used as part of the overall magazine protection 'system' some design and use constraints may apply to the adjacent compartments and as such, fire prevention techniques may similarly apply.

7.3.3 Where it is necessary to install machinery in the magazine for handling munitions, the choice of prime mover for the machinery should be the subject of a risk assessment as part of the design process. The following risk reduction measures from a fire prevention aspect should be considered in the design:

- a. Where the design solution uses hydraulic machinery, the operating fluid should be non-flammable. Any pressure relief valves fitted should vent/discharge outside the magazine.
- b. Where the design solution uses pressurised air machinery, the operating pressure is to be kept as low as possible to reduce the risk of any equipment pressure burst propagating high velocity fragments.
- c. Where the design solution uses electrical machinery, the equipment should comply with Part 3 of this standard.

7.4 Fire Prevention Through the Explosives Safety Management System

7.4.1 General regulation on procedure for fire prevention for explosives safety is given in JSP 862 supported by the design and equipment requirements of Appendix 8 of this standard. The development, implementation and adherence to the procedures of an effective fire prevention SMS applied to explosives play an important part achieving and maintaining ALARP levels of risk on board.

7.4.2 Fire prevention best practise, advice and Regulation on a whole ship basis is the responsibility of NA Fire (MESH FS) and the requirements of their Def Stan 07-204 and BR2170 for Damage Control and Firefighting are fundamental to magazine and explosives areas with regard to fire prevention measures.

7.4.3 Awareness of the fire prevention requirements of these documents and the SESC can be heightened through the display of Fire Safety Notices both inside and outside the magazine and in areas of the ship adjacent to the magazine. Design and display of the notices should be in accordance with Def Stan 02-784.

7.4.4 A suitable laminated Fire Safety Notice for display onboard is RN S1149 (3/95).

APPENDIX 8 FIRE FIGHTING ARRANGEMENTS

8.1 Description

8.1.1 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the provision of suitable arrangements for fire fighting systems in magazines and DDAs in MOD Ships. The specific protection requirements for Magazine Lockers are given in Appendix 6 of this standard.

8.1.2 It is critical for the designer to conduct a fire hazard assessment for the areas requiring protection as part of the Overall Platform Design Safety Strategy described in MAP 01-103. This must also be linked with the whole ship fire assessment required by NA Fire in NAR Chapter 7. These actions should determine the credible fire sources to be considered and the performance required to prevent event escalation before selecting an appropriate fire fighting system for the explosives stowage and handling areas.

8.1.3 The ACOP below gives current best practise based on existing magazine fire threats, stowage designs and compartment sizes (typically Frigate based). The stowage design, density, compartment dimensions (height and volume) and munition packaging/container design all have a critical effect on fire fighting system performance, and must be considered carefully. Therefore the current ACOP may not provide an ALARP solution to future ship designs.

8.1.4 DSS NAExp in its continual Research and Development (R&D) programme to investigate the latest fire fighting technologies and mitigation techniques for magazines has included additional guidance, on Fire Hazard and Munitions Protection Assessment which can be found in ANNEX I along with a process map.

8.2 Performance Requirements for General Fire Fighting Arrangements

8.2.1 Five primary performance requirements are to be satisfied in reducing to ALARP both the risk to munitions from fire and risk to the ship from munitions on fire, actual arrangements are to be justified in the SESC. The essential requirements for fire fighting arrangements in magazines, small magazines and DDAs are:

- a. To reliably detect the presence of excessive heat, fire or smoke.
- b. To react to the fire detection stimuli to provide early warning alarms and for automated systems, to activate fire suppression in a time that prevents escalation of the event.

- c. To provide rapid effective containment and cooling of an event within or outside such spaces as to prevent escalation of that event. Wherever possible the fire source should be extinguished, where this is not possible, effective suppression and cooling of munitions, surfaces, boundaries and environment should be achieved to control the event and maintained for an adequate period of time.
- d. To ensure fire detection, alarm and suppression system designs for such spaces follow a systems engineering approach and that supporting ship systems are integrated with them to ensure the required level of performance.

8.2.2 Advice on suitable arrangements for magazines, small magazines and DDAs is given in the ACOP. General requirements for fire fighting systems, including sea water supply, are given in Def. Stan. 07-204 Part 1.

8.2.3 The fire fighting arrangements in magazines, small magazines and DDAs shall meet the explosives SMS and SSOW requirements of JSP 862, other SEMS and other ship Key Hazard Certification requirements. In particular the requirements of Naval Authority Fire and associated whole ship Fire Safety Certification shall also be met outside magazines and DDAs where applicable. The duty holder shall take measures to ensure that all relevant requirements are satisfied.

8.3 ACOP for Common Principles of Fire Detection and Spray Control Systems

8.3.1 An adequate number of heat and smoke detectors are to be fitted throughout the magazine area.

8.3.2 Where designed to activate the spray system, they must react, either directly or through an integrated control system, to operate the spray system in the magazine in a time that is sufficient to prevent escalation of the event. Current guidance on this time is given in Rapid Reaction Spray System (RRSS) ACOP below.

8.3.3 Where the detectors are linked to a control system that initiates the spray system, the control system should be located outside the magazine. The control system should be provided with interlocks and remote testing facilities that permit routine testing and maintenance to be carried out without hindering the operation of the system.

8.3.4 Where the magazine is large (requiring more than one sprayhead) consideration should be given to configuring the system into zones, a maximum of 4 is recommended, such that a whole magazine is not "wetted" when a fire/heat source is confined to a small area. However, the use of zoned systems must be justified to DSS NAExp and designed carefully to ensure fire fighting performance is maintained as this can adversely affect some small droplet/low flow spray/mist systems as the benefits of local oxygen depletion are lost.

8.3.5 When the detection and control system is activated separate audible and visual alarms should be operated locally outside the magazine and at appropriate remote positions throughout the ship.

8.4 ACOP for Fire Detection

8.4.1 Fire detection arrangements should comprise measures for smoke, flame and heat detection, as identified in the ACOPS below.

8.5 ACOP Smoke Detection Alarms

8.5.1 To achieve an acceptable level of protection the minimum number of smoke detectors should be determined on deckhead area, based on the following guidance:

Deckhead area $< 12 \text{ m}^2$: 1 sensor fitted

Deckhead area 12 m^2 to 25 m^2 : 2 sensors fitted

then, 1 extra detector for every additional 50 m^2 (or part thereof)

8.5.2 Where the size of the magazine requires the spray system to be configured into zones, in accordance with Appendix 8.3.4 above, the number of smoke detectors calculated from the table above should be shared as equally as possible between each zone.

8.5.3 Any single smoke detector signal should activate audible/visible alarms, both locally and remotely in the SCC/HQ1, or other locations appropriate to the ship's protection organization. The alarms are to operate independently of controls to activate the spray system.

8.5.4 In ships where the SCC or ship's protection organization is not continually manned, additional alarms should be fitted next to the Officer of the Watch position at sea, and next to the Quarter Masters position in harbour.

8.5.5 Where there is a potential fire risk, adjacent compartments should also be fitted with smoke detection measures, for early warning of a fire incident.

8.5.6 Detailed Guidance on best practise relating to smoke detection is contained in Def Stan 02-603.

8.6 ACOP Heat Detection

8.6.1 To achieve an acceptable level of protection and to allow for a level of built in redundancy, there should be a minimum of 3 heat detectors for the magazine with the recommended maximum distance between detectors not greater than 9m and distance from detectors to bulkhead not more than 2m. Where there is no adjacent compartment hazard, the 2m distance from the bulkhead/ships side can be relaxed.

8.6.2 The detectors should be sited just below the deckhead and distributed across the deckhead, taking into account the layout of the magazine, potential heat flow distribution and the relationship of its boundaries to the potential risk from the adjacent compartment/area.

8.6.3 Consideration should also be given to the fitting of detectors that detect the rise in bulkhead temperature due to fire in an adjacent compartment.

8.6.4 The heat detectors may either provide a continuous readout of temperature that the system control unit can electronically process, or be of the form where the device triggers or activates at a preset temperature (68 degrees C).

8.6.5 Detectors should be of low thermal inertia capable of sensing and responding to extremely steep temperature/time gradients of at least 25 degrees C per second.

8.6.6 Any single heat detector signal indicating 68 degrees C or more is to activate audible/visible alarms, both locally and remotely in the SCC/HQ1, or other locations appropriate to the ship's protection organization. The alarms are to operate independently of controls to activate the spray system.

8.6.7 Each detector must be capable of individually sensing and responding to heat stimuli. i.e. the system should not be configured with combined detector loops.

8.6.8 Where there is a potential fire risk, adjacent compartments should also be fitted with heat detection measures, for early warning of a fire incident.

8.6.9 Guidance on best practise relating to heat detection is contained in Def Stan 02-603.

8.7 ACOP for Magazine Spray Systems (General)

8.7.1 The selection of an appropriate magazine fire suppression and cooling system must be based on a fire hazard and munition protection assessment. The advice of DSS NAExp and NA Fire (MESH FS) should be sought as appropriate.

8.7.2 This ACOP below gives current best practise based on existing magazine fire threats, stowage designs and compartment sizes (typically Frigate based). The stowage design, density, compartment dimensions, munition type, packaging or container design will all have a critical effect on fire fighting system performance, and must be considered carefully. Therefore the current ACOP may not provide an ALARP solution to future ship designs. Of particular concern should be any design where the aforementioned design parameters vary from those found in existing magazine designs and where large quantities of propellant and/or certain Insensitive Munitions may be stowed due to their potential to contribute to very large deflagration events (albeit detonation may be less of a concern).

8.7.3 A water based spray system should be fitted within the magazine which delivers water quickly enough, in sufficient quantity and with adequate coverage to meet the Performance Requirements in Appendix 8.1.2. Gaseous systems do not cool effectively enough to be considered for magazine protection on their own although their use in combination with a water based arrangement would not be ruled out if fully justified.

8.7.4 Modern water mist or fog systems have attractive benefits with low water usage requirements and good atmospheric cooling and suppression capabilities, particularly in well enclosed areas. However they have yet to be demonstrated in magazine scenarios or against munition fire loads and trial evidence suggests their low application rates may be a drawback when seeking to ensure rapid surface cooling over large areas or in large volumes.

8.7.5 The preferred system at present (and based on a series of trials during the 1980's) is the Rapid Reaction Spray System or RRSS. This is a generic term for a fully automatic system activated by heat detectors (smoke detectors in early versions) and supplied with seawater at 7 bar from the ship's High Pressure Sea Water (HPSW) / fire main. Using an automated spray control valve (with manual intervention mode) the system uses normally dry pipework, within the magazine and open ended large droplet sprinkler nozzles capable of protecting 9m^2 of deck area from a height of 3m at a delivery rate of 30l/min/m^2 . This has proved to be a relatively low-maintenance system with reduced risk of leakage and corrosion of the magazine pipework. In many ships it is supplemented by a backup pressurised reservoir to ensure reaction times can be met while fire main pumps provide full flow to the nozzles.

8.7.6 Suitable nozzles (see Annex I Table 1 & Annex L for spray head layout) are to be selected and arranged within the magazine so that all stowages and boundaries will be covered with a water spray pattern optimised to the munitions stowed. Where boundary cooling is required, it is essential that the whole bulkhead (up to the deckhead joint) is effectively sprayed. Boundary cooling of bulkheads is not required when the 'boundary' is the ship's side or a compartment/ tank containing water.

8.7.7 Drainage should be configured to enable water to remain on the deck to provide boundary cooling in the event of a fire in the compartment below but removed quickly when required.

8.7.8 To achieve adequate coverage the following guidance is given, although the specific configuration must be determined on a case-by-case basis and justified in the SESC:

- a, The distance between nozzles and between nozzles and bulkhead where boundary cooling is required should be assessed using the guidance contained in Annex I
- b, Munitions should be stowed such that the underside of the nozzle is at least 300mm clear of the top munitions.

- c, Where the 300 mm clearance is not achievable, additional nozzles may be fitted in lieu in order to provide the required spray coverage.
- d, A reduction in nozzle/munition stack clearance to between 250-300 mm could be considered for up to 25% of the total number of nozzles, provided adequate coverage is still obtained.
- e, Additional nozzles should be considered for directing specifically at the warheads in munitions such as Torpedoes, Depth Charges and Guided Weapons.

8.7.9 Whenever munitions are present in the magazine, the design of the water supply systems should enable the immediate availability of an adequate water supply.

8.7.10 Facilities are to be provided to enable the spray system to be flushed and drained. A means of clearing any obstructions is also to be provided.

8.8 ACOP for Rapid Reaction Spray Systems (RRSS)

8.8.1 Where a RRSS is chosen as the design solution, it should react rapidly and reliably to detector stimuli and be capable of three modes of operation:

- a, Automatic - the system should operate when a valid detection is sensed, as defined below. Existing RRSS's are activated in response to stimuli from either heat or smoke detection. The more modern systems generally react to heat detection and are preferred because they are more efficient.
- b, Manual - a facility is to be provided at both Local and Remote Control positions to switch from automatic to manual mode and to activate the nozzles.
- c, Manual Intervention – the ability to manually open the main seawater valve supplying the magazine.
- d, On simultaneous activation of at least 2 ionisation smoke detectors separately spaced in the magazine, the local control panel should command a power operated spray control valve to open and allow full water flow from the spray heads.
- e, The response time from a valid detection signal to full flow of water through the spray heads should be determined by the characteristics of the munitions within the magazine. Best practise indicates that response times to achieve full water flow in the range 8 to 20 seconds can be obtained without undue cost implications. Therefore, in line with ALARP principles, a time of 8 seconds or better should be the Basic Safety Objective with a time of 20 seconds being the Basic Safety Limit.

8.9 ACOP for RRSS - Heat Activated Systems

8.9.1 The system control unit may, if monitoring the sensor temperatures continuously, read all sensors simultaneously or poll each in turn. In the latter case each sensor should be polled not less than once every 100 milliseconds.

8.9.2 The system control unit should have an internal operating delay commensurate with the overall full water flow time requirements. This is likely to be in the order of 0.1 second on receipt of a valid detection to produce a control output to the power operated valve.

8.9.3 The system control unit should have facilities to enable "self test checks" of the sensors to be carried out as part of the routine maintenance procedures.

8.9.4 The system control unit should have facilities to enable full functional tests of the system to be carried out. The spray system should be configured such that the spray heads themselves may not be activated but that water flow from the downstream side of the operating control valve is checked and suitably discharged over board. Def Stan 07-204 part 3 provides guidance.

8.10 ACOP for RRSS – Smoke Activated Systems

8.10.1 A pressure switch is to be fitted in the air pipe from the air storage bottle to the solenoid valve to give audible and visual warning at the Control Panel, of low air pressure.

8.10.2 System isolating valves (locked open) are to be fitted upstream and downstream of the Pneumatic Spray Control Valve. The latter is for full functional test purposes.

8.10.3 For full functional test purposes, a 65 mm instantaneous hose connection terminating in a 40 mm bore ball valve and Locked Shut, is to be fitted on a short branch just downstream of the Spray Control Valve. A facility is to be provided to discharge the test water overboard.

8.11 ACOP for RRSS - Local and Remote Operation Requirements

8.11.1 Heat Activated Systems

8.11.2 Each magazine spray system is to be provided with a manual Local Control Facility (LCF) linked to the system control unit.

8.11.3 The LCF should be sited in a readily accessible position, adjacent to the magazine access. It should not be sited within another compartment or on a different deck level.

8.11.4 Each magazine spray system is to be provided with a manual Remote Control Facility (RCF) sited in the SCC/HQ1 or other location appropriate to the ship's protection organisation.

8.11.5 The RCFs for all the ships magazines should be co-located if practicable.

8.11.6 At least one deck, or a main watertight bulkhead, should separate the RCF from the LCF.

8.11.7 Design justification may show that a third operating position is required. This position is to be fully independent of the other manual operating positions. It is to be sited on the weatherdeck and must have its own emergency back up power supply.

8.11.8 In order to ensure that there is no inadvertent operation of the spray system at either the Local, RCF or Emergency Operating positions, suitable inter lock arrangements are to be provided in accordance with the security requirements given in Appendix 14.

8.11.9 If a key control system is provided as part of the inter lock arrangements, spare keys should be held in frangible fronted RED key boxes sited adjacent to the Local and Remote Control Facilities and Emergency Operating positions.

8.12 Smoke Activated Systems

8.12.1 Each magazine spray system is to be provided with a local Control Panel to enable manual activation of the Pneumatic Spray Control Valve.

8.12.2 The Control Panel is to be sited in a readily accessible position outside the magazine in an access lobby or passageway.

8.12.3 Each magazine spray system is to be provided with a remote Control Panel sited on the weather deck to enable manual activation of the Pneumatic Spray Control Valve.

8.12.4 The activation of the Pneumatic Spray Control Valve from the local and remote Control Panel is to be by key operated switch.

8.12.5 The remote Control Panel is to be protected in a lockable watertight cabinet.

8.12.6 All controls are to be clearly marked on the outside of each cabinet and the instructions for operating the controls are to be clearly indicated inside the cabinet.

8.12.7 A key for each cabinet is to be stowed in a breakable glass fronted key box, sited adjacent to the cabinet and Control Panel.

8.12.8 The RCFs for all the ships magazines should be co located if practicable.

8.13 ACOP for RRSS - Manual Intervention in Operation - Heat Activated Systems

8.13.1 The automatic spray control valve is to be provided with a means of enabling the water supply to be turned on manually.

8.13.2 Suitable protection measures and operating procedures should be implemented to ensure manual operation of the valve is only carried out under authorised conditions.

8.13.3 If a key control system is provided as part of the protection measures, spare keys should be held in frangible fronted RED key boxes sited adjacent to the local spray control valve.

8.14 ACOP for RRSS - Manual Intervention in Operation Smoke Activated Systems

8.14.1 The Pneumatic Spray Control Valve is to be sited in a readily accessible position outside the magazine in an access lobby or passageway.

8.14.2 The Pneumatic Spray Control Valve is to be capable of manual operation locally at the valve.

8.14.3 The Pneumatic Spray Control Valve, complete with actuator, air bottle and manual operating lever is to be suitably protected in a lockable cabinet. The cabinet and contents are not to be sited in any compartment that is capable of being locked.

8.14.4 All controls are to be clearly marked on the outside of each cabinet and the instructions for operating the controls are to be clearly indicated inside the cabinet.

8.14.5 A key for each cabinet is to be stowed in a breakable glass fronted key box, sited adjacent to the cabinet and Control Panel.

8.15 ACOP for Thermal Bulb activated Spray Systems

8.15.1 Subject to a suitable design safety justification being made and agreed by NAExp, thermal bulb activated automatic systems may be fitted in magazines and DDAs. These systems, which were in common use before the introduction of RRSS and remain fitted to many vessels, have the advantage of relatively simple and reliable detection and control systems, but can be prone to false activation as bulbs can be broken accidentally. As this is a fully pressurised system the use of high quality non-corrosive materials in these systems is essential and strict attention to condition of pipework and fittings is required. Two general types are common both fitted with thermal 'quartzoid' bulb sprayheads:

a. **Quartzoid Bulb Spray Systems (QBSS)** – basic system where a fire or heat breaks individual bulbs as they reach 68 (+/-5) degrees C admitting water through the nozzle only in that area. A known disadvantage of this system is that each sprayhead tends to temporarily cool its neighbour as it goes off resulting in a delay to complete activation of a grid if the fire is spreading relatively slowly.

b. **Metron Activated Spray Systems (MASS)** – a development of QBSS which allows the operator to activate all nozzles (or zones of nozzles) by electronically firing metron protractors fitted to each spray head. This may be in reaction to the flow alarm indicating one nozzle has been set off and their being time to confirm an event warrants complete drenching of the magazine as soon as possible or just because the situation warrants full activation (battle damage etc). A simple and flexible system which is a good compromise between the potential oversimplification of QBSS and complexity of some RRSS. A known problem has been inadequate system RADHAZ hardening resulting in false activation of protractors by neighbouring vessel's radar in a few cases.

8.15.2 The water nozzles, fitted with Quartzoid bulbs, should be designed to operate at a temperature not exceeding 68 (+/-5) degrees C.

8.15.3 Where liable to damage the Quartzoid Bulbs should be guarded, with design of the guard not adversely affecting the spray pattern.

8.15.4 The system must be pressurised with an adequate supply of water at all times when munitions are present in the magazine, and best practise indicates the need for fresh water priming.

8.15.5 A spray grid shut off valve is to be fitted in an accessible location either inside the magazine or outside and close to the access boundary of the magazine. Clear indication of valve open and shut positions is to be provided.

8.15.6 The spray grid shut off valve is to be operable at the valve only, and where sited outside of the magazine is to be locked open.

8.15.7 A system isolating valve is to be fitted between the strainer and Fresh Water Priming connection adjacent to the strainer. It is to be operable at the valve only and locked open.

8.15.8 A key is to be provided in a breakable glass-fronted key box, sited in close proximity to the valves. Where additional isolating valves are fitted in the system, they are to be locked-open and their keys held in accordance with the NBCD requirements.

8.15.9 Spray pipe fittings within the magazine are to be brazed in accordance with either Def Stan 02-743 Part 5 or BR 3013. A sufficient number of flanged or screw cone union fitments are to be incorporated to enable the system to be dismantled for repair.

8.15.10 For flushing and draining purposes, a 65 mm instantaneous hose connection with a 40 mm bore Locked Shut ball valve is to be fitted on a short branch between the spray shut-off valve and the flow alarm unit (Grinnell).

8.15.11 To facilitate air bleeding and periodic testing, a 12.7 mm lockable ball valve is to be fitted to the extremity of each branch of spray pipe. The valve is to have a screw thread suitable for connecting a length of plastic or rubber hose to enable water to be piped into a suitable container during testing operations. To prevent airlocks and ensure that this system is fully primed with water, additional lockable air bleed valves are to be fitted in the system.

8.15.12 In Metron Activated Spray System (MASS), the Piston Protractors are to be capable of breaking all the Thermal Bulbs by a manual initiation from a control box sited outside the magazine in an adjacent access lobby or passageway.

8.15.13 MASS activation systems and piston protractors must be suitably protected against RADHAZ to prevent false activation.

8.16 ACOP for Manual Spray Systems

8.16.1 A manual spray system may be fitted to upper deck launchers, normally loaded with torpedoes or guided weapons magazines containing water activated stores that need protection against the effects of false spray system activation. Including magazines housing small quantity of explosive stores e.g. pyro/smoke SQTU.

8.16.2 The system is normally dry consisting of open-ended spray heads fed from the HPSW main.

8.16.3 A spray control valve is to be fitted in the seawater branch close to the magazine access.

8.16.4 For upper deck launchers, sufficient nozzles should be provided to ensure that all parts of the launcher are completely drenched with water at an appropriate flow rate (see guidance) at the sea water main pressure, nominally 7 bar.

8.16.5 For upper deck launchers the spray valve is to be sited in the supply branch in close proximity to the launcher, but inside the ships structure.

8.16.6 The spray control valve is to be capable of both local and remote operation.

8.16.7 The remote operating position is to be separated by 1 deck or a main watertight bulkhead from the local position.

8.16.8 Each operating position is to be capable of independent operation.

8.16.9 For flushing and draining purposes, a 65 mm instantaneous hose connection with a 40 mm bore Locked Shut ball valve is to be fitted on a short branch between the spray shut-off valve and the strainer.

8.17 ACOP for Pressurised Fresh Water Reservoirs

8.17.1 For automatic spraying systems in magazines requiring large volumes of water instantly and where the fire main is not continuously pressurised or there is a lack of fire pump redundancy, a pressurised reservoir is to supply the magazine spray system, until working pressure is achieved by the Fire/SW main. Where the ship is fitted with a continuously pressurised fire main, with pumping redundancy of twice the capacity of the magazine spray systems or greater and justification can be provided of multiple fire pumps, with independence of electrical supplies, pump starting capability and prime movers, than a pressurised reservoir is not required. SME advice on pressurised reservoir design and where necessary HP air supply systems is available from MESH FS and MXS IPTs, this expertise should be consulted at the design stage to ensure achievement of MOD requirements.

8.17.2 A non return valve is to be fitted into the HPSW supply branch to prevent contamination of the pressurised FW system.

8.17.3 Each fresh water reservoir is to be easily accessible for inspection and maintenance and where fitted allow quick replacement of the pressure diaphragm.

8.17.4 A fresh water filling/draining connection and an overflow pipe fitted with a stopcock, is to be provided for each reservoir. A non-return valve is to be fitted in the discharge line.

8.17.5 The reservoir operating the pressure should be set to 1 bar above the normal HPSW system pressure

8.17.6 If air pressure is required, it should be provided to each reservoir by means of HP air bottles charged at 275 bar. Pressure reduction is to be achieved in two stages, reducing pressure to 70 bar and then to the operational requirement of 7 bar. One stage pressure reduction may be accepted subject to design approval.

8.17.7 The air bottles are to be charged from the ships HP air system with air driers and filters fitted as necessary to ensure the proper functioning of the pressure controllers.

8.17.8 For RFAs all pressurised reservoir systems are to be acceptable to both MOD and MCA.

8.17.9 All valves and cocks etc, are to be fitted with suitable locking arrangements and clear indication of open and shut positions.

8.18 ACOP for Seawater Supply Systems

8.18.1 Automatic spray systems should be fed from two separate sections of the ship's pressurised seawater main (for RFAs this may be the spray or fire main) and/or fresh water reservoir to achieve a degree of redundancy for these safety critical systems.

8.18.2 Each supply branch is to be fitted with an isolating valve close to the seawater main. An indicator at the valve should show clearly whether the valve is 'OPEN' or 'SHUT'.

8.18.3 To reduce the likelihood of sediment finding its way into the spraying system, each branch is to be led away from the sea water main with an upward tilt and a strainer is to be fitted close to and on the sea water main side of the alarm unit, in a horizontal portion of the branch and in an accessible position for ease of maintenance. In large ships (nominally over 5000 tonnes displacement) a second strainer is to be fitted on the sprinkler side of the locked open spray valve where the distance between the spray valve and the alarm unit makes this necessary.

8.18.4 For RFAs strainers are to be fitted whenever the spray supply is taken from the fire main or general sea water system. Where a completely separate spray system is fitted throughout the ship or holds, strainers need only be fitted adjacent to the spray pump.

8.18.5 An additional isolating valve may be required on the seawater side of the strainer to assist draining and periodic maintenance/cleaning, where the length of the supply branch is considerable.

8.18.6 Spray systems should be provided with a pressurised reservoir where there is insufficient water readily available in the sea water main to meet the spray system flow rate requirements or reaction times.

8.18.7 Where a reservoir is fitted, the system should be designed to prevent sea water ingress into the primed fresh water side of the system.

8.18.8 Where the seawater main cannot provide an adequate water supply, automatic spray systems - with or without fresh water reservoirs - should have additional sea water pump(s) started automatically to maintain spray system flow rate requirements.

8.18.9 It is acceptable in RFA Ship Defence, NAV's and Minor War Vessels (MWV) Magazines, fitted with automatic spray systems, to have manual fire pump start up on receipt of a signal from an early warning detection system, where no fully pressurised sea water main/firemain is fitted.

8.18.10 Where the spray system is normally pressurised, the design of the system should include arrangements for priming the spray grid with fresh water.

8.19 ACOP for Water Flow Sensors, Pressure Sensors and Associated Alarms

8.19.1 Water flow and pressure sensors are to be fitted at appropriate places in all spray systems.

8.19.2 The electrical supply to the sensors should be from the ships normal electrical supply, with an alternative back-up supply provided.

8.19.3 The sensors are to activate alarms as follows:

8.19.4 For RRSS: Visual and audible alarms fitted with a mute facility to enable quiet testing, are to be provided at the local control panel and at the SCC/HQ1. For RFAs and NAVs additional sensor alarms are to be provided either in the Bridge area or at any other control station that is provided with direct communication with the Bridge.

8.19.5 For QBSS/MASS: Visual and audible alarms, fitted with a mute facility to enable quiet testing, are to be provided adjacent to the magazine. In MWVs and RFA magazines for self-defence munitions, audible alarms are also to be provided on the weatherdeck. In ships where the SCC or ship's protection organisation is not continuously manned, additional alarms are to be fitted next to the OOW position at sea and next to the Quarter Master's position in harbour. In NAVs and other ships not manned by Naval personnel, the additional alarms are to be centralised either on the Bridge area or at any other suitable control station that is provided with direct communication with the Bridge.

8.19.6 Where Grinnell type Alarm Systems are installed the following applies:

- a, Each installation is to comprise of a flow valve, local alarm and diaphragm switch or switches, with associated electrical circuits to the local alarm and to the NBCD HQ/SCC.
- b, The flow alarm valve is to be fitted in the nearest convenient passageway, lobby or unlocked compartment and not in the magazine.
- c, The test and drain pipe from the flow alarm is to terminate into the nearest scupper.
- d, The action of water flowing through the flow alarm valve operates the diaphragm switch or switches. Operation of the diaphragm switch gives immediate indication at the spray VCS or Machinery Control and Surveillance (MCAS) unit in the NBCD HQ/SCC for that magazine.

NOTE: Provided that the flow of water to the diaphragm switch or switches is maintained for longer than 12 seconds the local alarm (YODALARM) will then activate between 9 and 12 seconds after initial closing of the diaphragm switch.

8.20 ACOP for Provision of Drains in Spray System Pipework

8.20.1 Dry spray systems such as RRSS are to have a suitable facility fitted in the branch pipe immediately down stream of the spray control valve to indicate readily if the valve is passing.

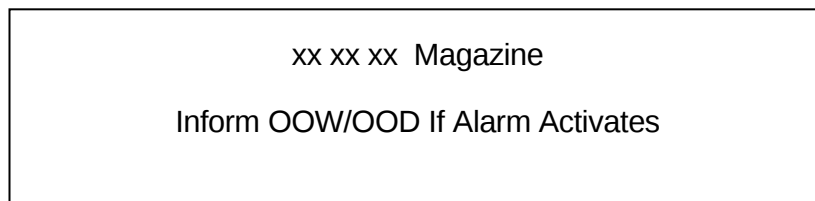
NOTE: In thermal bulb systems such as QBSS and MASS, the spray isolating valve is normally open and therefore no drain facility is required.

8.20.2 The drain facility should be identified by a notice, displayed in a prominent position, with the words 'DRAIN' in BLACK text on a WHITE background together with a BLACK arrow.

8.21 ACOP for Magazine Spray System Signs/Notices

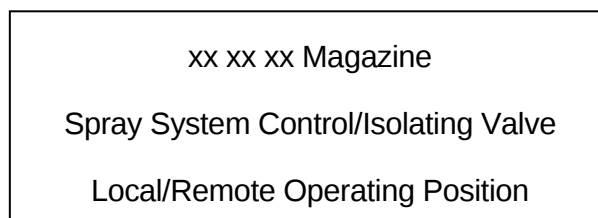
8.21.1 Spray system signs/notices are to be in accordance with the requirements of Def Stan 02-784/NES 784.

8.21.2 A mandatory sign should be sited adjacent to all alarms with the legend:

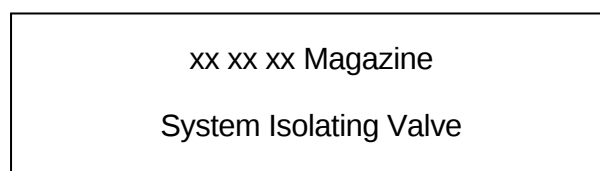


8.21.3 Each spray control/isolating valve and operating position for all spray systems is to have a clearly visible sign adjacent to it which identifies the magazine being served, and its normal system line-up position.

8.21.4 Signs at manual spray control operating positions are also to include whether it is the 'local' or 'remote' operating position, e.g.



8.21.5 System isolating valves are to have a clearly visible sign adjacent to it that identifies the magazine being served and its normal state i.e. open or shut.



8.22 ACOP for First Aid Fire Fighting Equipment in Magazines

8.22.1 An adequate number of hand held fire extinguishers are to be provided based on a risk assessment, either inside the magazine or in the immediate vicinity of the magazine. Further guidance is given in Appendix 8.33.1 Note that NA Fire (MESH FS) are the SME for first aid fire fighting/damage control in ships and Def Stan 07-204 and BR2170 should be consulted in addition to the specific magazine requirements listed here.

8.22.2 Where the magazine entrances are on exposed weather decks, due consideration is to be given to protecting the extinguishers from the environmental conditions or siting them inside the magazine.

8.22.3 Provision of first aid fire fighting services/equipment should be made to permit the manual cooling of the boundaries of "large magazines". Due cognisance of the hazards within the adjacent compartment and the size of the magazine should be taken when considering the extent of the facilities/services provided. Further guidance is given below.

8.23 ACOP for Fire Fighting Arrangements in Silo Magazines

8.23.1 Where vertical launch missiles are stowed in a silo magazine, a Rapid Reaction Spray System (RRSS) is to be fitted. In addition the following are also to be provided:

- a, A spray system capable of drenching the exterior of each missile container. Where warhead shielding/mitigation is provided between canisters care must be taken to ensure that all parts of the canisters are drenched fully.
- b, Where missile launch canisters are fitted with integral deluge nozzles, provision is to be made for a suitable connection to the ship's HPSW / fire main.

8.24 ACOP for Fire Fighting Arrangements in DDAs (including Vehicle Decks and Weapon Parks)

8.24.1 The requirements for smoke and heat detectors in DDAs are detailed in Appendix 8.2 above.

8.24.2 The compartments listed at Appendix 2.1.8 and in other DDAs where smoke and heat detectors are employed, they are to activate audible and visible alarms, both locally and remotely in the SCC/HQ1 or other location appropriate to the ship's protection organisation. More detailed guidance is given below.

8.24.3 Where the smoke and heat detectors are linked to a control system that initiates the spray system, the control system should be located outside the DDA and provided with interlocks and remote testing facilities that permit routine testing and maintenance to be carried out without hindering the operation of the system. More detailed guidance is given below.

8.24.4 The number of smoke and heat detectors employed should be based on compartment size and the need to prevent delayed detection due to the distance between a fire source and a detector. See Def Stan 02-603 for further guidance on fire detection best practise.

8.24.5 A water spray system is to be fitted within the DDA compartment, connected to the ship's fire main, which delivers water in sufficient quantity and coverage to deal with all credible fire scenarios and prevent escalation of the event.

8.24.6 Where the DDA compartment is large; consideration should be given to configuring the system into zones such that a whole area is not "wetted" unnecessary when the spray system is activated.

8.24.7 Guided weapon hoist trunks and weapon lifts, which may be used in wartime for stowage of missiles and weapon preparation areas, sited adjacent to magazines, should be fitted with the same type of spray system as the magazines.

8.24.8 Package Examination Rooms may be fitted with a manual spray system.

8.24.9 Vehicle decks and LPD/LSD(A) dock areas, where munitions may be stowed in vehicles as part of an Embarked Military Force, should be fitted with manually operated spray arrangements in accordance with Def Stan 07-204/NES 119 section 4.11.4 and taking into account the requirements and guidance in BR1754 (Regulations for POL Safety).

8.24.10 Vehicle Decks and LPD/LSD(A) dock area spraying systems should be capable of being sub-divided, so that different sections on each deck may be sprayed individually, and operate with either fresh water or sea water mixed with Aqueous Film Forming Foam (AFFF).

8.24.11 Weapon Parks should to be provided with Fire Monitors capable of laying down a large quantity of water or AFFF on the complete park and surrounding area. Where the weapon park is covered, spraying arrangements may be a suitable alternative to monitors.

8.24.12 Fire Monitors or weapon park sprays should be capable of both local and remote operation.

8.24.13 Unless otherwise stated in this standard, areas where temporary stowage of munitions is likely to occur should to be provided with either a hose connection or be fitted with a manual spray system.

8.25 ACOP for Fire Fighting Arrangements in Naval Armament Lighters

8.25.1 Appropriate measures are to be taken to allow the rapid spraying or flooding of the hold of a Naval Armament Lighter (NAL) in the event of fire.

8.25.2 Use of fire detection (heat and/or smoke) within the hold with audio/visual upper deck and towing vessel linked alarms is encouraged. This could be considered best practise in support of any ALARP risk based argument despite limited time at risk. A significant proportion of each NAL movement is with the hold and NAL itself unmanned, and so early warning of any event, however minor, could be critical.

8.25.3 If the NAL is not fitted with a pressurised fire main, a dry spray grid should be fitted to allow water from an outside source to be used, i.e. when being towed and alongside a warship/RFA. The system should be capable of connection to the source of supply by hoses via instantaneous couplings on deck. The locations of these should be clearly marked and visible from associated vessels. Any isolating valves fitted should be clearly labelled and normally locked open. Sufficient spray heads should be fitted within the hold at the correct height and with the correct spacing to provide spray coverage to all stowed munitions in accordance with the manufacturer's nozzle data.

8.25.4 Sufficient portable 9 litre AFFF extinguishers (with spare charges and a charge holder) should also to be provided in convenient positions at both ends of the vessel.

8.26 Guidance - Magazine Fire Fighting Arrangements - General

8.26.1 Assessment of risk-based design requirements for fire fighting arrangements for a specific magazine or DDA requires a detailed consideration of the safety characteristics of the munitions to be stowed. Further guidance is given below. Where a large magazine may hold a wide variety of munitions, the risk-based design may have to be based on consideration of realistic or 'worst case' outloads.

18.26.2 The design should be based on the 5 key requirements stated at Appendix 8.2.1. The solutions to the key fire fighting design principles result in provision of:

1. Reliable and effective smoke and heat detection across the full envelope of the magazine and/or compartment.
2. A control system to react to ensure prompt and effective water spray coverage to the contents and full envelope of the magazine and/or compartment.
3. Adequate "free air space" adjacent to all the boundaries of the magazine and/or compartment and water supply to provide boundary cooling.
4. Tailored cooling of munitions to prevent sympathetic reaction.
5. Effective "Fire Alarm" and "Fire Fighting" systems that are integrated into the ship's overall Fire Prevention and Damage Control arrangements.

8.26.3 Justification for the first three requirements has been demonstrated by trials and by past experience. Relevant trial reports and summaries may be obtained from NAExp. US operational experience and past RN experience gives rise to the fourth requirement. Operational experience and the broader requirements of Fire Safety Certification as one of the ship Key Hazards, justifies the fifth requirement. The following paragraphs give some insight to the rationale underpinning the key fire fighting design principles and for the need to understand the characteristics of the munitions.

8.27 Guidance - the Design Requirements for Smoke and Heat Detection

8.27.1 The nature of any event that might initiate a munitions fire should be determined through Hazard Identification studies conducted in accordance with Def Stan 00-56 and JSP 430 Part 2. Whether such an event is a fire in an adjacent compartment or a fire within the magazine or DDA, prompt detection of the smoke and/or heat from such an event is essential to prevent escalation of the incident. Three main parameters govern the effectiveness of the detection; the activation temperature for a valid detection; the thermal inertia of the detectors and for both heat and smoke and the siting of the detectors within the magazine or compartment. Furthermore it is essential that the detection system has a low false alarm rate. Each parameter is discussed in the following paragraphs but MOD SME for Fire detection is NA Fire (MESH FS) from whom expert advice may be sought.

8.27.2 Activation temperature. For systems using QBSS, the temperature at which the sprays are activated, namely 68 (+/-5) degrees C is predetermined by the boiling point of the alcohol in the bulb. Past experience has shown this to be a satisfactory compromise design solution. However, for Fully Automatic Fast Spray System (FAFSS) using independent heat detectors, the activation temperature should ideally be selected at the lowest possible value commensurate with that of not inducing an adverse false alarm rate caused by excursions in the ships heating and ventilation system.

8.27.3 Thermal inertia of heat detection. The ability to detect and respond to extremely steep temperature/time gradients is a vital feature of the detection system. Figure 3 shows the virtually instantaneous temperature rise when a rocket motor is ignited in a magazine compartment. The two curves reflect the peak temperature adjacent to the rocket motor and the average of temperatures measured throughout the magazine. Although this represents an extreme case of a rocket motor functioning in design mode, it does illustrate the high rate of energy release from energetic materials. The requirements to detect a steep or rapid rise in temperature in Appendix 8.32.5 Fig 5 below should be related to this example. Previous standards gave the thermal inertia performance requirement for detectors as capable of responding to temperature gradients of 25 degrees C per second. This figure should now be regarded as an absolute minimum and detectors with the lowest possible thermal inertia should be selected.

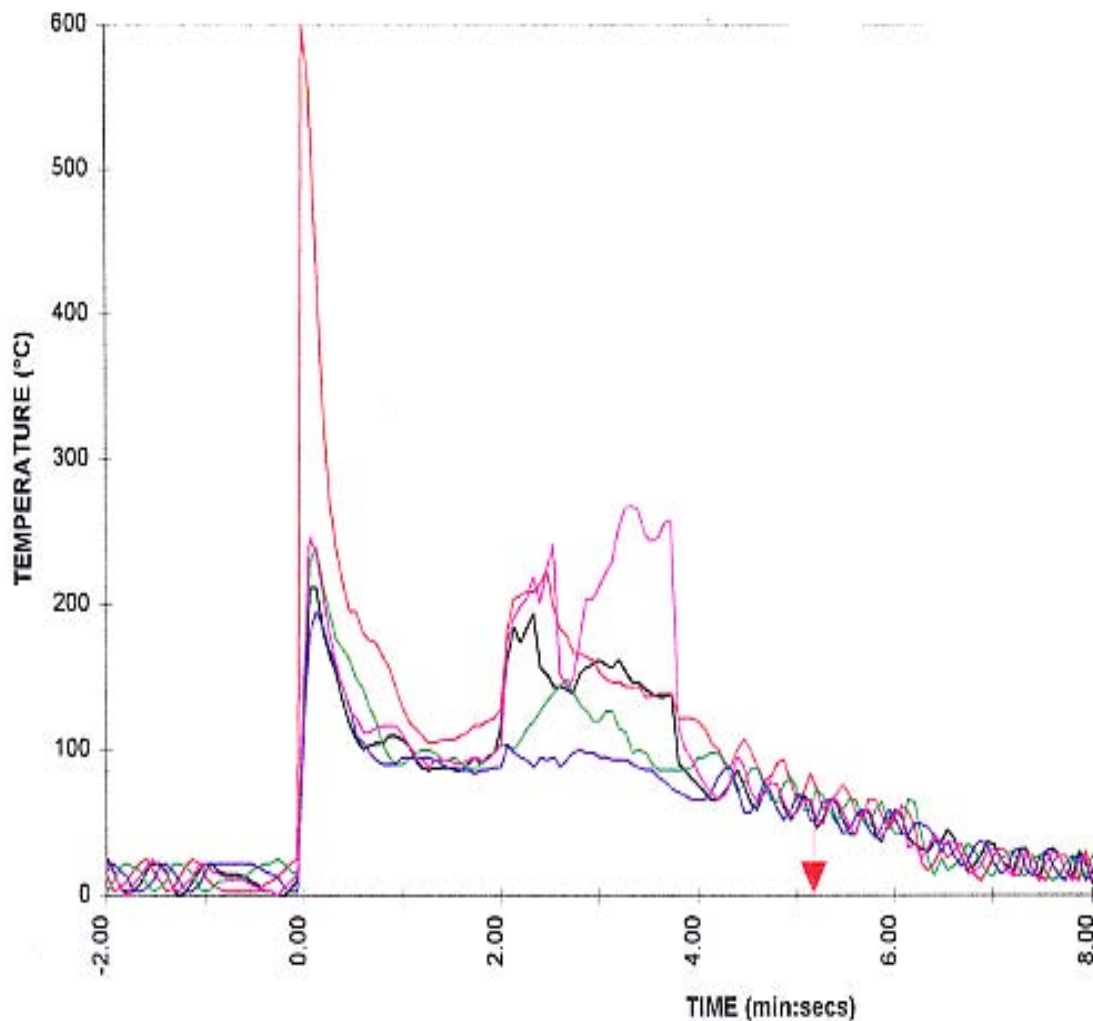


Figure 3 - Temperature/Time curves – Propellant Burn

8.27.4 Siting of detectors. The siting of heat and smoke detectors is an integral part of the magazine and DDA design and, as such, locations can only be determined when the contents and usage profile of the compartment are known. Clearly detectors should be placed where they are likely to be effective above munition stowages. However, an additional and very important element in determining the location of certain of the heat detectors is the need to be effective in detecting rises in boundary temperature caused by fires in adjacent compartments. Figure 4 shows the temperature measured from within a magazine when a 1 MW fire is burning in an adjacent compartment. One curve reflects the highest actual bulkhead temperature and other curves reflect the corresponding temperatures at deckhead detectors at various distances from the bulkhead.

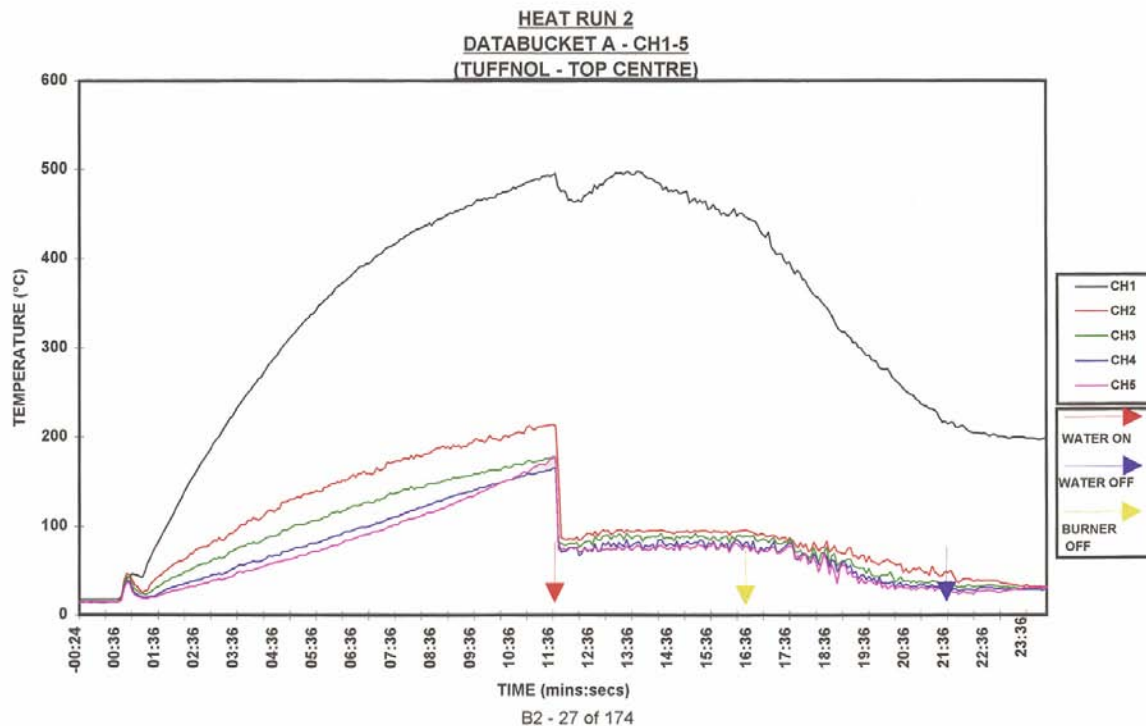


Figure 4 - Temperature Rise with Time – 1 MW Fire

8.27.5 The trial results show that it takes a significant time for deckhead sensors to detect a rise in temperature from the heating of an adjacent boundary bulkhead. The size of this magazine was approximately 100 m³. Heat distribution characteristics will vary for specific magazines depending on their volume and the packing density. However, the following principles may be applied:

- a. In the event of an intense fire in adjacent compartment, the free air temperature in the magazine close to the “hot bulkhead”, as shown in Figure 3, may be at a level that poses a considerable threat to the munitions stowed in the magazine. The threat to munitions is explained at Appendix 8.32 below. It follows that it is desirable to sense directly the bulkhead temperature where the risks of intense fires in adjacent compartments warrant it to reduce risks to munitions. This requirement is allied to the precaution of maintaining adequate free air space around all boundaries of the magazine in line with the discussion of the issues in Appendix 8.30 below and adequate distance between munition stowages and boundaries as described above.
- b. The other requirement for direct bulkhead sensing arises from the time delay in spray activation. From Figure 3 above it can be seen that the temperature/time differential between bulkhead and deckhead sensors will result in a significant time-lapse to valid detection from the time that temperature at the “hot spot” is at a level that poses a threat to munitions.

8.28 Guidance - Design Requirements for Spray Coverage

8.28.1 Fire needs to be fought quickly and effectively. The key parameters that govern efficiency of water spray coverage are speed of response, spray pattern and water quantity and siting of nozzles relative to the munitions and the boundaries. These parameters are discussed in the following paragraphs.

8.28.2 Water spray response times. The energetic materials used in munitions have a typical temperature of ignition in the range 120 degrees C to 200 degrees C. Given that the heat detector has a threshold value of something in the range 50°C degrees C to 68 degrees C and the temperature rise gradient is likely to be steep, it is vital that full water flow is achieved with the minimum of delay, if escalation of the incident is to be avoided. Previous standards gave the response time for automatic spray systems from detection to full water spray flow in the magazine as 12 seconds or better. This figure should be used as the "benchmark" to judge whether the design solution being proposed for automatic systems can be considered as ALARP when conducting risk assessments for the actual munition outfit. A further 'stretch target' for ships with an Invitation To Tender (ITT) after 2015 is to meet a time of 8 seconds or better.

8.28.3 The type of water spray pattern. The type of spray pattern for all systems should be optimised to suit the type of munitions being stowed or in the DDA. It is essential that whichever system and/or spray pattern is used, it must provide full water coverage of all munitions in their stowage's, particularly around the warheads and/or motors of non-IM munitions, together with all internal compartment surfaces, including the upper corners at the bulkhead/deckhead intersection. Optimisation can take the form of water spray, water mist or water fog. MOD trials have shown that water mist and water fog can be extremely effective against certain types of fires, notably those involving liquid fuels, as the mist and fog reduces the supply of oxygen to the source of the fire. Therefore, where munitions containing liquid fuels are present in the magazine a combination of water spray and mist or fog could provide an effective design solution for fire suppression and compartment cooling. The other aspect to be considered is the water volume delivery requirement. This aspect can be divided into three components; firstly boundary cooling for a fire in an adjacent compartment; secondly that required to manage the heat generated by a munitions fire in the magazine or DDA. The third component is the cooling required to prevent a fire and/or burning munition/explosives from heating adjacent munitions. Each component is discussed below.

8.28.4 Boundary cooling with a fire in an adjacent compartment. There are a large number of variables associated with the nature of any fires in adjacent compartments and these will need refinement through the hazard identification processes of Def Stan 00-56 to produce the design case for which solutions will be developed. There are also many variables concerning the nature of the bulkheads within the various types of magazine and DDAs and so the use of empirical data to calculate the heat transfer function becomes complex. Previous versions of this standard have used prescriptive requirements for water flow of either 30 l/min/m² or 40 l/min/m² depending on the type of fire fighting system being considered. It is recommended that these figures be used as current "Best Practise" as follows.

8.28.5 For ships up to DD/FF size main magazines should have water spray boundary cooling of not less than 30 l/min/m² and ideally 40 l/min/m² or better.

8.28.6 For all larger ships, whether warships or RFAs, 40 l/min/m² should be the minimum requirement for water spray boundary cooling.

8.28.7 Achievement of these flow rates, when taken in conjunction with effective design of the direction of the water spray and provision of free air space adjacent to the boundaries of the magazine discussed below, should provide a coordinated approach to the design solution and lead to a robust design safety justification to support the SESC.

8.28.8 Cooling and heat management of a fire within a magazine. The majority of energetic compositions in munitions burn pyrophorically, that is they burn without an independent supply of oxygen. Therefore, once burning they cannot be extinguished. The other part of the design solution for spray rates is thus to manage the heat generated by the initiatory event such that no escalation occurs. The aim is to prevent the spread of fire within the ship. As explained above previous prescriptive requirements for water flow specified either 30 l/min/m² or 40 l/min/m² depending on the type of fire fighting system. It is recommended that these figures should be used as current "Best Practise" as follows.

8.28.9 Magazines with a design capacity of up to 5,000 kg NEQ should have a spray system delivering a water flow of not less than 30 l/min/m² and ideally 40 l/min/m² or better.

8.28.10 Magazines with a design capacity in excess of 5,000 kg NEQ should have a spray system delivering a water flow of not less than 40 l/min/m².

8.28.11 For each magazine design and for DDAs, specific fire scenarios should be prepared and used to test the efficacy of the design solution to ensure the proposed solution reduces the risks to ALARP. As there are many variables and unknowns against which to develop the design solutions, DSS NAExp will be undertaking further work in this area and can provide advice on request. In particular, the water volume requirements for magazines could be determined by assessing the calorific values and quantities of the energetic compositions in the munitions and designing the system to manage the amount of heat generated by the burning munitions. Work is proceeding to compile the data required for this purpose.

8.28.12 Cooling of Other Munitions. To satisfy the requirement to keep other munitions cool it will be sufficient to establish:

- a, The generic type of energetic materials e.g. propellant, high explosive, pyrotechnic, liquid fuel.
- b, The NEQ for each material.
- c, The response of each munition to two key safety tests (the “Fast Heating” and “Slow Heating” tests).

8.28.13 The significance of the primary characteristics of munitions is discussed in Appendix 8.32 below. Pending further research and advice from DSS NAExp it is recommended that the figures given in Appendix 8.28.8, 8.29.9 and 8.28.10 above should be used as current “Best Practise” in the design. For the time being the assumption should be made that the water delivery rate will provide sufficient cooling effect to manage the heat and prevent escalation of the event. However, it is also important that the supply of cooling water is maintained for at least 30 minutes after the fire has burnt itself out. This is because heat energy that reached other munitions before water was applied will continue to dissipate and some of the heat will migrate internally to the energetic materials. If sufficient heat energy exists it could cause the energetic materials to ignite. Past experience and trials have shown that detonation can occur in heated munitions up to at least 30 minutes after heat application ceases. Therefore, cooling must continue for sufficient time to ensure that stored heat energy is dissipated into the cooling water and not into the energetic materials!

8.28.14 Location of water nozzles. Nozzles should be located to ensure that both boundary bulkheads and stowages receive gapless spray coverage. DSS NAExp trials have shown that the distance of stowages from the bulkhead and the position of spray heads relative to the stowage, deckhead and the bulkhead are critical to achieving effective coverage. Where bulkhead wetting is required for boundary cooling, upward spraying heads give better coverage to the top of the bulkhead. Further advice may be obtained from DSS NAExp.

8.29 Guidance - Requirements for Fresh Water Priming

8.28.1 In order to minimise corrosion problems in wet spray systems the system is pressurised with fresh water, through a fresh water filling connection, up to the system isolating valve

8.30 Guidance - Requirements for Free Air Space around stowages

8.30.1 The importance of achieving this requirement has been illustrated in preceding paragraphs. Appendix 8.1.124 discusses the heat convection effect from a “hot bulkhead” and Appendix 5.1.15 stated that the stowage/deckhead/bulkhead separation distances have an influence on how much water is sprayed onto the stowage and bulkhead. Additionally, Appendix 4.1.65 identifies the need to design compartment water drainage arrangements to provide a “flooded deck” to provide boundary cooling in the event of a fire in a compartment below. For any given compartment the specific “free air space” will need to be developed as part of the design by bringing together the type of munitions stowed and/or embarked with the factors just mentioned for design safety justification in the SESC.

8.31 Guidance - Integration of Magazine Fire Alarm Systems

8.31.1 The magazine designer should have the lead role in specifying his fire alarm and fire fighting solutions, but these will need to be done both in conjunction with and in compliance with appropriate requirements for the ship’s overall fire prevention and damage control arrangements (Def Stan 07-204 refers). This is a systems interface issue between two of the Key Hazards identified in JSP 430 that require independent Safety Certification, namely overall ship Fire Safety Certification and Ship Explosives Safety Certification. While NAExp have lead responsibility for the explosives SMS to be operated for the magazines and related compartments, these arrangements should be coordinated with the fire SMS for the rest of ship regulated by Naval Authority (Fire).

8.32 Guidance - Munition Fire Characteristics

8.32.1 The primary information on characteristics of munitions is the type and quantity of the energetic materials used in the munitions and how the energetic material reacts to the Fast Heating and Slow Heating safety tests in each specific munition design. In principle the Fast Heating test characterises the munitions reaction to a fire where the munition is insulted rapidly with intense heat. The Slow Heating test indicates the munitions reaction at the other end of the continuum of thermal input where the input is progressive over a long period of time. The two forms of heat input cause differing forms of chemical change within the energetic materials and hence often lead to different end events.

8.32.2 As an example, in a non-Insensitive Munition the response to both Slow and Fast Heating could be a Type I reaction. Alternatively it could be that its slow heating response is more benign than the fast heating reaction or indeed the reverse could apply. The munition design and nature of the energetic materials will determine what the end events are for both tests. It is important to recognize that the tests only characterize the munition reaction to somewhat idealized test scenarios. In practise the heat input from a real fire in a magazine is likely to lie somewhere between Fast and Slow, but closest to Fast, particularly if large quantities of propellant are involved or where torching occurs(further details can be found in NAN EXP/03). It is also important to note that some energetic materials, particularly propellants, can react violently when they are subjected to temperatures of circa 70 degrees C / 80⁰C for periods as short as 10 minutes. This temperature is significantly below the typical Temperature of Ignition of 160 degrees C / 180 degrees C for propellants. The result illustrates how chemical changes in the energetic material accelerate with potentially severe consequences if the materials are not “kept cool”. Therefore, in order that the risks can be deemed as ALARP, it is best practise to design the fire fighting arrangements based on the “worst case” situation which will be the time to reaction in the Fast Heating test.

8.32.3 Further information on Fast and Slow Heating tests is given in Part 4 of this standard, STANAG 4439 and STANAG 4240 (Liquid Fuel Fire Test for Munitions) and STANAG 4382 (Slow Heating Test for Munitions). The assessed or test results for these cases should be stated in the munition (OME) safety case and summarised in the SEXSSI. This should be related to the generic type of energetic materials e.g. propellant, high explosive, pyrotechnic, liquid fuel etc and the NEQ for each material.

8.32.4 As Insensitive Munitions (IM) are introduced progressively, the reaction to both tests for IM munitions embarked should be a Type V, i.e. “no worse than burning”. However this does not equate to absence of risk. The important parameter is the “time to reaction”. Under Slow Heating test conditions munitions have a time to reaction in excess of 10 hours and typically the time is some 30 hours. It follows that the key parameter for the design of magazine fire fighting arrangements is the result of the Fast Heating test coupled with an understanding of the amount of energy or heat generated. It is also important to know the configuration of the munition when it was subjected to the test and relate this to the state when it is in the magazine and/or DDA (i.e. whether packaged or unpackaged, whether part of a Unit Load, an individual munition or part of a munition).

8.32.5 Figure 5 below shows the range of times to reaction for a typical sample of 56 munitions likely to be embarked on ships. The following deductions follow from Figure 5:

- a, Mean Value of reaction time 3.3 minutes.
- b, Standard Deviation of reaction time 3 minutes
- c, Of the 6 munitions with a reaction time less than 1 minute the reaction times range from 1 second to 58 seconds with a mean value of 44 seconds.

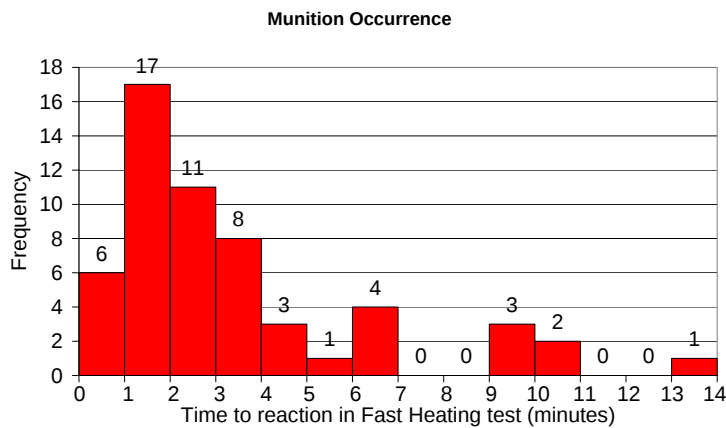


Figure 5 - Munition Time to React to Fast Heating

8.32.6 Once alight and with a reaction “no worse than burning”, the energetic material will release its heat energy quickly, although the rate of release will be very dependant upon the degree of confinement. In their design mode propellants and high explosives burn extremely rapidly but if their casings are disrupted through, for example fragment attack, then the burn rate will be lower. The graph at Figure 6 below shows the heat energy released against time per unit kg of a typical energetic composition. The following observations are made.

- a, Propellants typically have a calorimetric value in the range 3.2 to 4.9 MJ/Kg.
- b, TNT has a calorimetric value of 4.1 MJ/Kg with most other HE materials slightly higher.
- c, An NEQ of 1 kg of typical energetic material will generate some 4 MJ of energy. The power (rate of energy release) will be dependant on the period of time over which this energy is released.

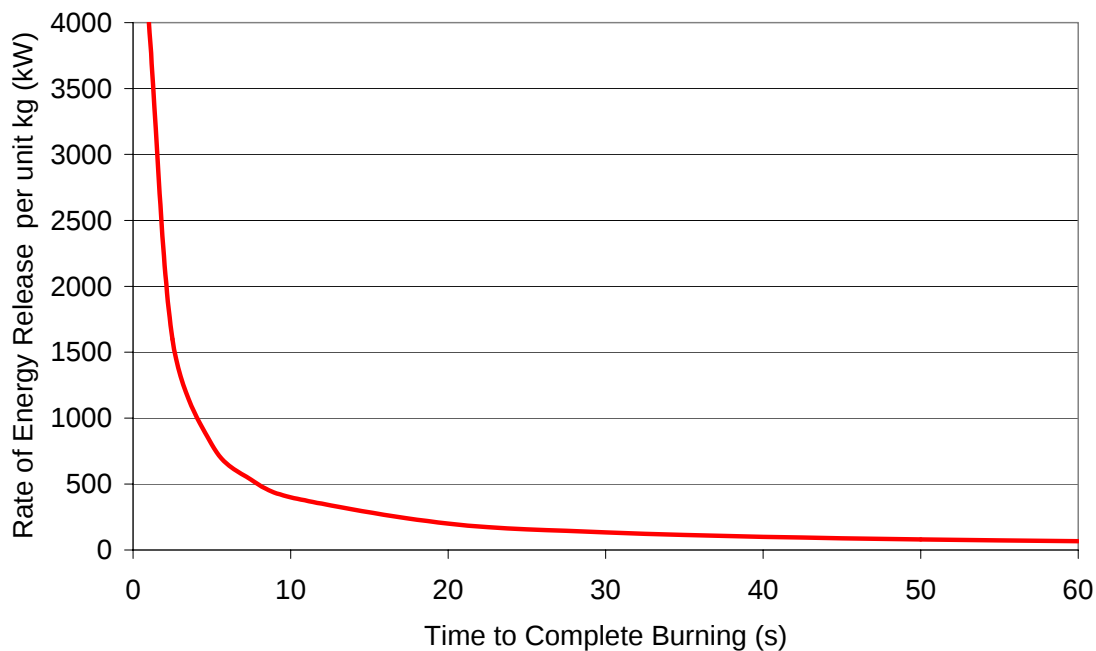


Figure 6 - Munition Heat Energy Release Rate

8.33 Guidance - First Aid Fire Fighting Equipment for Magazines and DDAs

8.33.1 Fire Extinguishers. (See ACOP at 8.22 above) To provide first aid extinguishers for early attack of fires of a non explosive nature magazines are normally provided with 2 in No. 9 litre AFFF extinguishers, placed one inside and one outside the magazine. For weather deck magazines the extinguishers are placed inside the magazine for protection against the elements. The precise number of extinguishers provided should take into consideration the size of the magazine and the potential risks involved. For example an additional 9 litre AFFF extinguisher should be provided when hydraulic handling machinery using flammable oil is fitted in a magazine, or when liquid fuel is contained in a missile. The purpose of the extinguishers is to provide at least one ready use first aid extinguisher inside to be available when the magazine is occupied; and an extinguisher outside to be available for the first person arriving on the scene to investigate an alarm. Provision of 2 extinguishers also harmonises with best practise in NATO. A DDA should have at least one extinguisher readily available.

8.33.2 Fire Hydrants and Hoses. In the event of a fire in a compartment adjacent to a magazine or DDA, the ships fire/emergency party will attempt to provide boundary cooling irrespective of whether the temperature within the magazine has risen sufficiently to initiate the spray system, or to threaten a munition in a DDA. Services are therefore required to facilitate this 'manual' boundary cooling. As a minimum, a fire hose should be sited within or very adjacent to a magazine for this purpose, with larger magazines also provided with a hydrant off the Salt Water Main. Similarly DDAs should have a hose and hydrant available in the near vicinity. Where the DDA is not equipped with a spray system, the hose and hydrant should be within the DDA.

8.33.3 Fire Monitors. Weapon Parks should be provided with Fire Monitors to provide cooling to all the weapons in the park, or to assist in fighting fires. They may operate with water or AFFF, although the former is preferred for efficient cooling of weapons. Coverage should include adjacent areas where these may be cut off by fire. Where the weapon park or preparation areas are internal then a suitable manual or automatic spray system should be provided depending on the assessed risk. Consideration should also be given to providing fire monitors in other appropriate DDAs. Fire Monitors need to be capable of both local and remote operation in the event of a serious conflagration. Ideally they should be linked with a CCTV system covering the area for remote observation.

APPENDIX 9 MAGAZINE AIR CONDITIONING / VENTILATION SYSTEMS

9.1 Description

9.1.1 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the provision of suitable arrangements for air conditioning/ventilation systems in magazines used for the stowage, handling, preparation/testing and deployment for use of munitions from MOD ships. Where relevant, they should also be applied to DDAs.

9.2.2 Air conditioning/ventilation in magazines is required primarily to keep the chemical compositions of explosives in a stable state. All explosive compositions degrade naturally with time. This is accentuated by extremes of temperature and humidity. Maintenance of a stable environment is a key requirement to ensure that the probability of self-initiation of explosives is incredible. Maintenance of chemical stability will also maximise the safe life of explosives and hence keep costs to a minimum. It is also important to ensure an acceptable working environment is maintained for personnel during rounds or when manned during high states of readiness.

9.2 Performance Requirements for Magazine Air Conditioning/Ventilation Systems

9.2.1 The design, manufacture and installation of air-conditioning and ventilation systems are to be in accordance with Def Stan 02-102/NES 102. MOD SME advice should be sought from the sponsor MESH FS.

9.2.2 Adequate air-conditioning/ventilation systems are to be installed to maintain the explosive compositions of munitions in a safe and serviceable condition in addition to providing a satisfactory environment for human occupants. Details of the environmental requirements are given in Part 4 Generic Naval Environment (GNE) of this standard. Advice on achieving this requirement is given in the ACOP and Guidance sections below.

9.2.3 Design of magazine ventilation systems must incorporate arrangements to assist control of fire products in / out of the affected compartment and Isolate magazine from external events to ensure risks to the explosive safety are maintained at ALARP and tolerable levels.

9.2.4 Magazine and small magazine air-conditioning and ventilation systems are also to be designed to maintain the watertight integrity, flash/flare tightness, anti-sabotage and NBCD requirements of this standard, JSP 862 and other SEMS and Key Hazard areas as appropriate. Supporting design guidance is contained within this standard and Def Stan 07-204. The duty holder shall take measures to ensure all relevant requirements are satisfied.

9.3 ACOP for Environmental Requirements

9.3.1 The objective of the air conditioning and ventilation system in a magazine is to minimize chemical degradation of explosive compositions in munitions. The environment within the magazine is to be maintained within that specified in Part 4 (GNE) of this standard or as specified by the Munition IPT for a specific munition where this is a more onerous requirement.

9.3.2 Air-conditioning systems should be designed to maintain a Relative Humidity (RH) of between 30% and 70% for all operational scenarios.

9.3.3 Cooling arrangements are required, to minimize chemical degradation of explosive stores as follows:

- a. Where the temperature in a magazine, containing propellant, may rise above 32 degrees C in the hottest climatic condition in which the ship is required to operate. Note that specific munitions may have different maximum temperature requirements that will require to be addressed – see guidance below for examples.
- b. In any magazine containing other explosive stores, where the temperature may rise above 35 degrees C.
- c. Temporary ventilation/cooling arrangements are to be provided if, upon a system failure, the magazine temperature could rise above 40 degrees C in 12 hours and remain so for more than a further period of 12 hours. To permit temporary cooling, provision is to be made to allow a hose to be connected to the ventilation system/trunking outside the magazine.

9.3.4 Magazine heating is required when, in Arctic Conditions (as defined in Def Stan 02-102/NES 102), the internal temperature of the magazine may fall below 7 degrees C .

9.3.5 Air-conditioned magazines that are required to be manned in Action/Defence States shall be maintained at a minimum temperature of 15 degrees C.

9.3.6 If the required heating cannot be provided by hot water, approved electric 'in line heaters' may be fitted in the trunk supply, subject to the following conditions:

- a. The 'in-line-heater' should be sited outside of the magazine and upstream of the watertight butterfly valve.
- b. An automatic isolating switch should be provided to the heater power supply, but fitted outside of the trunking. It should be capable of isolating the power supply if the heater temperature rises above normal conditions.

- c. An independent temperature sensor should also be fitted downstream of the heating element but within the trunking. The sensor should be capable of rapidly sensing a rise in heater element temperature due to reduction of air flow, and hence initiate action to operate the isolating switch and provide warning of the fault condition. The temperature of air being delivered from the trunking should not rise above 60 degrees C under any conditions.

9.4 ACOP for Magazine Ventilation System Design and Installation

9.4.1 The general requirements of Def Stan 02-102 and 07-204 are to be followed. MOD SME advice should be sought from the sponsor MESH FS.

9.4.2 Magazines requiring air-conditioning/ventilation to meet the requirements of the (GNE) Part 4 of this standard, which may be supplied from either a dedicated magazine system or a shared system provided the shared compartments are not defined as 'high risk' compartment or accommodation space.

9.4.3 Magazines designed for the carriage of explosives in bulk should be fitted with an independent air conditioning system.

9.4.4 A dedicated magazine air-conditioning/ventilation system can serve either a number of separate magazines or a magazine complex and may be a recirculation (recirc) system. Where a magazine or magazine complex may require to be manned, fresh air make up should be provided.

9.4.5 Where air bleed off valves are required by Def Stan 02-102/NES 102, they should exhaust to atmosphere.

9.4.6 Magazines stowing weapons containing hazardous or noxious liquids/gases should have a dedicated supply or a supply from an adjacent ventilation system and fan exhaust direct to atmosphere

9.4.7 A shared air-conditioning/ventilation system must be configured so that the magazine(s) in the system exhaust direct to atmosphere, i.e. does not recirculate.

9.4.8 Small magazines and magazine lockers, where entry is not possible, do not normally require a ventilation system. Arrangements for minor magazines including Ship's Pyrotechnic and Smoke Stores are covered in Def Stan 02-102.

9.4.9 Magazines containing weapons/munitions that may release toxic fumes should be provided with an appropriate fume detector connected to a local and remote alarm position as required for smoke and heat detectors.

9.5 ACOP for Magazine Ventilation Trunking

9.5.1 Ventilation trunking outside the magazine should be watertight (to the same pressure as the compartment through which it passes). Gastight standards are acceptable for fittings and ventilation trunks between adjacent magazines.

9.5.2 In compartments where water tightness is not required for damage control purpose, the trunking should be flash/flame tight as a minimum standard over its whole length from the boundary of the magazine to the flash/flame tight barrier or to the ATU.

9.5.3 A flash/flame tight barrier should be fitted within the trunking as close as practicable to the magazine boundary. In practise this may be in the ATU compartment.

9.5.4 Flash/flame barriers may restrict airflow. Size of ventilation trunking shall be calculated with care as increased ATU size and trunking may be necessary to provide correct airflow rate. The effect of the gauze is exacerbated if the length of trunking is considerable and if a single ATU serves a number of compartments. Therefore it is recommended that magazines are served by dedicated ATU(s), if possible.

9.5.5 The air inlet in the AFU/ATU should be arranged to prevent water entry to the vent system.

9.5.6 In vessels that are designed to meet low magnetic signatures, trunking may be of a composite material, as approved by MOD SME in MESH IPT and DSS NAEExp.

9.5.7 It is a mandatory requirement of Appendix 14.5.7 to design and construct ventilation trunking and openings to prevent foreign bodies and liquids being passed into the magazine. This is to prevent sabotage, arson and terrorist attack. This may be achieved by the use of fine wire mesh gauze within the trunking and at inlets and outlets. Ventilation trunking terminating in a gooseneck may be used to prevent liquids passing into the trunk.

9.5.8 Inspection or access covers should not be fitted in trunking outside and close to the magazine that it serves. This is also a security and anti-sabotage precaution. Portable sections of the trunking should be arranged as necessary for cleaning purposes, these being secured by flanged joints.

9.5.9 Ventilation trunking systems should not interfere with magazine water spray or ammunition handling arrangements.

9.5.10 Smoke clearance trunking from other compartments may pass through a magazine provided it does not impair magazine airtightness integrity. Where a smoke clearance system is required for the magazine, it should be a dedicated system, albeit a number of magazines may be linked.

9.6 ACOP for Magazine Ventilation Isolation Arrangements

9.6.1 A central facility for 'crash-stop' ventilation should be provided to switch-off all magazine supply and exhaust fans.

9.6.2 Watertight valves should be fitted in both supply and exhaust trunking, external to the magazine boundary and adjacent to the bulkhead to satisfy the watertight integrity and smoke boundary as identified by the Red Risk Zone see Appendix 4.13.5 and 4.13.6. Def Stan 02-360/NES 360 lists types of Water Tight Butterfly Valves (WTBV).

9.6.3 Ventilation natural supply and exhaust terminals should be fitted with a hinged watertight cover capable of being pinned or locked shut and provided with hold open arrangements.

9.7 ACOP for Magazine Ventilation Valves – Local and Remote Operating Positions

9.7.1 All magazine ventilation watertight valves are to be capable of both local and remote operation. This is a mandatory requirement to enable the spread of smoke and toxic products to be controlled for the safety of the ship's company. The operating positions should be sited as follows:

- a. Where the magazine is sited within the citadel, both the local and remote operating positions should also be sited inside the citadel. The local operating position should be outside and adjacent to the magazine boundary.
- b. Where a magazine is outside the citadel, operating positions may be either inside or outside the citadel.
- c. Local and remote ventilation valve operating positions should be sited in a readily accessible place with unrestricted access.
- d. They should not be sited in compartments that are normally locked unless it is acceptable for a key box, containing the compartment key, to be provided at the compartment access.
- e. Operating positions should not be sited where the contents of the compartment may block accessibility to them.
- f. Remote operating positions should be sited to allow operation of the valve without risk to personnel from any hazard in the magazine or at the local operating position. In general, this may be achieved by separating the remote operating position by 1 deck or a main watertight bulkhead from the local position.

9.7.2 In Minor War vessels, NAVs, NALs and other minor craft, where it is not practicable to meet the remote operating position requirements of this section, the remote position should be sited on the weather deck, clear of the magazine boundary and housed in a lockable spray-proof cabinet. If this is also not practicable, an alternative method may be to use a flush-deck operating fitting and place the operating key in a lockable box on adjacent structure.

9.7.3 Access to the remote operating position should not require the local position to be passed en-route, other than when exiting from the magazine.

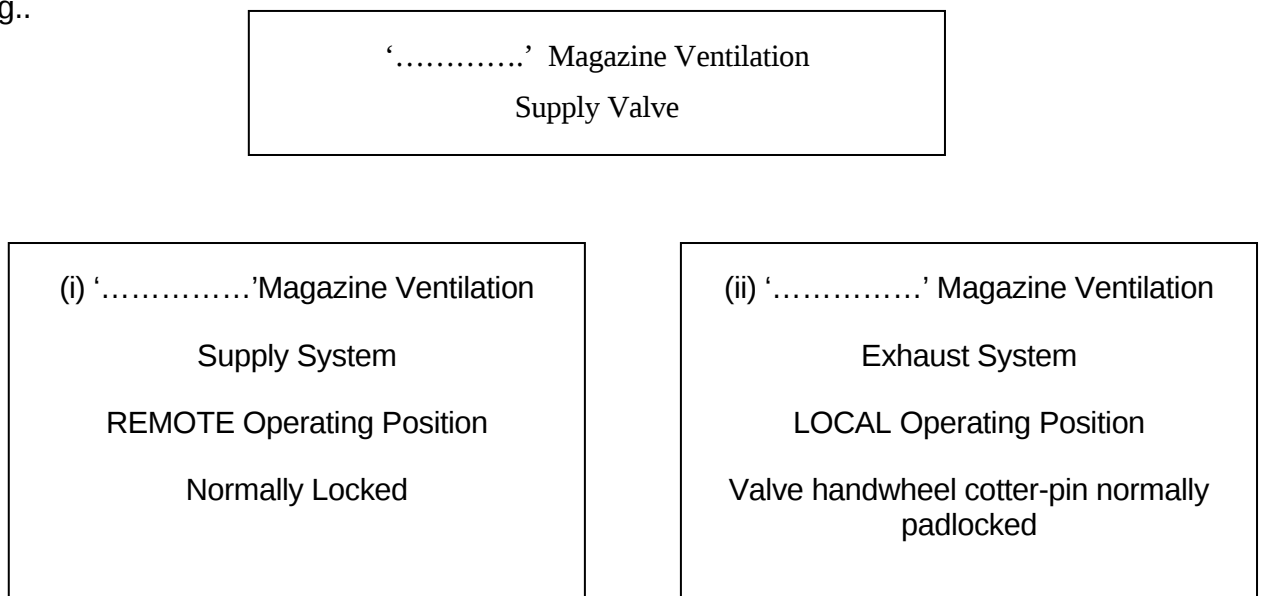
9.7.4 Both local and remote ventilation valve operating positions should be lockable and capable of accepting an approved padlock. A frangible keybox and key are to be provided in vicinity of operating position.

9.7.5 Local and remote ventilation valve operating positions must be able to operate the system with the other position still padlocked. This is essential for the operating positions to be fit for purpose.

9.8 ACOP for Magazine Ventilation System Notices

9.8.1 Ventilation System 'NOTICES' should be in accordance with the requirements of Def Stan 02-784/NES 784.

9.8.2 A 'NOTICE' identifying the magazine served by the ventilation system and its function (i.e. supply/exhaust/recirc) should be fixed or painted next to each valve. The NOTICE is also to indicate its normal system line-up position, i.e. 'Locked Open/Shut', e.g..



9.8.3 A 'NOTICE' identifying the magazine served by the ventilation system and its function should be provided at each valve operating position. The notice is to state whether the position is the LOCAL or REMOTE and also its normal system line-up position e.g.:

9.9 Guidance – Magazine Air Conditioning/Ventilation Systems

9.9.1 The requirement to minimise chemical degradation of explosive compositions is generally compatible with the requirement to provide an acceptable working environment in magazines.

9.9.2 The classification of hazardous areas into Zones in IEC 60079-10 is based on the principle that the area in which flammable explosive stores are handled or stowed should be designed, operated and maintained so that releases of material are kept to a minimum. The provision of good ventilation is an essential element in ensuring that any gas/vapour concentration is reduced by dispersion or diffusion. However, it is probable that “dead” spaces will occur. Furthermore, under conditions of action damage, release of material is more likely and ventilation may not be fully available. Magazines that contain Compatibility Group J explosive stores or a hydraulic system with a flammable fluid are therefore classified as Zone 2 areas (i.e. an area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to occur infrequently and will exist for short periods only). See Def Stan 00-101 Part 3 for the categorisation of Zone 2 and non-Zone 2 Magazines. Further information on the use of ventilation in reduction of concentrations of gases and vapours is given in IEC 60079-10.

9.9.3 Some rocket motors require the maximum ambient temperature to be limited to below the limit of 32 degrees C (see Appendix 9.3.3) to prevent too rapid chemical or physical degradation. Examples are 27 degrees C for Vertical Launch Sea Wolf (VLSW) and 29 degrees C for Sea Dart.

9.9.4 Magazine shared ventilation systems are requirement to exhaust to atmosphere to prevent spread of Smoke and Fire products from being fed back inside the ship.

9.9.5 If a shared system is utilized then it should serve the minimum number of compartments. In this case, it is recommended that the magazine(s) be the last compartment(s) served by a supply fan. The exhaust should either be a natural exhaust or the magazine should be nearest to the exhaust fan. Accommodation spaces as referenced in Appendix 9.1.14 above are to be considered as sleeping and messing quarters of the ship's company.

9.9.6 Trunking external to the magazine within a watertight compartment should be watertight to contain toxic products and smoke generated from within the magazine and to keep out flood water until the WTBV is closed. Watertight trunking will also be flame/flashtight.

9.9.7 Trunking external to the magazine within a compartment that does not require to be watertight should be flash/flametight. This is to contain flash, flame, toxic products and smoke generated from within the magazine and to keep out flash, flame, toxic products and smoke from external accidents until the WTBV is closed.

9.9.8 Some stores, e.g. Compatibility Group G stores, can release heavier than air toxic vapours/dust during storage. In compartments where these stores may be embarked, the ventilation arrangements are to take account of these emissions with the provision of low level exhaust facilities.

9.9.9 Magazines containing munitions that may release toxic fumes should be provided with an appropriate fume detector connected to a local and remote alarm position as required for smoke and heat detectors.

9.9.10 It is a requirement of the ACOP to fit Flash/flametight barriers in all magazine vent trunks. These are normally in the form of wire mesh gauzes. The barrier may be a single screen of corrosion resistant wire of 144 meshes per cm² using wire of 0.3 mm diameter, or two corrosion resistant screens of 64 meshes per cm² using wire of 0.4 mm diameter, spaced between 12 mm to 38 mm apart. Best practise requires these to be easily removable for inspection and cleaning but they are to be locked in position when installed (with anti-sabotage fittings). Further guidance on fitting of Flash/flame barriers is given in Def Stan 02-102.

9.9.11 MOD Subject Matter Expert advice on Ventilation and Air Conditioning in applicable general standards is available from MESH IPT in addition to DSS NAExp.

APPENDIX 10 MITIGATION METHODS TO PREVENT INITIATION OR REDUCE CONSEQUENCES FROM MUNITION INCIDENTS

10.1 Description

10.1.1 The SETHA methodology including magazine/hold, munition safety and vulnerability assessments will derive a class or Platform and OME Protection Strategy.

10.1.2 This may highlight proposed platform design shortfalls and shortfalls in the inherent safety of munitions when integrated into the Naval environment that may produce unacceptable and intolerable consequences to the ship, personnel and the environment.

10.1.3 This appendix details the Performance Requirement, ACOP and Guidance that will support duty holders in determining mitigation methods that will optimise design for stowage, handling and use of explosives. The design should reduce the potential consequences to the ship from threats to tolerable levels by selecting appropriate protection and mitigation methods.

10.1.4 The Classified Annex to this Def Stan ((NAN) EXP/03) gives more detailed guidance on some of the techniques available for use in munition mitigation and is available on from DSS NAExp on request.

10.2 Performance Requirements for Explosives Mitigation Methods

10.2.1 MAP 01-103 provides details of the Ship Explosive Threat Hazard Assessment. These will determine whether appropriate measures are required to reduce risks from explosives to ALARP when stowed, handled or used in ships. Where the residual consequences are not tolerable, a Platform and OME protection strategy is required to be determined that will prevent initiation of munitions and/or reduce platform consequences to tolerable levels that are ALARP and ensure that defined Operational Capability levels can be maintained.

10.2.2 The duty holder shall take measures to ensure all relevant requirements are satisfied to achieve the derived Platform and OME Protection Strategy with inclusion of any URD/SRD requirements and with consideration for the performance of the weapon system. The chosen methods must be addressed and justified in the SESC as appropriate. Guidance on this is given below and in the Classified Annex (NAN) EXP/03.

10.3 ACOP for Mitigation Measures

10.3.1 The mitigation system or technique may be designed into the ships structure or magazine/hold configurations with additional (non-structural or appliqué) mitigation systems applied to compartment boundaries, stowage's and around munition containers. Techniques and systems are available to manage blast by reducing consequences to the magazine/holds/weapon areas boundaries within the platform. Fire systems are described in 0. Other techniques for example, include procedures such as how munitions are stowed in relation to each other (Appendix 5 - Stowage Plans) and JSP 862

10.3.2 Boundaries exist at four points in a platform design where mitigation methods may be applied:

- a. Whole ship design and magazine boundaries.
- b. Magazine/weapon area protection.
- c. Munition Stowage.
- d. Inherent munition protection

More detail is given in the guidance section Appendix 10.11 below.

10.3.3 Where munitions to be embarked fully meet the Insensitive Munitions requirement as set by the Insensitive Munitions Acceptance Panel (IMAP), then mitigation in accordance with the ACOP paragraphs below may not be required, depending on how the munition responds to threats in the Naval Platform environment and the potential consequences. However, the tests used to measure Insensitive Munition signatures may be of a lesser energy loading than that seen for a particular Platform environment. The use of the SETHA will help to enable the susceptibility of the Insensitive Munitions to the particular threats identified for a platform to be assessed. Further guidance for this is below and in the Classified Annex ((NAN) Exp/03).

10.3.4 The response of the munition should be assessed in the configuration used for stowage in MOD ships, or in the configuration when in the DDA. This may be in the unpackaged condition. The test results should be analysed to ensure that they relate to the required configuration.

10.3.5 All mitigation systems will have to conform to an acceptable balance of performance, weight, bulk and cost and practicality. The material properties will need to be both compatible for effective performance and to meet requirements of the Naval environment. and also not present additional hazards to the stowed munitions.

10.3.6 Barrier materials to prevent sympathetic reaction will need to absorb, modify (change impulse) and deflect shockwaves, prevent or reduce fragment/jet velocities and provide thermal barriers. All this without becoming a threat to adjacent munitions by changing into a non-threatening form on breaking up from the forces involved.

10.3.7 Any system will require validation for its specific application either using existing information or by approved testing.

10.3.8 Mitigation may only be necessary for the vulnerable element of the munition. For example, if only the warhead is vulnerable to the credible threat then only the warhead requires protection or mitigation. It may however, be more cost-effective to provide mitigation to the whole stowage or to the boundary of the magazine closest to the vulnerable munitions.

10.3.9 These techniques should also be considered along with those recommended in 0 for configurations of magazine stowage's and in developing Stowage Plans. Methods of assessment/test of mitigation are described in the THA (Reference MAP 01-103) and in the Classified Annex ((NAN) Exp/03).

10.4 ACOP for Mitigation of Fire

10.4.1 Magazine, DDA and adjacent compartment fire protection and spray/flood systems in accordance with Appendix 8 and Def Stan 07-204 are designed to prevent exposure of munitions to fast heating.

10.4.2 Susceptible munitions should not be placed adjacent to the flight deck or weather deck or in the vicinity of aircraft or vehicles or the fuelling points of either.

10.4.3 Where fast heating, or fast heating and impact, could lead to an initiation of munitions in a VERTREP configuration and this leads to in-tolerable consequences to the platform, personnel and to operational capability, VERTREP may be subject to operational restrictions as specified in the SEXSSI and in JSP 862.

10.4.4 Magazine, DDA and adjacent compartment fire protection, detection, spray/flood and alarm systems in accordance with Appendix 8 and Def Stan 07-204 are designed to prevent exposure of munitions to continuous slow heating.

10.5 ACOP for Mitigation of Fragment Attack

10.5.1 Consideration should be given to armour protection of the elements of munitions, vulnerable to fragment attack. The munition container or a jacket around the munition may provide suitable protection, but advice should be sought from the munition SMEs and NAExp for individual munitions.

10.5.2 Mitigation measures for RATTAM threats or Sympathetic Reaction may offer some or all of the protection required from Fragment Attack. It is important, that each case be comprehensively evaluated to determine the driving threat(s). The relationship between the penetrative capability of armour piercing (AP) bullets and fragments will vary when alternative materials are used. Guidance is given in the Classified Annex to this standard - (NAN) Exp/03. This outlines comparative details of the weight, bulk and cost of armour materials and combinations of materials.

10.5.3 It is important to bear in mind that it is more difficult to achieve a high level of ballistic efficiency against fragments than it is against AP bullets. This is due to these generic types of projectiles having distinctly different geometry's, generally a fragment is blunt and irregular while an AP is a slender profiled shape. Consequently, it is easier for a ballistic armour to impart significant damage, disruption or destabilisation to a slender projectile than it is to achieve the same against a fragment.

10.5.4 Specific advice should be sought from NAExp on suitable measures that are currently under development for fragment protection. See Guidance in Appendix 11 below and in the classified annex (NAN) Exp/03 for further information.

10.6 ACOP for Mitigation of Bullet Attack

10.6.1 Mitigation for Armour Piercing (AP) Bullet Attack is likely to be required where munitions susceptible to bullet attack are permanently stowed above the waterline.

10.6.2 Reduction of risk from Bullet Attack during embarkation and disembarkation should be provided by explosives safety management measures detailed in JSP 862. Risks may be reduced by minimizing exposed susceptible explosive components, and if necessary by temporary screens. Further guidance on mitigation for bullet attack is outlined in the Classified Annex to this standard -(NAN) Exp/03.

10.7 ACOP for Mitigation of Blast Overpressure and Under Water Shock

10.7.1 Measures to reduce the damage to structure caused by explosive reactions are detailed in Appendix 12 with further guidance in the Classified Annex (NAN) EXP/03. Blast suppression systems are also under development. Advice should be sought from DSS NAExp on suitable measures.

10.7.2 The consequences to munitions from underwater shock are to be reduced to levels that are tolerable and ALARP. The level of degradation to a munition from underwater shock will be specified from the URD and generally categorised as being either Safe or Safe and Serviceable for use (See Part 4 of this Def Stan (GNE). Munitions susceptible to underwater shock loadings will require suitable protection from non-contact underwater shock. Underwater shock effects in the ship may include whipping effects. Detailed guidance for underwater shock protection is given in BR 8470 and CB 8469 [previously BR 3021 and CB 5012].

10.8 ACOP for Mitigation of Sympathetic Reaction (SR)

10.8.1 Intolerable consequences produced from munitions that sympathetically react are to be reduced to tolerable levels with the aim being to prevent SR from occurring. It is required to derive the maximum tolerable explosive event which then provides the level that SR is to be unitised too. This informs the extent of SR mitigation that will be required.

10.8.2 Munitions that are susceptible to prompt shock initiation leading to sympathetic reaction should be provided with mitigation as a minimum requirement. The vulnerable elements of the munition should be protected from the effects of the response of a munition from credible initiation events. Guidance is given in the classified annex to this standard - (NAN) EXP/03 on mitigation techniques for this purpose. Specific advice should be sought from NAExp on suitable measures that are currently under development.

10.9 ACOP for Mitigation of Rocket Efflux and Propulsive Reaction

10.9.1 Suitable protection against rocket efflux can be achieved by stowing munitions such that the efflux from a missile does not play directly upon another munition or a magazine boundary. Where this is not practicable, protective ablative or heat resistant material should be fitted between stowage's and bulkheads or decks or other munitions.

10.9.2 Adequate restraint and protection arrangements should be provided in the stowage of munitions that exhibit propulsive reactions such that they are restrained and the efflux does not initiate or damage adjacent munitions. Adequate fixing arrangements must be provided for the efflux barriers.

10.10 ACOP for Mitigation of Stowage of Shaped Charge Warheads including Demolition Munitions.

10.10.1 The orientation of Shaped Charges, in their stowage's, should be arranged to reduce the risk to other munitions and the ship to levels that are tolerable. Stowage positions for munitions with shaped charge warheads should be chosen so that the warhead is directed away from other adjacent munitions and should be placed facing platform structure, ideally, greater than 1.0m apart. Account is to be taken of compartments or the environment on the other side of the warhead direction and the consequences of high velocity jets escaping to these areas. See guidance in the Classified Annex (NAN) EXP/03).

10.11 Guidance on Deriving Mitigation Methods

10.11.1 Boundaries exist at four points in a platform design where mitigation methods may be applied to:

- a. Whole ship design and magazine boundaries:
 - i. The whole ship design including siting of magazines within the hull or superstructure to obtain maximum protection. This may be achieved by placing magazines below the water line or central in the hull with side protection from other compartments, passageways or tanks/wing tanks, separation from other susceptible magazines and stand-off from crucial or high risk components. Such vulnerability reduction strategies are also discussed [Reference 76]

- ii. Vulnerability reduction strategies and boundary hardening including armouring configurations that may include Fragment/RATTAM protection, side protection systems i.e. compartment or tank/wing tank surrounds, appliqué armour.
 - iii. Blast Suppression including Blast Resistant Structure, blast resistant structural connections and blast over-pressure venting routes which may be exploited to manage the release of blast over-pressure gases. Also including active blast suppression systems. See Classified Annex ((NAN) EXP/03).
 - iv Munitions that incorporate Shaped Charge warheads will require special protection principles and advice should be sought from DSS NAExp in these instances. See Classified Annex ((NAN) EXP/03).
- b. Magazine/weapon area protection:
 - i. Magazine and other munition area boundary hardening should be considered for all probable threat directions including out to in and vice versa.
 - ii. Barriers within the magazine compartment that are configured around, or as part of, discrete stowage areas with the aim of isolating individual stowage areas from adjacent munitions reducing a credible event to tolerable levels of damage (Unitisation).
 - iii. The magazine or Designated Danger Area (DDA) boundaries provide a frame to which mitigation methods may be applied to prevent energy from entering the compartment or which may reduce the consequences from own munition initiation by using blast resistant structure or suppression systems. See Classified Annex ((NAN) EXP/03)
- c. Munition Stowage
 - i. Stowage layout (Stowage Plans): Established principles (Appendices 5) should be followed to minimise the occurrence and scale of an explosive event caused by reactions between stowed munitions. The guidance provided on weapons orientation and their proximity to other neighbouring munitions and bulkheads should be observed.
 - ii. Stowage system design: The design, material and structure of the munition stowage system should be configured to mitigate the effect of munition reaction upon adjacently stowed munitions by including barriers between individual or units of munitions to effectively unitise the size of an initiation event.

iii. The munition stowage, racking or the locality and orientation of where the susceptible munitions are placed. Mitigation may be applied to the whole stowage, individual munitions or to protect just the susceptible areas of munitions.

d. Inherent munition protection:

i. Munition containers: Individual containers, packaging or casings, if utilised, should be configured such that they provide the dual function barrier for the general protection of the munition during storage, handling and movement and also protection of neighbouring munitions with the racking system.

ii. Protection blankets/over-packs/water surrounds applied to individual munitions.

iii. Utilise inherent packaging design to best effect. (Insensitive Munitions) – see guidance in Classified Annex ((NAN) EXP/03).

iv. Inherent to the munition system design or within the packaging. Further details available from the Ordnance, Munitions and Explosives Safety Instructions and Defence Ordnance Safety Group (DOSG).

10.11.2 More detailed guidance on the mitigation methods for each of the four boundary points is given in the Classified Annex ((NAN) EXP/03).

APPENDIX 11 FRAGMENT and RATTAM PROTECTION

11.1 Description

11.1.1 The threat from wartime and terrorist activity presents potential hazards to unprotected munitions that are susceptible to threat weapons. As a minimum, protection against the defined threat is required in MOD ships.

11.1.2 For terrorist activity this is known as the RATTAM concept, which stands for Response to ATtack on Ammunition and is defined by a threat weapon that will cause an intolerable reaction from susceptible munitions.

11.1.3 Classified Annex (NAN) EXP/03 gives more detailed guidance on specific threat levels and techniques to achieve appropriate protection where a munition is classified as fragment and RATTAM susceptible. This is available on from DSS NAExp on request.

11.1.4 This appendix details the Performance Requirement, ACOP and Guidance that will support duty holders in achieving RATTAM protection where required.

11.2 Performance Requirement for Fragment and RATTAM Protection

1.2.1 Adequate protection is to be incorporated into MOD ships against Fragment and RATTAM threats to reduce the potential to response to susceptible munitions, in their permanent approved stowages, to levels that are ALARP and tolerable

11.2.2 Currently, the vulnerability of a munition, without protection, will be undertaken as part of the DOSG inherent safety assessment, where the CSOME is the output. This will include test or assessment against the requirements of STANAG 4496 and STANAG 4241. The results will be included in the OME Safety Case Report and associated CSOME and OME Safety Instruction. The specific Platform Vulnerability and RATTAM threat requirement should be specified in the URD/SRD, actual arrangements are to be justified in the SESC. Definitions of the threats are given in the Classified (NAN) EXP/03.

11.2.3 Fragment and RATTAM threats and the response of the munition are to be assessed as part of the Protection Strategy process (see MAP 01-103) The threats are one of a range of hazards that munitions may be subject to in the Naval Environment.

11.2.4 Design safety justification for the fragment RATTAM protection is to be detailed in the DDD and summarised in the SESC.

11.3 ACOP for Fragment and RATTAM Threat Requirement

11.3.1 The prescribed fragment and RATTAM threat level is determined from current intelligence of the most likely threat that may be used against Naval Platforms in their required theatre of operations. This threat level is set by Customer one (DEC) and will be described in the URD/SRD for each platform. The threat levels described in Appendix 11 of Classified Annex Naval Authority Notice EXP/03 are a minimum requirement; additional terrorist threats may be defined in the URD/SRD. For in-service platforms the PDH is to establish the required level and to assess whether the existing level of threat protection is sufficient, in consultation with the relevant DEC. Further advice is available from DSS NAExp.

11.3.2 The requirement for threat protection for a munition should be assessed in the configuration that will be used for stowage in MOD ships; this may be in the unpackaged condition. The test results should be assessed to ensure that they relate to the required stowage condition. This will include munitions introduced into service to be stowed and carried on existing platforms. Methods of assessment/test are described in Appendix 11 with guidance contained in the Classified Annex (NAN) EXP/03.

11.3.3 Where weather deck stowage is essential (e.g. Surface to Surface Guided Weapons (SSGW) and vertically launched weapons) measures should be taken to reduce the likelihood of occurrence of the most severe response of one explosive store to the RATTAM threat causing a sympathetic reaction in adjacent stores that is greater than Burning (Type V Reaction). Further detail is provided in Classified Annex (NAN) EXP/03.

11.3.4 Threat protection need only be provided to the susceptible element of the munition. e.g. if the munition propellant response is deemed acceptable but the warhead response is not protect only the warhead and not the propellant. Albeit it may however be more cost effective to provide threat protection to the whole susceptible area of the exposed side(s) of the magazine.

11.4 ACOP for Threat Protection Assessment

11.4.1 The ballistic effectiveness of a given thickness of plate, material or armour system may be determined by a validation test. This test should be conducted in accordance with an appropriate agreed test methodology and reporting dependant upon the type of scheme chosen [Refer to the Classified Annex (NAN) EXP/03]. The results of the test or assessment should be included in the design safety justification. It is possible that a theoretical assessment may be undertaken using computer simulation but this is to be agreed, at an early stage, with DSS NAExp

11.4.2 Munition susceptibility data should be provided by the OME IPT as a result of the munition testing required by JSP520. Specific details should be provided as part of data created in support of the CSOME. Specific testing is described below:

- a. RATTAM threat levels A1 or A2: This may be determined from munition tests in accordance with STANAG 4241.
- b. RATTAM threat level B: This may be determined from assessment of RATTAM threat level A or from munition testing in accordance with STANAG 4496 (Fragment tests).
- c. RATTAM threat level C: This may be determined from munition tests in accordance with US Military Standard 2105B, where undertaken.
- d. Fragment Threats: This may be determined from munition tests in accordance with STANAG 4496 (Fragment impact tests). Note that the size and energy of fragments used for these tests may not be compatible with those seen from the derived platform threat definition. Refer to Part 4 GNE and NEAS forms.
- e. Where no munition testing has been undertaken or interpretation of munition results are required then advice is to be sought from DOSG and DSS NAExp.

NOTE: the test requirement specified by STANAG 4241, 4496 or Mil Stan 2105B should cover both the packaged and unpackaged condition, where appropriate.

11.4.3 To assess a threat protection schemes that rely on partial protection, the following factors should be determined and explained in the design justification. Further advice is given in the Classified (NAN) EXP/03:

- a. The assessment or test of the protection scheme should determine the residual velocity and mass of the threats on exit from the protection scheme.
- b. The assessment or test of the susceptible munition should determine the minimum threshold velocity/energy level below which the munition will not react by Shock to Detonation and produce in-tolerable consequences to the platform, personnel and the environment.

11.5 ACOP for Methods of Fragment and RATTAM Protection

11.5.1 Explosive stores susceptible to the current threat levels should be stowed wherever possible below the waterline. The depth of the stowage beneath the waterline for a given loading condition requires assessment depending on the defined level of threat. Further guidance is given in the Classified (NAN) NAEXP/3.

11.5.2 Munitions stowed below the calculated waterline will only be vulnerable to the current defined RATTAM threat when they are moved to a position providing exposure to potential terrorist attack. Munitions stowed above the waterline are potentially vulnerable at all times, whilst in operating environments, when a terrorist threat is present. It is considered reasonable to assume during movement of ammunition that where the munition is screened so that the terrorist cannot select the munition as an aiming point then the risk of effective attack is very low.

11.5.3 If stowage below the waterline is not possible, or if the Hazard Classification Code/Compatibility Group of the store prevents stowage below the weather deck, guidance on suitable methods to provide threat protection is described in Classified (NAN) EXP/03.

11.5.4 Siting and orientation of the munitions relative to the threat directions and to sympathetic reaction responses may prevent initiation or subsequent reactions. Further guidance is given in (NAN)EXP/03.

11.5.5 There are a number of armour options that may be either built into boundary structure or applied as appliqué armour. The protection could also be fitted into stowage's or surrounding individual munitions and may be part of a combined mitigation system designed to also prevent sympathetic reaction between munitions. Where it is intended to fit an armour scheme to defeat other wartime threats it may be that this will also suffice for the RATTAM threat or vice versa. However, the armour designed to defeat a fragment threat may not be suitable to defeat the RATTAM threat or vice versa. The protection option to be chosen can be derived from using the SETHA methodology. Guidance is given in the Classified Annex (NAN) EXP/03.

11.5.6 The ballistic effectiveness of a given thickness of plate material or armour system may be determined by a validated test. This test should be conducted in accordance with the appropriate agreed test methodology and reporting dependent upon the type of scheme chosen.(refer to classified Annex NAN EXP/03) The results of the test or assessment should include in the design safety justification. It is possible that a theoretical assessment may be undertaken using computer simulation but this is to be agreed at an early stage with DSS NAExp

11.6 ACOP for Angle of RATTAM Attack

11.6.1 The RATTAM threat is assumed to be from either beam, from above, ahead and from astern unless otherwise specified in the URD/SRD. Protection may be required for vertical launch systems or exposed upper/weather deck stowage's from overhead (e.g. when passing under bridges). The specific threat to particular, susceptible, munition(s) in the ship should be assessed in detail, Classified Annex (NAN) Exp/03 Appendix 11 provides guidance.

11.6.2 For RATTAM threat weapons A1 and A2, the angle of attack has an influence on the performance of the projectile, which, in certain conditions will lead to tumbling in unpredictable directions, or ricochet. For RATTAM threat angles, see Appendix 11 of the Classified Annex (NAN) EXP/03.

11.6.3 Where RATTAM protection is required; the susceptible element of the explosive store exposed to threats A1 and A2 should be protected, as a minimum, against angles of attack as specific in the Classified Annex (NAN) EXP/03.

11.6.4 Any applied Fragment and RATTAM protection scheme is not to draw attention to the presence or position of any magazine.

11.7 Guidance – Fragment and RATTAM Threats

11.7.1 Classified Annex (NAN) EXP/03 gives guidance on specific threat levels and techniques to achieve appropriate protection where a munition is classified as susceptible. It is available from DSS NAExp on request. It is currently protectively marked RESTRICTED.

APPENDIX 12 MAGAZINE OVER PRESSURE RELIEF - VENTING PLATES

12.1 Description

12.1.1 Magazine over-pressure relief venting plates are designed to prevent the structure of a magazine or preparation area being damaged by a credible incident in the magazine involving the gas produced from the ignition of propellants (Liquid or solid) or high explosives (Insensitive Munitions response of Type V burning).

12.1.2 They are not designed to cater for overpressure (Quasi Static over-Pressure or QSP) caused by blast from detonation type reactions (Type I or II). Measures discussed at appendix 10.11 should be considered for blast overpressure (QSP).

12.1.3 Classified Annex (NAN)EXP/03 gives more detailed guidance on the design of venting plates for magazine over pressure relief. It is available from DSS NAExp on request.

12.1.4 This appendix details the Performance Requirement, ACOP and Guidance that will support duty holders in achieving satisfactory design of pressure relief venting plates where required.

12.2 Performance Requirements for over Pressure Venting

12.2.1 Where susceptible OME are identified from conducting a SETHA, as described in Chapter 9 with full details outlined in (MAP) 01-103, that may produce intolerable consequences on the boundary structure, appropriate measures are to be taken to relieve pressure from credible incidents in magazines to ALARP.

12.2.2 The benefit of over-pressure relief venting design is to be considered in relation to other magazine and munition protection techniques. Design safety justification for the pressure relief venting protection is to be detailed in the DDD and summarised in the SESC and supported with outputs from the STG VENT modelling code.

12.3 ACOP for Over Pressure Venting Plates and Vent Routes

12.3.1 The use of a SETHA will identify susceptible munitions and determine the scenario that is likely to occur if the propellant or HE is ignited (i.e. Type IV-Deflagration or Type V-Burning response or, Propulsive Burn). The assessment is to determine also whether there is the potential for propagation of the ignition event to more propellants or a multi-burning response from the HE (IM Type V reaction) components. The assessment is to determine the level of damage that may be tolerated to the boundary structure and to calculate the permeable compartment volume for gas to fill. The assessment is also to determine the number and size of the over-pressure vent plate(s), including the trunking volume and numbers of turns required to relieve the over-pressure to atmosphere whilst achieving the required level of structure protection. Further guidance is in the Classified Annex (NAN) EXP/03.

12.3.2 To assist in the SETHA for over-pressure venting requirements a validated software program "STG Vent" to calculate vent plate sizing for given design parameters. "STG Vent", complete with a guidance manual, is available from DSS NAExp .

12.3.3 As a minimum requirement, over-pressure relief venting plates should be provided where munitions, ignited by a credible incident, produce a Quasi Static Pressure (QSP) of 0.2 bar (20.4 kN/m²) (3 psi) or more in their normal designated stowage position.

12.3.4 The venting route should blow direct to atmosphere with a dedicated venting trunk fitted between the munition area and atmosphere.

12.3.5 Vent plates must be provided with restraining arrangements to limit the propulsion of the plates and risk of damage to the immediate area. "STG Vent" software allows calculation of this.

12.3.6 The vent plate arrangements are to be designed to ensure that structural and water tight integrity is maintained in accordance with the magazine and platform design intent. The required scantlings for the vent trunk structure are to be calculated as for the magazine boundary requirements specified in appendix 4.

12.3.7 Wherever a large venting area is required, more than one plate may be fitted. (see guidance in the classified Annex (NAN) EXP/03).

12.3.8 Where the vent trunking is to include an escape route, the arrangements for hatches must prevent over-pressures from escaping into other internal compartments. Ladders and fittings are to minimise impedance of escaping over-pressure gas.

12.4 ACOP for Marking of Over Pressure Vent Plates

12.4.1 A “Prohibitive” sign ‘VENTING PLATE-DO NOT OBSTRUCT’ is to be painted on the outside of the venting plate in accordance with Def Stan 02-784/NES 784. The plate perimeter should be highlighted by yellow and black hazard stripe.

12.4.2 The vent plate in the magazine should also be marked with a descriptive sign ‘Vent Plate’ in accordance with Def Stan 02-784/NES 784.

APPENDIX 13 ANTI FLASH PROTECTION

13.1 Description

13.1.1 The products of an explosion are flash, transient flame, blast and (possibly) fragments. Flash in this theoretical context refers to an electromagnetic radiation, travelling at the speed of light, which is, in itself, no hazard to cased propellant or encapsulated weapons.

13.1.2 In the context of magazine design in Lloyds Naval Rules and in this Standard as mandated by Naval Authority Regulations (Exp), the term flash embraces transient flame and associated pressure wave in addition to the electromagnetic radiation referred to above. The protection against flash required by the magazine design must cater for the effects of all three phenomena.

13.1.3 Anti-flash protection is designed to reduce injury or death of personnel due to the flash and transient flame products of explosion of munitions. Other effects arising from the explosion of munitions (e.g. fragments and blast) can only be mitigated or controlled by the methods described in (NAN) EXP/03 and other appendices in this standard.

13.1.4 This appendix details the Performance Requirement, ACOP and Guidance that will support duty holders in achieving satisfactory design of anti-flash protection in magazines where required.

13.2 Performance Requirement

13.2.1 The preferred SETHA methodology, as described in Chapter 9 with full details outlined in (MAP) 01-103, should identify susceptible munitions and where Anti Flash Protection is required, appropriate measures are to be taken to reduce risks from credible incidents in magazines to ALARP.

13.2.2 The Anti Flash design measures are to be detailed in the magazine design. This must be considered in relation to other magazine and munition protection. Design safety measures for anti flash are to be detailed in the DDD and justified in the SESC

13.3 ACOP for Anti Flash Protection

13.3.1 Magazines and RU magazines should be protected by a flash tight barrier at the exit of the ammunitioning routes or as near to them as is practicable.

13.3.2 Magazine and RU magazine access doors should be flash tight when closed.

13.3.3 Magazines that open on to the weather deck should be provided with an access that is flash tight when closed.

13.3.4 When ammunitioning routes that enter the hangar from inside the ship are closed, the barrier formed should be flash tight.

13.3.5 Openings in magazines for secondary supply routes should be flash tight when closed.

13.3.6 RFA Magazines should be flash tight when the main access is closed.

13.3.7 ANNEX F details the minimum standard of protection to meet flash tight requirements. It is accepted that watertight or airtight/gastight openings meet flash tight requirements when closed.

13.3.8 Requirements for anti-flash protection in ventilation and air-conditioning systems are stated in Appendix 13.

13.4 ACOP for Anti Flash Protection in Weapon Lifts and Hoists

13.4.1 All openings to weapon lifts/hoists should be fitted with a door/shutter that is flash tight when closed.

13.4.2 Interlocks should be provided so that only the door/shutter at the level at which the lift/hoist is stopped can be opened. In RFA magazines, doors at each level should be interlocked.

13.4.3 Where there is more than one access to the lift/hoist from separate compartments at the same level (of which at least one is a magazine) interlocks should be provided so that only one of the doors/shutters at that level can be opened.

13.4.4 Where a magazine is served by two lift systems, the requirement for interlocks to prevent access doors/shutters on the same level being opened at the same time should be assessed and the risks reduced to ALARP.

13.5 Guidance - Anti Flash Protection

13.5.1 Past battle damage experience in the Royal Navy has demonstrated on many occasions that the electromagnetic radiation and transient flame arising from explosions involving propellant can cause severe personnel injuries. In general, Anti-Flash Protection should be provided for stowage's and supply routes of all types of propellant except:

- a. Munitions of 40mm diameter and below, where the potential for generation of a damaging flame front is reduced by the lower NEQ of the stores.
- b. Protection is not necessary for stores containing propellant that are themselves inherently flash tight. In practise this means that protection for packaged munitions is not required.

13.5.2 The specific effects of the blast wave and any fragments generated by propellant explosions may be mitigated by the measures described in (NAN) EXP/03. In the context of this section, the pressure wave is driving the flame front.

13.5.3 Detonation of high explosives (HD 1.1) will also cause electromagnetic radiation in the form of an intense light flash. The blast and fragment effects caused by the detonation normally mask the effects of flash on exposed personnel near to the point of initiation. Mitigation for detonation and sympathetic reaction is described in (NAN) EXP/03.

13.5.4 The aim of the design safety assessment of the flash tight measures for each magazine should be to assess:

- a. The potential for the natures of ammunition in the magazine (or on the ammunition route) to generate flash. This will enable the flash consequences of the worst credible incident in the area to be assessed.
- b. The likelihood of an incident giving rise to the generation of flash in the area. For an ammunition route this will include an assessment of the likely usage of the areas for munitions – to evaluate time at risk.
- c. The potential hazards in the area that may give rise to an incident that will generate flash.

13.5.5 Risk management should then proceed to reduce the risks identified to ALARP by elimination, where practicable, of the hazards identified in the area, or reduction in the risk by quantity, flash mitigation or control measures. The most practical method of flash mitigation is to provide a flash tight boundary to the magazine. This will generally much reduce the flame front even though the boundary may be being damaged by the pressure wave at the same time.

13.5.6 Where the response of the munitions to credible accidents or enemy action is burning (Type V) it is unlikely that own munitions will contribute significantly to flash in the context of this standard. However a significant heat load may be generated. The fire protection measures identified in Appendix 7 and 8 are intended to mitigate this threat.

13.5.7 Partial protection for personnel is provided by the wearing of anti-flash protective clothing at high degrees of readiness. This includes all embarked personnel including E3. The wearing of protective clothing is to be regarded as a “last ditch” measure for individual protection. Positive measures are required to eliminate or reduce substantially the flash before it reaches personnel.

13.5.8 Application of the requirements for interlocks for lifts and hoists in the paragraphs above will also meet the requirements for interlocks for blast protection specified in (NAN)EXP/03

APPENDIX 14 SECURITY AND ANTI SABOTAGE ARRANGEMENTS

14.1 Description

14.1.1 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the provision of suitable arrangements for the security and anti-sabotage arrangements for munitions in MOD ships.

14.2 Performance Requirements for Security and Anti Sabotage

14.2.1 Appropriate measures are to be taken to safeguard the security of munitions onboard MOD ships. This is a mandatory requirement to meet the requirements of MOD security policy and UK legislation defined in JSP 440

14.2.2 The requirements for all security and anti-sabotage arrangements are to be assessed and incorporated in accordance with Def Stan 07-207/NES142. The measures are to be detailed and justified in the SESC. Guidance on appropriate security measures is given below.

14.2.3 The requirements for keys and tallies in Def Stan 02-141/NES 141 are to be met.

14.2.4 The security and anti-sabotage arrangements for munitions shall meet the requirements of JSP 862, other SEMS and other ship Key Hazard Certification requirements. The duty holder shall take measures to ensure that all relevant requirements are satisfied. In particular the measures are to be compatible with the requirements of JSP 862 Chapter 4 to enable effective and auditable control of security of munitions to be exercised.

14.3 ACOP for Security of Doors, Hatches, Manholes and Escape Scuttles

14.3.1 Access doors, hatches and their associated manholes to magazines, lids/doors to lockers containing explosives and the tops of any trunks or hoists which deliver direct into magazines are to be fitted with arrangements suitable to accommodate the approved securing arrangement as detailed in Def Stan 07-207/NES 142.

14.3.2 Securing arrangements are to be designed to prevent the possibility of entry by removing hinge pins or other irregular means.

14.3.3 Where emergency escape scuttles are fitted to magazines they are to be operable only from within the magazine.

14.4 ACOP for Prevention of Access

14.4.1 It must be possible to prevent access into magazines through auxiliary weapon lifts, hoist trunks, or doors by means of an approved securing device on the magazine side, e.g. by pinning the door in the closed position.

14.4.2 Embarkation hatches of magazines are to be provided with arrangements on the inside to prevent unauthorized entry e.g. a sliding bolt arrangement.

14.4.3 In RFA magazines, locking arrangements are to be fitted on the magazine side of the lift trunk doors/shutters. Sliding bolts are not required on the inside of embarkation hatches for RFA magazines.

14.3.4 In NAVs and NALs Armament Cargo Hold hatch covers are to be made secure either by means of locking bars secured by approved padlocks, or other positive means. Sliding bolts are not required on the inside of embarkation hatches.

14.5 ACOP for Security and Anti Sabotage Arrangements

14.5.1 Physical security against unauthorized access and sabotage is to be achieved to protect all explosive stores/munitions. Guidance is given in JSP 440.

14.5.2 Key cupboards, magazine lock and key designation is to be in accordance with Def Stan 02-141/NES 141.

14.5.3 Key tallies to Detonator Lockers and the compartment(s) in which they are housed are to be of magazine type, i.e. round.

14.5.4 All magazine spray and ventilation system valve operating positions are to be fitted with an approved securing arrangement in accordance with Def Stan 07-207/NES 142.

14.5.5 Emergency lighting stowage's, sited external to the magazine, should be provided with an approved securing arrangement in accordance with Def Stan 07-207/NES 142.

14.5.6 Air Conditioning Unit drains, LP air valves, hydraulic valves and compartment drain valves should be provided with an approved securing arrangement in accordance with Def Stan 07-207/NES 142.

14.5.7 All ventilation trunks are to be designed to prevent the passage of foreign bodies or liquids into the magazine.

14.5.8 Exhaust outlets, air inlets and automatic air escapes are to be anti-sabotage construction.

14.5.9 Pipe systems permitted to pass through, or terminate in a magazine, are to be of a welded construction within the magazine. They are to be fitted with anti-sabotage arrangements at the terminals to prevent the passage of foreign/bodies liquids into the pipe. See ACOP at Appendix 7.3

14.5.10 Pipe systems are not to terminate in a magazine unless they serve it.

14.6 Guidance - Security and Anti Sabotage Arrangements

14.6.1 The aim of the design assessment of security and anti-sabotage arrangements should be to assess:

- a. The positions of the munitions stowages within the ship – to evaluate security risks.
- b. The potential consequences of unauthorised access to magazine areas or lockers.
- c. The potential for acts of sabotage.

14.6.2 Security risk management should then proceed to reduce the security and sabotage risks identified to ALARP by elimination, where practicable, of the security deficiencies identified in the area or reduction in the risk by other control measures. Application of the design requirements specified in Def Stan 02-141/NES 141 should ensure that adequate security and anti-sabotage arrangements are achieved.

14.6.3 In general, the aim should be to prevent access without detection to munitions that may be attractive to terrorists, criminals or ill-intentioned persons. Guidance to police and local authorities for civil explosives storage indicates that the HSE would expect a primary aim to be to resist unauthorised access until the response force can make an effective response when alerted by the intruder alarm/surveillance system.

14.6.4 In the maritime field, the SMS in JSP 862 provides for several operator procedures to ensure security. The presence of a Quartermaster/gangway sentry to control access to the ship and a response force to tackle any intruder detected are part of the controls in place. Daily magazine rounds, rounds to check that approaches to magazines are locked and remain secure and rounds of adjacent compartments are intended to both deter and detect intrusion.

14.6.5 The aim of anti-sabotage measures is to prevent or deter the insertion of explosive charges or explosive/corrosive/flammable liquids into the magazine or magazine lockers.

14.6.6 Where the consequences of ill intentioned access or sabotage might be critical to UK defence capability further measures should be taken. Examples include intruder alarms/surveillance and CCTV monitoring of locked approaches.

14.6.7 Physical security of water spray/flood, ventilation, hydraulic/pneumatic and drain systems is required to ensure that these services remain in their operational state without unintentional or wilful interference that may prejudice the safety of the magazine or magazine locker.

APPENDIX 15 REQUIREMENTS FOR STATIC CONTROL AND CONDUCTING DECKS

15.1 Description

15.1.1 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to static control measures and the provision of conducting decks where required in MOD ships.

15.2 Performance Requirements for Static Control Measures and Conducting Decks

15.2.1 Appropriate static control measures are required where explosive stores containing an Electro-Explosive Device (EED) with exposed contacts, terminals or circuitry are vulnerable to contact during handling.

15.2.2 A conducting deck is to be provided where the Munition IPT or PIPT specifies that static control precautions in stowage, preparation/test or handling are required for a vulnerable munition.

15.2.3 The static control measures for vulnerable munitions shall meet the requirements of JSP 862, other SEMS and other ship Key Hazard Certification requirements. The duty holder shall take measures to ensure that all relevant requirements are satisfied.

15.3 ACOP for Static Control Measures and Conducting Decks

15.3.1 Ships carrying explosive stores requiring static control precautions should have a separate area with a conducting deck to allow examination of any stores with damaged or broken packaging. A conducting deck area to examine damaged munitions is not required in NAVs and NALs.

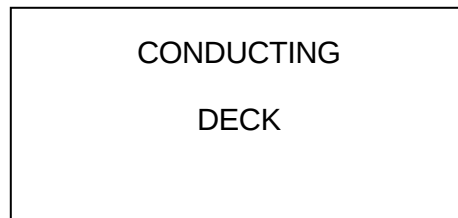
15.3.2 Certain munitions require various assembly/disassembly tasks carried out on board ship that require static control precautions to be taken. If a conducting deck is required as part of the precautions, a conducting deck area should be provided of sufficient size to allow all work to be carried out in the designated area. The remaining area of the deck space should be coated with the standard paint scheme for decks.

15.3.3 Magazines and areas where the preparation, test, assembly or examination of munitions are carried out and which require a conducting deck should have a Hazardous Area Personnel Test Meter (HAPTM) Mk.3A (NSN 6625-99-591-3495) static monitoring device installed, immediately adjacent to their access.

15.3.4 Conducting deck areas are to be prepared in accordance with the guidance of BR3939 and painting scheme as called up in WARPAINT.

15.3.5 The resistance to earth of the conducting deck must be less than 50 k Ω to be effective. This is to be checked by a planned maintenance activity.

15.3.6 A 'notice' similar to the following should be provided in a prominent place in the compartment:



15.3.7 Where there is a conducting deck requirement a "static control precautions notice" should be prominently displayed in the magazine and associated preparation/handling areas/rooms. The safety colour is to be in accordance with the requirements of Def Stan 02-784/NES 784.

15.4 Guidance - Static Control Measures and Conducting Decks

15.4.1 The aim of the design safety assessment of static control precautions should be to assess:

- a. Identification of munitions with EED's that require static control precautions and the states in which these precautions are required (i.e. packaged, unpackaged, during handling, assembly, test, preparation, following action damage etc).
- b. The munition stowage and processing areas within the ship where munitions with vulnerable EED's are handled – to evaluate conducting deck requirements.
- c. The potential consequences of unauthorised or incorrect handling or processing in areas without conducting decks.
- d. The potential for loss of mission capability in the event of action damage to conducting deck areas.

15.4.2 Risk management should then proceed to reduce the risks identified to ALARP by elimination, where practicable, of the deficiencies identified in the provision of conducting deck areas, or reduction in the risk by other control measures. Application of the design requirements specified in BR3939 should ensure that adequate static control arrangements are achieved.

15.4.3 Details of explosive stores, which necessitate the use of static control measures such as conducting decks, should be obtained from the munition safety cases.

15.4.4 To enable personnel entering the magazine to observe static control precautions, the most prominent handhold adjacent to the magazine door/hatch should be maintained as bare, bright metal to provide a good path to earth. This will enable personnel to discharge any personal electro-static charge as they enter the magazine.

15.4.5 The wearing of conducting footwear by all personnel in accordance with instructions in JSP 862 forms an essential part of the safe system of work to avoid the build-up of personal electro-static charge at all times.

APPENDIX 16 AMMUNITION HANDLING – EMBARKING, STOWING AND SUPPLY

16.1 Description

16.1.1 This appendix sets out the Performance Requirements, ACOP and Guidance that relate to the provision of safe and suitable arrangements for the handling of munitions in MOD ships.

16.2 Performance Requirements for Ammunition Handling Safety Policy

16.2.1 When transferring ammunition, the risk to the munition, handlers, the ship and the environment is to be reduced to a level that is ALARP. This is to be justified in the SESC.

16.2.2 MXS IPT are the subject matter experts for all munitions manual handling and mobile mechanical handling equipment. They sponsor JSP 467 (MoD general handling Regulations) and BR 3027. They should be consulted for advice on all aspects of manual handling and MMHE including the production of appropriate procurement specifications for such equipment in all MoD ships.

16.2.3 The general design, construction and operation of munitions handling equipment must also meet the SEMS and SSOW requirements of JSP 862, other SEMS and Key Hazard areas as appropriate. The duty holder shall take measures to ensure all relevant requirements are satisfied.

16.3 Performance Requirements for Ammunition Handling – Novel Designs

16.3.1 Before developing specialized handling equipment for a new weapon system, the feasibility of using in service weapon handling equipment is to be assessed.

16.3.2 All necessary drill procedures are to be provided for ammunition handling equipment. The procedures are to be published in handbooks for use by the munition handlers. Such procedures form an essential part of the “safe system of work” to meet the requirements of the SEMS in JSP 862 and the Health and Safety at Work etc. Act 1974.

16.3.3 The safety of the proposed new arrangements for ammunition handling shall be demonstrated. This may be by virtual reality modelling or trials. Operator procedures are to be proved with inert munitions before use.

16.4 Performance Requirements for Ammunition Routes

16.4.1 A primary ammunition route is to be provided for all munitions from the embarkation point to their dedicated permanent stowage or launcher.

16.4.2 Apart from vertical launch missiles, SSGW weapons in canisters and large decoys (above 100 mm in diameter) replenished only in harbour, a secondary route is also to be provided from the embarkation point to the dedicated permanent stowage or launcher.

16.4.3 Where appropriate, primary and secondary ammunition routes are to be provided from permanent stowage to RU Magazines/RU Magazine Lockers (where fitted) and to the point of use.

16.4.4 The rate of supply and manpower shall meet the requirements of the URD/SRD.

16.4.5 Assault routes are to be provided for routes of transit of E3 munitions through the ship to the point of disembarkation. Areas used to stow/hold/prepare munitions on assault routes are to be classified as DDAs.

16.4.6 Adequate communications facilities are to be provided between separate manned sections of ammunition and assault routes.

16.4.7 Embarkation/RAS/VERTREP arrangements (ramps, cranes, weapon lifts, hoists, Fixed Mechanical Handling Equipment, communications and overhead handling equipment etc.) are to be provided in accordance with General Arrangement Drawings, Def Stan 07-279/NES 114 and information supplied by the Ship Design Authority/PIPT.

16.5 Performance Requirements for Explosives Handling/Lifting Equipment

16.5.1 All necessary handling equipment, (including davits, cranes, miller's flaps, chutes, cruets, eyeplates, whips, sheaves, rollers, jackstays, lifting strops, portable dumping platforms and other associated fittings) is to be provided together with procedures for striking down or supply of munitions, safely and efficiently, along both primary and secondary ammunition routes.

16.5.2 Equipment for the handling/lifting of munitions is to be specified in the ship's Ammunition Route Drawings, Weapons/Drill Handbooks, and Rigging Warrants/Ships Lifting Equipment Registers.

16.5.3 The manual handler lifting limitations contained in Manual Handling Operations Regulations (as amended) 1992 (MHOR), HSE Guidance Tool INDG383 and Def Stan 00-25 are to be observed.

16.5.4 Secure rattle free stowage's are to be provided for all handling equipment retained onboard. Further guidance is given in Def Stan 02-703.

16.5.5 Handling arrangements shall be able to operate safely within the environment specified in the URD/SRD/Staff Requirement in accordance with Def Stan 08-123/NES 1004 and the environment specified in Part 4 of this Def Stan (GNE).

16.5.6 Handling and lifting equipment in the magazines and ammunition routes is to be tested/examined in date in accordance with the requirements of BR 3027(1) and Def Stan 02-113.

16.6 Performance Requirement – Mobile Mechanical Handling Equipment (MMHE) in MOD Ships

16.6.1 All Mobile Mechanical Handling Equipment (MMHE) used for handling/carriage of munitions shall be fully compliant with the electrical equipment requirements laid down in Part 3 of Defence Standard 00-101.

16.6.2 Where MMHE is to be used in a Zone 2 Magazine or DDA, or to handle UN HCC J munitions, then it shall also be certified and clearly designated as being Zone 2 compliant.

16.6.3 All MMHE that is used to move munitions shall comply with the additional minimum specifications detailed in Annex H.

16.7 ACOP for Ammunition Handling

16.7.1 Embarkation of munitions should be by derrick, crane, vehicle ramp, RAS(A) high point or stump mast or VERTREP, to the appropriate embarkation point on the weather deck, vehicle deck/hangar or RAS sponson. The position of the embarkation point should not be more than 9 m above the waterline.

16.7.2 Portable rails, guides, trackways, mobile cranes or loading systems may be used for embarking missiles, torpedoes, other ammunition and decoys into launchers, launch tubes or embarkation hatches. All such equipment should meet the ammunition lifting test and examination requirements of BR 3027(1) and Def Stan 02-113.

16.7.3 Where ship's cranes are fitted they should be compliant with JSP467, BR3027(1) and Def Stan 02-113 to allow use for embarking ammunition.

16.7.4 The manning level of any handling option should be as low as possible commensurate with safety.

16.8 ACOP for Ammunition Routes

16.8.1 Ammunition Routes should be designed to enable the munitions to be moved rapidly from the embarkation point to its permanent stowage, and, where required, to its ready use stowage or point of use, with the minimum of manpower. Primary and secondary routes should be selected to optimize the safety of the evolution and organized so that:

- a. Both primary and secondary routes should be as direct as possible, commensurate with safety.
- b. They should be sheltered as far as practicable, from the climatic, physical and electromagnetic environment.
- c. The secondary route is intended to provide an alternative route, not utilising the same mechanical handling equipment as the primary route, in the event of equipment failure or damage to the ship. So far as practicable, it should not be common with the primary route.

16.8.2 The following principles should apply to primary ammunition route equipment:

- a. Equipment dedicated to other operational requirements (e.g. aircraft lifts), should not be used on the primary route.
- b. The primary route should also not interfere unnecessarily with other important ship operations (e.g. aircraft movement).
- c. The primary route may include a dedicated hoist or lift or make use of hatches and doors provided for normal ship access.
- d. Maximum use should be made of mechanical handling aids.

16.8.3 The following principles should apply to secondary ammunition route equipment :

- a. Equipment dedicated to other purposes (e.g. aircraft or stores lifts) may be used. All such equipment should meet the ammunition lifting test and examination requirements of BR 3027(1) and Def Stan 02-113.
- b. Maximum possible use of mechanical handling aids is to be made.

16.8.4 The following principles should apply to movement of munitions on the ammunition route:

- a. The movement of munitions from the dump area to their stowage location should be by standard trolleys, special-to-type pallet trolleys, Replenishment at Sea (RAS) crates and handling equipment.
- b. When moving munitions along their ammunition routes, they should be protected at all times by a container, canister, Ammunition Container Assembly (ACA), transit frame or trolley. The exception to this is larger gun ammunition (greater than 100 mm) supplied to the gun by the secondary route.
- c. Any type of container mounted on wheels should have a fail safe braking system and be capable of being negotiated safely through the ship without bottoming.

- d. Ramps with anti slip surfaces should be provided in way of door sills, and should be as light as possible consistent with adequate strength. The gradient of ramps should not exceed 1:6 or such lesser gradient required to prevent 'bottoming' of munitions trolleys as they cross its peak.
- e. Suitable secure, rattle free, stowage arrangements should be provided for the ramps when not in use.
- f. Doors and hatches should be consistent with the requirements for safe weapon supply and replenishment.
- g. Where sloping ladders are an integral part of the ammunition route they should be capable of being either struck down or turned to form chutes.
- h. Cruets should be provided to avoid damage to cases, packages, ACAs, containers etc when lowered or raised through hatches.
- i. For temporary rigging between decks, guide wires and spreader bars should be fitted.
- j. Where mechanical handling is specified, lashing points for restraining should be provided in the preparation area.

16.8.5 Assault Routes and procedures should be provided for all munitions to be issued and disembarked/re-embarked by or for E3.

16.8.6 Appropriate ship's internal communications should be provided between manned stations or sections on ammunition/assault routes (e.g. all stations on lifts, weapon park to preparation area/magazine, magazine to assault assembly point or missile/gun control compartment to embarkation hatch/hoists position).

16.9 ACOP for Millers' Flaps

16.9.1 Millers' flaps should be provided at the following positions on ammunition routes:

- a. At hatches below which the vertical drop height is in excess of 6 metres;
- b. To provide a platform for use when transferring munitions into and out of a cruet employing guide wires.

16.9.1 Whilst being strong enough to resist the impact of the heaviest load that may be moved up or down, through the hatch (including the cruet), millers' flaps should be constructed to be as light as possible.

16.9.2 Where millers' flaps are not permanently fitted, a secure, rattle free stowage close to the hatch should be provided.

16.9.3 The design of the millers' flap stowage should allow safe and effective installation and operation by personnel during ammunition movements. A diagram of a typical millers flap is shown at Annex J.

16.10 ACOP for Fixed Handling/Lifting Equipment in Magazines and DDAs

16.10.1 General design requirements for munition handling and lifting equipment are set out in JSP 467 and BR 3027(1) and Def Stan 02-113. Electrical requirements are given in Part 3 of this standard. Mechanical and environmental requirements are the same as for other magazine equipment as specified elsewhere in this standard.

16.10.2 The handling system should ensure that the load is always under positive control within its design limits and operational environment and will not slide or topple.

16.10.3 Ship motion prediction programs are acceptable to derive both the lateral and vertical accelerations at which the handling equipment has to operate and survive for design purposes. See also guidance in Part 4 (GNE) of this standard. Such programs should be validated adequately.

16.10.4 If a degaussing system is fitted to the ship, handling equipment shall be tested to Def Stan 59-411 i.a.w. Def Stan 08-123/NES 1004.

16.10.5 Where appropriate equipment is to be tallied as specified in BR 3027, a pad, for securing tally plates, is to be provided and fixed prior to the testing of the appliance.

16.10.6 Powered lifting and embarkation equipment should have an alternative means of raising or lowering the load if there is a power failure.

16.10.7 The load should remain secure and under control in the event of a power failure.

16.10.8 Cordage used for moving munitions should be manufactured from natural fibres or polypropylene. When moving munitions with exposed EED wiring or with a bare EED (including those in a damaged state), then the use of natural fibre cordage is mandatory. See guidance below.

16.11 ACOP for Ammunition Route Drawings

16.11.1 Embarkation, Striking Down and Course of Ammunition Route Drawings for all munitions listed in the Armament Statement should be provided for each MOD ship. Example drawings/sub sheets are shown at Annex G.

16.11.2 Ammunition drawings should detail the routes and all handling equipment necessary for the movement of munitions throughout the ship. This includes Assault Routes and procedures for E3 munitions.

16.11.3 Drawing sheets should be of A3 size, assembled into bound folders for inclusion in the Ship Datum Pack. Final or draft versions should be available in the ship prior to Slow Run Through (SRT), tests and trials.

16.11.4 The top-level drawing should be a Master General Arrangement containing a schematic of all ammunition routes.

16.11.5 Individual primary and secondary route drawings, indicating the route to a magazine or magazine locker (or group of magazines on the same deck and within the same watertight subdivision) should be identified on schematic drawings referenced from the Master Drawing.

16.11.6 Separate tabulated sheets, broken down into sub routes, should be provided to identify the following:

- a. Sub-routes, (e.g. along deck or through a line of hatches);
- b. Handling method employed (e.g. 2 man lift or hoist);
- c. Equipment to be cleared before use (e.g. ladders in way of hatches);
- d. Equipment items to be used or rigged (e.g. rails, hoists or cruet), annotated with route drawing and rigging warrant references;
- e. Details of any special precautions, etc.

16.11.7 Where special to type equipment is required, details should be shown on separate sheets of the individual route drawing.

16.11.8 Common equipment should be identified on sub-sheets of the master route schematic indicated above.

16.11.9 Where appropriate, handling equipment system assembly drawings should be provided.

16.12 Guidance - Ammunition Handling Safety Assessment

16.12.1 The aim of the design safety assessment of ammunition handling – embarkation, stowing and supply should be to assess:

- a. The safety of munition embarkation within the ship – to evaluate ammunition handling - embarkation, transfer route, stowage and supply arrangements.
- b. The potential consequences of unauthorised or incorrect ammunition handling.
- c. The potential for loss of mission capability in the event of action damage to ammunition handling arrangements.

16.12.2 Risk management should then proceed to reduce the risks identified to ALARP by elimination, where practicable, of the deficiencies identified in the provision of ammunition handling arrangements, or reduction in the risk by other control measures. Application of the design requirements specified in this standard should ensure that adequate ammunition handling arrangements are achieved.

16.12.3 Interference should not be caused to any operational activity in the Action or Defence State, unless these are mutually exclusive. In peacetime, other ship activities should be arranged so as not to cause interference to weapon practises and ammunition movements. Temporary barriers and/or warning signs should be provided, where appropriate, to avoid uninvolved personnel entering a hazardous area. Primary routes should not use frequently used main passageways or ship emergency evacuation routes.

16.12.4 To ensure that natural fibre cordage is in use when potentially damaged munitions with exposed EED's need to be moved it is advisable to specify natural fibre cordage for secondary ammunition handling/lifting appliances so far as practicable.

16.12.5 The requirements for manpower on ammunition routes should be minimised both to reduce the potential number of personnel at risk in case of accident and also to reduce the manpower demand from the ship's company.

16.12.6 Use of existing handling machinery and equipment in new ship development may ease training and logistic costs.

16.12.7 The safe lifting height for a munition is generally determined by a 12 m drop test or assessment (see GNE in Part 4 of this standard). Providing munition dump points at 9 m or less from the waterline ensures that a margin of safety is available to cover the height of lifting above the deck edge and any obstacles and the distance below the waterline that the load may be in the lighter.

16.12.8 Adequate communications are essential to enable timely and positive control of weapon movement to reduce risks. Operating procedures should require the fitting and proving of communications prior to any evolution.

16.13 Guidance – Mobile Mechanical Handling Equipment (MMHE)

16.13.1 Design requirements specific to explosives MMHE are currently described in JSP 482 Chapter 16. JSP 482 does not, nor is it expected to, take cognisance of an operational ship environment. Performance Requirements listed in this standard correlate to the categorisation of Magazines and DDAs undertaken in Def Stan 00-101 Part 3 in accordance with the ATEX regulations. MOD subject matter experts, DLogME MXS IPT sponsor of JSP 467 and Def Stan 02-113 are to be consulted for all ship MMHE advice including the production of appropriate technical procurement specifications for MMHE in MOD ships.

16.13.2 Additional requirements for MMHE in a ship environment are as follows:

- a. Adequate clearance shall be provided within passageways, lifts, doorways and in deckhead height to ensure that equipment as procured can operate within the ship environment. New ship designs can ensure that adequate clearance is provided on build to allow standard sizes of commercially available COTS MMHE to be used, minimising through life costs of procuring and maintaining MMHE.

- b. Movement of missile containers along passageways is very difficult for certain types of MMHE. This aspect shall be given due consideration during the design phase. It may be advisable to procure more than one type of MMHE to best handle different types of munitions within their containers e.g. missiles. However this does limit flexibility of use and thus shall be given due consideration.
- c. In general, diesel vehicles can climb a 30 degree incline.
- d. Generally, electrically powered MMHE can climb a 10 degree incline.
- e. Facilities to enable clearance of ramps shall be provided.
- f. Allowance shall be made for deckhead structure and services.

NOTE: Lighting may be positioned a considerable distance below the deckhead.

ANNEX A - RELATED DOCUMENTS

Ref No	Reference	Title	Sponsor/Contact
1	IEC 60079-10	Electrical Apparatus for Explosive Gas Atmospheres Classification of Hazardous Areas	IEC
2	IMDG Code	International Maritime Dangerous Goods Code	MCA
3	STANAG 4240	Liquid Fuel/External Munitions Test Procedure	DStan/NATO
4	STANAG 4241	Bullet Impact, Munitions Test Procedure	DStan/NATO
5	STANAG 4382	Slow Heating, Munitions Test Procedures	DStan/NATO
6	STANAG 4439	Policy for Introduction, Assessment and Testing for Insensitive Munitions (MURAT)	DStan/NATO
7	AOP-39	Guidance on the Development, Assessment and Testing of Insensitive Munitions (MURAT)	DStan/NATO
8	STANAG 4496	Fragment Impact, Munitions Test Procedure	DStan/NATO
9	US Mil Std 2105B	Hazard Assessment Tests for Non-Nuclear Munitions	DOD
10	BS 5499 All Parts	Graphical symbols and signs - Safety signs, including fire safety signs	BSI
11	LNSR	Lloyds Naval Ship Rules – Rules and Regulations for the Classification of Naval Ships	Lloyds Register
12	AMS	Acquisition Management System	DE&S
13	JSP 375	MOD Health & Safety Handbook	CESO(MOD)
14	JSP 418	MOD Sustainable Development and Environment Manual	CESO(MOD)
15	JSP 430	Ship Safety Management System Handbook	DSS – SSMO

Ref No	Reference	Title	Sponsor/Contact
16	JSP 440	Joint Service Security Manual	D Def Sys
17	JSP 467	Power Driven Lifting Appliances Used for Handling Conventional and Nuclear Armaments	MXS IPT
18	JSP 482	MOD Explosives Regulations	DOSG
19	JSP 520	Ordnance Munitions and Explosives Safety Management System	DOSG
20	JSP 862	MOD Maritime Explosives Regulations	DSS NAExp
21	Def Stan 00-25	Human Factors for Designers of Equipment	DStan
22	Def Stan 00-35	Environmental Handbook for Defence Materiel	DStan
23	Not Used		
24	Def Stan 00-56	Safety Management Requirements for Defence Systems	DStan
25	Def Stan 02-102/NES 102	Requirements for Air Conditioning and Ventilation Design – Part 1 Surface Ships & RFAs	DStan
26	Def Stan 02-113/NES 113	Requirements for Mechanical Handling	DStan
27	Def Stan 02-127/NES 127 (Obsolescent)	Requirements for Access Fittings and Equipment	DStan
28	Def Stan 02-141/NES141	Requirements and Organisation for the Management of Access to and within Compartments (Surface Ships).	DStan
29	Def Stan 02-155/NES155 (Obsolescent)	Requirements for Structural Properties in Steel Surface Ships	DStan

Ref No	Reference	Title	Sponsor/Contact
30	Def Stan 02-179	Requirements for Lockers (Magazine, RU Magazine and Detonator) used for Storage of Explosive Stores in HM Surface Ships and Submarines	DStan
31	Def Stan 02-188/NES188	Requirements for the Procurement, Storage and Use of Timber.	DStan
32	Def Stan 02-360/NES360	Guidance to the Selection of Low Pressure Metric Standard Valves	DStan
33	Def Stan 02-361/NES361	Rod Gearing standard for valve operation	DStan
34	Def Stan 08-160	Requirements for Electrical Installations	DStan
35	Def Stan 02-603/NES 603 (Interim)	Guide to the Policy, Design and Installation of Fire Detection Systems in H M Ships (Category 1)	DStan
36	Def Stan 07-204/NES703	Thermal and Acoustic Insulation of Hull and Machinery.	DStan
37	Def Stan 02-712/NES712 (Obsolescent)	Requirements for Sewage and Grey Water Systems for Surface Ships	DStan
38	Def Stan 02-743/NES 743	Pipe Manipulation	DStan
39	Def Stan 02-748/NES 748	Requirements for Strainers in HM Surface Ships and Submarines	DStan
40	Def Stan 02-764/NES 764 (Obsolescent)	Flame Metal Spraying and Hot Dip Galvanising of Surface Ships	DStan
41	Def Stan 02-784/NES784	Requirements for Safety Signs and Colours.	DStan
42	Def Stan 02-791/NES791 (Obsolescent)	Requirements for Weldable Structural Steels	DStan

Ref No	Reference	Title	Sponsor/Contact
43	Def Stan 02-797/NES 797	Pipework Engineering	DStan
44	Def Stan 02-853/NES853	Requirements for the Identification, Colour Coding & Marking for Systems.	DStan
45	Def Stan 07-85	Design Requirements for Weapons and Associated Systems	DStan
46	Def Stan 07-204/NES 119	Requirements for Fire Protection and Damage Control for Surface Ships	NA Fire (MESH FS) & DStan
47	Def Stan 07-207/NES142	Requirements for Padlocks.	DStan
48	WARPAINT	Requirements for the Preparation and Painting of Compartments in Surface Ships	MOD booklet
49	Def Stan 07-279/NES 114	Requirements for Replenishment at Sea H M Surface Ships	DStan
50	Not Used		
51	Def Stan 08-100	GRP Ships Structural Design	DStan
52	Def Stan 02-314 Issue 2	Compressed Air Systems	DStan
53	Def Stan 08-107/NES 501	General Requirements for the Design of Electro technical and Naval Weapon Equipments	DStan
54	Def Stan 08-120/NES 814	Requirements for Determining the Shock Strength of Equipment	DStan
55	Def Stan 08-123/NES 1004	Requirements for the Design and Testing of Equipments to Meet Environmental Conditions	DStan
56	Def Stan 08-124	Radio Frequency Environment and Acceptance Criteria for Naval Stores Containing Electro-Explosive Devices	DStan

Ref No	Reference	Title	Sponsor/Contact
57	Def Stan 07-204	The Requirements for Fire Protection and Damage Control for Surface Ships – Part 3: Surface Ships and Submarine Equipment	DStan
58	Def Stan 08-147	Requirements for Damage Control and Fire Protection for the Safety of Surface Ships and Submarines – Part 2: Submarines	DStan
59	Def Stan 59-411	Electromagnetic Compatibility	DStan
60	JSP 430 Part 3 (NAR)	Naval Authority Regulations (now JSP 430 Pt 3)	DSS– SSMO
61	NAR(Ch 8)	Naval Authority Regulations (Explosives) [Chapter 8 of NAR JSP 430 Part 3]	DSS NAExp
62	MAP 01-103	Maritime Acquisition Publication (MAP) 01-103, Ship Explosives Safety Case (SESC) – Guidance For Platform Duty Holders, Part 1, Edition 1	DSS NAExp
63	BR 1029	Regulations for Naval Armament Services	
64	BR 1754	Safety Regulations for Storing & Handling Petroleum, Oils, Lubricants & Other Hazardous Stores in HM Ships	MPS 216
65	BR 2170	Ship NBCD Manual	MESH IPT
66	BR 2924	Radio Hazards in the Naval Service	DOSG
67	BR 3013	Admiralty Pipework Standards	
68	BR 3021(1)	Shock Manual (Metric)	
69	BR 3027	Manual of Safe Use, Examination and Testing of Lifting Equipment	MXS IPT
70	BR 4050	Instructions for the Conduct of Naval Weapon Inspections and Trials	MCTA
71	BR 8470	Shock and Vibration Manual	DSS – SR2

Ref No	Reference	Title	Sponsor/Contact
72	CB 4986	Confidential Addendum to BR 2924	DOSG
73	CB 5012	Shock Manual (Metric)	MCTA/MSAG
74	CB 8469	Shock in Ships and Submarines	DSS– SR2
75	STG/109/04/01 dated Dec 2001	D Manley: The Development of Survivability Requirements for Warships and Auxiliaries	DSS– SR
76	Qinetiq/FST/CMT/CR013559 2/1 dated January 2002	RM Murray, DJ Wright, J Bebbington and AS Swan: A Compendium of Vulnerability Reduction Strategies and Techniques for use in Warship Design	Qinetiq Rosyth
77	(NAN) EXP/03 (Guidance)	Classified RATTAM, Mitigation and Munition Protection guidance information (UK RESTRICTED)	DSS NAExp
78	DTEO Shoeburyness Report STN 12245 dated 26 Sep 96	Heat transfer experiments	DSS NAExp
79	EA	The Explosives Act of 1875	
80	HSWA	The Health and Safety at Work etc Act (HSWA) 1974.	
81	MSA	The Merchant Shipping Act (MSA) 1995.	
82	IMDG	The International Maritime Dangerous Goods Code.	
83	MCA	The Maritime & Coastguard Agency Regulations (for SOLAS)	

ANNEX B - ABBREVIATIONS

For the purpose of this Standard the following abbreviations apply:

AAE	Automatic Air Escape
ACA	Ammunition Container Assembly
ACOP	Approved Code of Practise
AFFF	Aqueous Film Forming Foam
AFSH	Auxiliary Fleet Support (Helicopter)
AFU	Air Filtration Unit
ALARP	As Low As Reasonably Practicable
AMS	Acquisition Management System
AOP	Allied Ordnance Publication
AOR	Auxiliary Oiler Replenishment
AP	Armour Piercing
ATEX	Atmosphere Explosibles
ATU	Air Treatment Unit
BR	Book of Reference (RN)
BS	British Standard
CCI	Cyalume Chemical Illuminators
CCTV	Closed Circuit Television
CSEO	Chief Environment & Safety Officer
CG	Compatibility Group
COSHH	Control of Substances Hazardous to Health
COTS	Commercial Off-The-Shelf
CSE	Certificate of Safety Explosives

CSOME	Certificate of Safety Ordnance, Munitions and Explosive
DC	Damage Control
DDA	Designated Danger Area
DDD	Design Disclosure Documentation
DE&S	Defence Equipment & Support
DEC	Director of Equipment Capability
Def Stan	Defence Standard
DOSG	Defence Ordnance Safety Group
DSHAR	Dangerous Substances in Harbour Areas Regulations
DStan	Directorate of Standardization
DTEO	Defence Test and Evaluation Organisation (now Qinetiq/DSTL)
EDC	Electrical Distribution Centre
EED	Electro-Explosive Device(s)
EIA	Environmental Impact Assessment
EMC	Electro-Magnetic Compatibility
E3	Extraordinary Embarked Explosives
ENEQ	Effective NEQ (qv)
FAFSS	Fully Automatic Fast Spray System
FBI	Fire Barrier Insulation
F-E-V (f-e-v)	Fish Eye Viewer
FIAM	Flight In Air Material
GNE	Generic Naval Environment [Part 4 of this standard]
GOCO or GoCo	Government Owned Contractor Operated

GPMG	General Purpose Machine Gun
GRP	Glass Reinforced Plastic
GW	Guided Weapon
HAPTM	Hazardous Area Personnel Test Meter
HCC	Hazard Classification Code (UN)
HD	Hazard Division (UN)
HE	High Explosive
HF	Human Factors
HP Air	High Pressure Air
HPSW	High Pressure Sea Water
HSE	Health and Safety Executive
HSWA	Health and Safety at Work etc. Act 1974
HV	High Voltage
IEC	International Electro-technical Committee
IM	Insensitive Munitions
IMAP	Insensitive Munitions Acceptance Panel
IMDG	International Maritime Dangerous Goods (Code)
IPT	Integrated Project Team
ITT	Invitation to Tender
JSP	Joint Service Publication
KUR	Key User Requirement
LCF	Local Control Facility
LCU	Landing Craft Utility
LCVP	Landing Craft Vehicle and Personnel

LOD	Lines of Defence
LOX	Liquid Oxygen
LP Air	Low Pressure Air
LPD	Landing Platform (Dock)
LPH	Landing Platform (Helicopter)
LSD(A)	Landing Ship Dock (Auxiliary)
MAP	Maritime Acquisition Publication
MARPOL	Maritime Pollution
MASS	Metron Activated Spray System
MCA	Maritime and Coastguard Agency
MCAS	Machinery Control and Surveillance
MCTA	Maritime Commissioning, Trials and Assessment
MESH	Marine Environment Survivability & Habitability
MESH FS	Marine Environment Survivability & Habitability Fire Safety
MFFM	Marine Firefighting, Fluid Power and Mechanical Handling
MFMB	Mineral Fibre Marine Board
MMERs	MOD Maritime Explosives Regulations
MMHE	Mobile Mechanical Handling Equipment
MOD	Ministry of Defence
MPS	Marine Propulsion Systems
MSA	Merchant Shipping Act 1995
MSER	Manufacture and Storage of Explosives Regulations 2005
MWV	Minor War Vessel

MXS	Marine Auxiliary Services
NAEAC	Naval Authority Explosives Advisory Committee
NAExp	Naval Authority Explosives (Regulator)
NAL	Naval Armament Lighter
(NAN)	Naval Authority Notice
NAR	Naval Authority Regulations
NAR Ch 8	Naval Authority Regulations Chapter 8 (Explosives)
NASS	Naval Armament Stowage Specification
NATO	North Atlantic Treaty Organisation
NAV	Naval Armament Vessel
NBCD	Nuclear Biological and Chemical Defence
NEQ	Net Explosive Quantity
NES	Naval Engineering Standard
NMSC	Naval Magazine Safety Committee
OME	Ordnance, Munitions and Explosives
OOD	Officer of the Day
OOQ	Officer of the Quarter
OOW	Officer of the Watch
PCO	Prime Contract Office
PDH	Platform Duty Holder
PER	Package Examination Room
PIP	Practically Instantaneous Propagation
PIPT	Platform IPT (qv)
PIPTL	Platform Integrated Project Team Leader

POL	Petroleum, Oils and Lubricants
QBSS	Quartzoid Bulb Spray System
QSP	Quasi Static Pressure
R&D	Research & Development
RADHAZ	Radiation Hazard
RAS(A)	Replenishment at Sea (Ammunition)
RAS	Replenishment At Sea
RAS(L)	Replenishment At Sea (Liquids)
RATTAM	Response to ATTAck on Ammunition
RCF	Remote Control Facility
RCMDS	Remote Controlled Mine Disposal System
RCS	Radar Cross Section
RFA	Royal Fleet Auxiliary
RH	Relative Humidity
RIH	Replenishment in Harbour
RMAS	Royal Maritime Auxiliary Service
RRSS	Rapid Reaction Spray System
RU	Ready Use
SCC	Ship Control Centre
SEMS	Safety and Environmental Management System
SESC	Ship Explosive Safety Case
SESCR	Ship Explosives Safety Case Report
SETHA	Ship Explosive Threat Hazard Assessment
SEXSSI	Ship Explosive Store Safety Instruction

SHIPCAT	Ship Categories (obsolescent)
SI	Safety Instruction (OME)
SI	Statutory Instrument (e.g. SI 1991:1531)
SLS	Service Life of Structure
SME	Subject Matter Expert
SMS	Safety Management System
SOLAS	Safety Of Life At Sea (store)
SOLAS	Safety of Life at Sea
SQTU	Small Quantity Top-Up (Magazine)
SRD	System Requirements Document
DSS	Directorate Sea System
DSS NAExp	Directorate Sea Systems – Naval Authority Explosives (section)
SSGW	Surface-to-Surface Guided Weapon
SSOW	Safe System of Work
SSP	Sea Systems Publication (obsolescent)
STANAG	Standardisation Agreement (<i>NATO</i>)
STO(N)	Stores and Transport Officer (Naval)
STUFT	Ship Taken Up From Trade
TAS	Torpedo and Anti-Submarine
TNT	Trinitrotoluene
ULC	Unit Load Container
ULS	Unit Load Specification
UN	United Nations
URD	User Requirements Document

VERTREP (Vertrep)	Vertical Replenishment
VLSW	Vertical Launch Sea Wolf
WP	White Phosphorus
WTBV	Watertight Butterfly Valve
WTC	Water Tight Compartment

ANNEX C - DEFINITIONS

For the purpose of this standard the following definitions apply:

Definitions in **bold** are established by this standard. Otherwise the source of the definition is indicated at the end of the definition within square brackets.

Adjacent Compartment	A compartment which has decks, deckheads or bulkheads in common with a Magazine [JSP 862]. An 'Indirectly' adjacent compartment has the corners of the decks, deckheads or bulkheads in common with the magazine.
Ammunition	See Munitions
Ammunition Route	Any route used for the movement of explosive stores [JSP 862]
Armament Hold	A compartment classified as a magazine where explosives may be stowed in their transit packaging.
Asymmetric threat	The asymmetric threat is a term used to describe attempts to circumvent or undermine an opponent's strengths while exploiting his weaknesses, using methods that differ significantly from the opponent's usual mode of operations. [(US DOD Joint Staff definition)]
Bulk Explosives	Packaged or pallets of packaged Class 1 Dangerous Goods for which there is not specific stowage space identified in the ship (i.e. not listed in Form S285K), and which will remain in the same transit packaging configuration and stowage until removed from the magazine or Armament Hold for off load from the ship. This includes munitions carried for the re-supply of HM Ships, for the supply of troops onboard prior to landing, for the carriage of munitions as cargo from a port to a point of off-load, whether for the supply of troops ashore or for general disembarkation [JSP 862].
Compatibility Group	In the UN Classification System for Dangerous goods, Class 1 is divided into Compatibility Groups denoted by letter. The letters are defined in the UN "Orange Book" and are used to define the kinds of explosive stores deemed to be compatible for storage and transport and those that have to be segregated. The definitions are summarised in JSP 862.
Cruet	Any item of equipment designed to contain rounds of ammunition or ammunition boxes/ACAs during handling.

Clearway 'Cul-de-sac'	The enclosed areas/passageways at either end of a Clearway in AFSH/AOR.
Designated Danger Areas	Compartments and spaces not fitted out specifically for the stowage of explosive stores, but in which there is likely to be an increased hazard to ship/submarine due to the temporary presence of munitions [JSP 862].
Dangerous Area	'Dangerous Areas' are normally accepted as safe for the temporary presence of munitions when these areas meet fully the requirements of BR 1754 – 'Safety Regulations for Storing and Handling Petroleum, Oils and Lubricants and certain other hazardous stores in HM Ships'.
Effective NEQ	When explosive components in a weapon system are initiated by unplanned stimuli and propagate a shock wave that results in Practically Instantaneous Propagation (PIP) with adjacent munitions leading to mass initiation, the combined NEQ that produces the response of blast overpressures with the ability to damage structural integrity is called the Effective NEQ. The criteria to assess ENEQ includes the type and confinement of explosive composition contained in the munition, whether it will propagate a shock wave producing a detonation response, the effects of casing/packaging break up reducing blast energy, the effect of mitigating designs in the munition or packaging including the confinement, configuration and orientation of munitions and whether the munition will sustain PIP to adjacent munitions.
Electro-Explosive Device (EED)	A one-shot explosive or pyrotechnic device used as the initiating element in an explosive or mechanical train, which is activated by the application of electrical energy [Def Stan 08-124].
Embarkation / Disembarkation	The activity during which ammunition is lifted into/out of a ship. The point of embarkation is established in the Ship's drawings [JSP 862].
Embarkation Dump Area	The area on board ship where explosive stores are placed prior to proceeding along the ammunition route. The area is used during RAS, RIH and Vertrep.

Explosives	A substance (or mixture of substances) which is capable by chemical reaction of producing gas at such a temperature and pressure as to cause damage to the surroundings. Included are pyrotechnic substances even when they do not evolve gases. The term "explosive" thus includes all solid and liquid materials variously known as high explosives and propellants, together with igniters, primer, initiatory and pyrotechnic (e.g. Illuminants, smoke, delay, decoy, flare and incendiary) compositions [AOP 38].
Explosive Ordnance	All munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. This includes bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket and small arms ammunition; all mines, torpedoes and depth charges, demolition charges; pyrotechnics; clusters and dispensers; cartridge and propellant actuated devices; electro-explosive devices; clandestine and improvised explosive devices; and all similar or related items or components explosive in nature [AAP-6].
Handling	The movement of munitions, either by man-handling or by use of approved appliances, from the point of embarkation/disembarkation along the ammunition routes, within the magazine and from the magazine to the RU Magazine Locker, or weapon launcher [JSP 862].
Hazard Classification Code	A combination of the UN Dangerous Goods code Classification System giving both the Hazard Division and the Compatibility Group.
Hazard Division	A division of the UN Dangerous Goods code (Class 1 = Explosives), indicating the type of hazard to be expected in the event of an accident.
Hazardous Fragment	A fragment with residual energy of 80 J or more (which strikes a person) [BR 8541].
Insensitive Munitions	Munitions which reliably fulfil their performance, readiness and operational requirements on demand but which minimise the probability of inadvertent initiation and severity of subsequent collateral damage to weapon platforms, logistic systems and personnel when subjected to unplanned stimuli [STANAG 4439].

Magazine	A compartment within the ship's structure, which is specifically designed and constructed for the safe, permanent stowage of the main outfit of the designated explosive stores/munitions [JSP862].
Magazine Locker	A self contained locker, designed for the permanent stowage of the whole or part of the ship's outfit of the designated explosive store(s) for which built-in magazine facilities have not been provided. It is free standing or recessed into the ship's structure, but its boundaries are not part of the ship's structure. It is surrounded by an air gap. A locker does not have an "adjacent compartment" because of this air gap and is of such a shape or size that it does not permit "walk-in" and the contents are handled while standing outside [JSP 862].
Munition / Ammunition	A device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in connection with defence or offence, including demolitions. Certain ammunition can be used for training, ceremonial or non-operational purposes [AAP-6]. A complete device, (e.g. Missile, shell, mine, demolition store etc.) charged with explosives, propellants, pyrotechnics, initiating compositions or nuclear, biological or chemical material, for use in connection with offence, or defence, or training, or non-operational purposes, including those parts of weapon systems containing explosives [AOP 38].
Multi-purpose magazine or hold	A compartment within the ship's structure, which is specifically designed and constructed for the safe, permanent stowage of bulk packed/ palletised explosive stores/munitions.
Net Explosive Quantity	The total Explosives contents of an Ammunition (AOP 38).
Ordnance	A weapon system with its associated munitions and auxiliary material needed to fire the munition [AOP 38].
OME	Ordnance, Munitions and Explosives (qv) [JSP 520].
Primary Route	The main route, from the point of embarkation to the Magazine and from the Magazine to the RU stowage, weapon launcher/gun/aircraft along which the ammunition is moved and/or returned.

Preparation	The activity during which ammunition is, where appropriate, unpacked, assembled, fuzed, prepared for use/launch/flight, and loaded to any prelaunch vehicle/boat/device or trolley.
Propellant	A substance or mixture capable, by burning at a controlled rate, of producing gases to do work, e.g. propel a missile or gun round or function a mechanical device [JSP 862].
Propulsive response	An explosive reaction whereby adequate force is produced to impart flight to the explosive store.
Radio Frequency (rf) Radiation	Electromagnetic radiation in the frequency range 0.2 MHz to 40 GHz [Def Stan 08-124].
Radio Hazards (RADHAZ)	The inadvertent ignition of electro-explosive devices (EED) resulting from exposure to radio frequency radiation, or coupled transient energy [Def Stan 08-124].
RATTAM	The threat from wartime and terrorist presents potential hazards to unprotected munitions. This is known as RATTAM, Response to ATtack on Ammunition and is defined by a threat weapon that will cause an intolerable reaction from susceptible munitions.
Ready-Use	Temporary stowage of explosive stores/munitions to facilitate quick supply when the relevant weapon is required to be in a high state of operational readiness.
Ready-Use Magazine Locker	A self-contained magazine locker designed for the temporary stowage of small amounts of explosives stores. [JSP 862].
Replenishment at Sea (Ammunition)	The activity during which ammunition is transferred by jackstay from an RFA Ammunition Ship or other vessel to the receiving ship whilst at sea.
Replenishment in Harbour	The activity during which munitions are transferred to/from an ammunition lighter (NAL) or alongside a licensed jetty into/out of a ship, whilst in harbour. The ship can be secured to a buoy, a jetty or at an ammunitioning facility.
Re-supply Route	The Supply Route being used after the initial supply of ammunition has been provided to the RU stowage and/or weapon launcher/gun.
Safety Related	A safety related function or system is one in which a failure or a design error could cause a direct hazard to personnel or materiel.

Safety (People)	Relative protection from adverse consequences [HSE].
Safety (System)	The expectation that a system does not, under defined conditions, lead to a state in which human life is endangered.
Secondary Route	The route from the point of embarkation to the Magazine and from the Magazine to the RU stowage, weapon launcher/gun/aircraft and vice versa, along which the ammunition is moved if the Primary Route is not available.
Semi-Automatic Spray System	A spray system whereby additional SW pumps are required to be manually started to achieve the water pressure and capacity needed for the spray system.
SHIPCAT	In HM Ships, RFAs and E3 magazines, explosive stores which are permitted to be stowed together have been classified in groups known as Ship Categories (SHIPCATs) allocated by CINO [JSP 862] (obsolescent).
Small Quantity Top-Up Magazine	A Magazine provided to stow explosive stores/munitions replenished alongside, which cannot be struck-down immediately after embarkation.
Small Magazine	Small Magazines are compartments within the ship structure, of a shape and size that do not permit walk-in and where the contents are handled whilst standing outside. They are specifically designed and constructed for the safe, permanent or temporary stowage of explosive stores/munitions.
Store	All up round
Stowage	The actual position in a Magazine/Magazine Locker in which munitions are stowed. This can be in any of the positions defined in JSP 862 or this standard that are authorized to stow ammunition.
Supply Route	The Primary and Secondary ammunition routes from the Magazine to the RU stowage or direct to the weapon launcher/gun if no ready use stowage exists and vice versa.
Torpedo/Depth Charge Trolley	A trolley on which a torpedo or depth charge is placed for safe handling during transfer, preparation or in the weapon park.

Type I response (Detonation)	The most violent type of explosive event. A supersonic decomposition reaction propagates through the energetic material to produce an intense shock in the surrounding medium (e.g. air or water) and a very rapid plastic deformation of metallic cases followed by extensive fragmentation. All energetic materials will be consumed. The effects will include large ground craters for munitions on or close to the ground, perforation, plastic deformation or fragmentation of adjacent metal plates and blast overpressure damage to nearby structures [AOP-39]. Blast overpressure at 5m greater than 140 kPa. Hazardous fragments beyond 15 m [BR 8541].
Type II response (Partial Detonation)	The second most violent type of explosive event. Some but not all the energetic material reacts as in a Type I response. An intense shock occurs; a part of the case is broken into small fragments; a ground crater can be produced, the adjacent metal plates can be damaged as in a Type I response and there will be blast overpressure damage to nearby structures. A Type II response can also produce large case fragments as in a violent pressure rupture (brittle fracture). The amount of damage relative to a Type I response, depends on the portion of material that detonates [AOP-39]. Blast overpressure at 5m between 70 and 140 kPa Hazardous fragments beyond 15 m [BR 8541].
Type III response (Explosion)	The third most violent type of explosive event. Ignition and rapid burning of the confined energetic material build up high local pressure leading to violent pressure rupture of the confining structure. Metal cases are fragmented (brittle fracture) into large pieces that are often thrown long distances. The un-reacted and/or burning energetic material is also scattered about. Air shocks are produced that can cause damage to nearby structures. Fire and smoke hazards will exist. The blast and high velocity fragments can cause minor ground craters and damage (break-up, tearing, gouging) to adjacent metal plates. Blast pressures are lower than for Type I or Type II responses [AOP –39]. Blast overpressure at 5m between 7 and 70 kPa (depending on size of store). Hazardous fragments may be beyond 15 m [BR 8541].

Type IV response (Deflagration)	The fourth most violent type of explosive event. Ignition and burning of the confined energetic material lead to non-violent pressure release as a result of low strength case or venting through the case walls (outlet gap, initiation capsule, etc...). The case may rupture but does not fragment; orifice covers may be expelled and un-burnt or burning energetic material may be scattered about and spread the fire. Pressure releases may propel an unsecured test item, causing an additional hazard. No blast effect or significant fragmentation damage to the surroundings, only heat and smoke damage from the burning energetic material [AOP-39]. Blast overpressure at 5 m between 0.7 and 7 kPa (depending on size of store) [BR 8541].
Type V response	The least violent type of explosive event. The energetic material ignites and burns non-propulsively. The case may split up non-violently; it may melt or weaken sufficiently to allow slow release of combustion gases; the case covers may be dislodged by the internal pressure. Debris stays in the area of the fire although covers may be thrown up to 15 metres. This debris is unlikely to cause fatal wounds to personnel [AOP-39]. Blast overpressure less than 0.7 kPa [BR 8541].
Upper Deck Weapon Park	An area on the flight deck or upper deck designated for pre-positioning of explosive stores prior to loading onto an aircraft or for immediate use.
Unitisation	The use of appropriate design techniques and operating procedures to minimise the consequence of a credible munitions incident aboard a JSP 430 applied vessel.
Vertical Launch Silo Magazine	A magazine compartment that houses a group of missiles that launch vertically.
VERTREP	The activity during which ammunition is transferred by helicopter from RFA/warship/land to the receiving RFA/warship/land whilst at sea, at anchor, at a buoy, at an ammunitioning facility or alongside.
Weapon Park	An area designated for the pre-positioning of explosive stores prior to loading onto an aircraft, landing craft, vehicle or for immediate use (e.g. by E3 troops).
Weapon Preparation Area/Space	A Designated Danger Area specified for weapon preparation [JSP 862].

Weapon System	The aggregate of the weapon, the associated launching vehicle or platform launching the munition, the available munition and the ancillary equipment necessary to aim, launch and guide the munition, as applicable.
Zone 2 Area	An area in which an explosive gas mixture is not likely to occur in normal operation and if it occurs it will only exist for a short time [IEC 60079-10].

RN Form S285K (Revised March 2008)

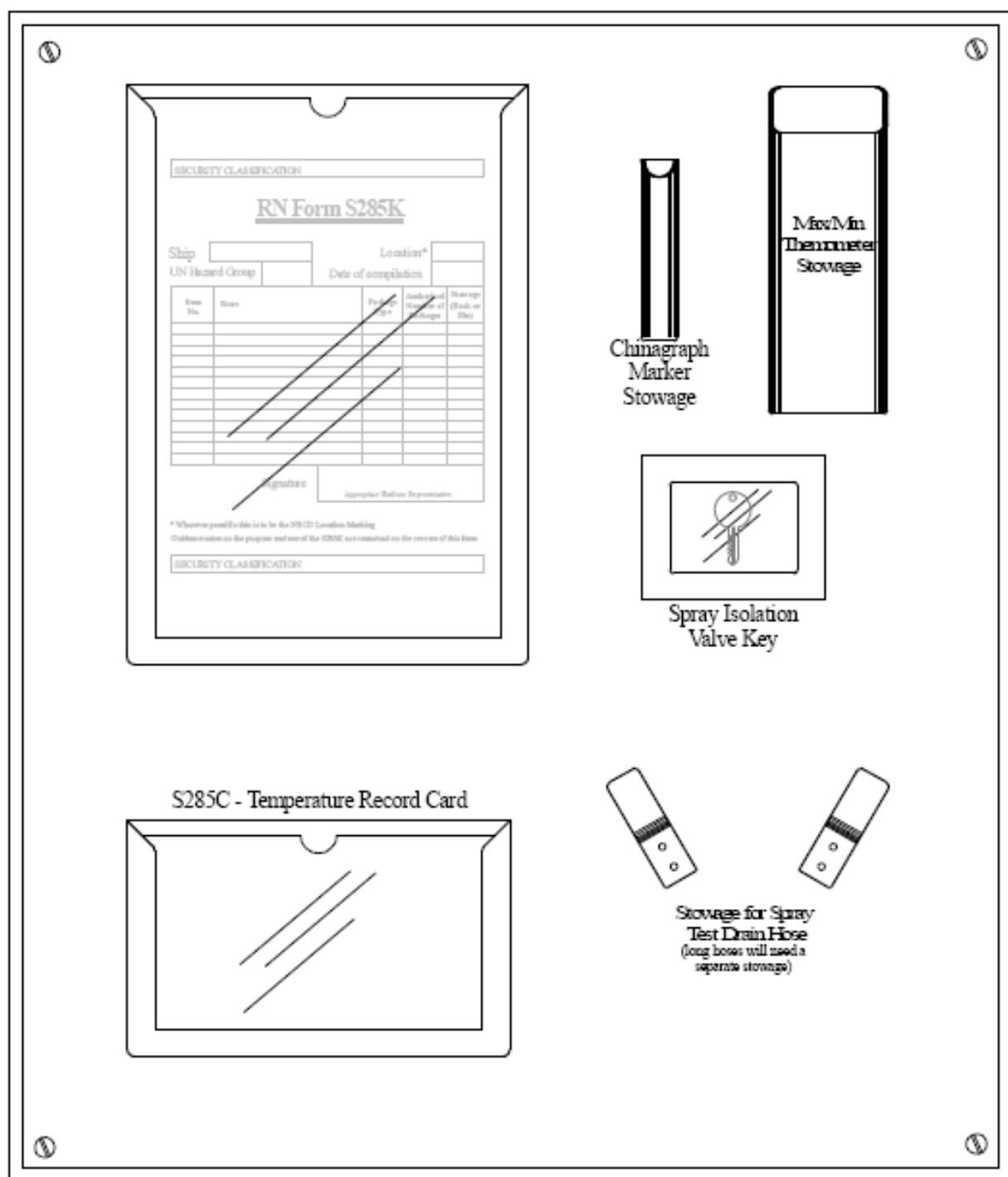
Guidance Notes for S285K

RN Form S285K - Magazine Designed Capacity List

Ref: JSP 862, - MoD Maritime Explosives Regulations.

1. RN Form S285K lists all explosive and non-explosive stores, including portable fittings and lifting equipment, that have been authorised by the Platform IPT Team Leader (PIPTL), for stowage in a given magazine /WSC/locker designed for the permanent stowage of explosives.
2. The 'designed capacity' is defined as the maximum quantity of 'packages' that can be safely stowed in a magazine / WSC / locker.
3. The Form is authorised by the PIPTL and will be updated to reflect design changes during the life of the ship.
4. The completed Form is to be protectively marked as RESTRICTED. The Form is to be kept securely in the appropriate Magazine Contents Board for surface ships. For Submarine Weapon Stowage Compartments or where the physical size of the explosives stowage precludes the fitting of such a Board, local arrangements for the fitting of an A4 size holder are to be made.
5. Identification/validation of discrepancies identified is to be notified, promptly, to the PIPT D - copy to CinC FLEET (EXP or WE POL SM), as appropriate.
6. The S285K Lists are not to be changed by Ships' Staff nor are they to be used for accounting purposes.

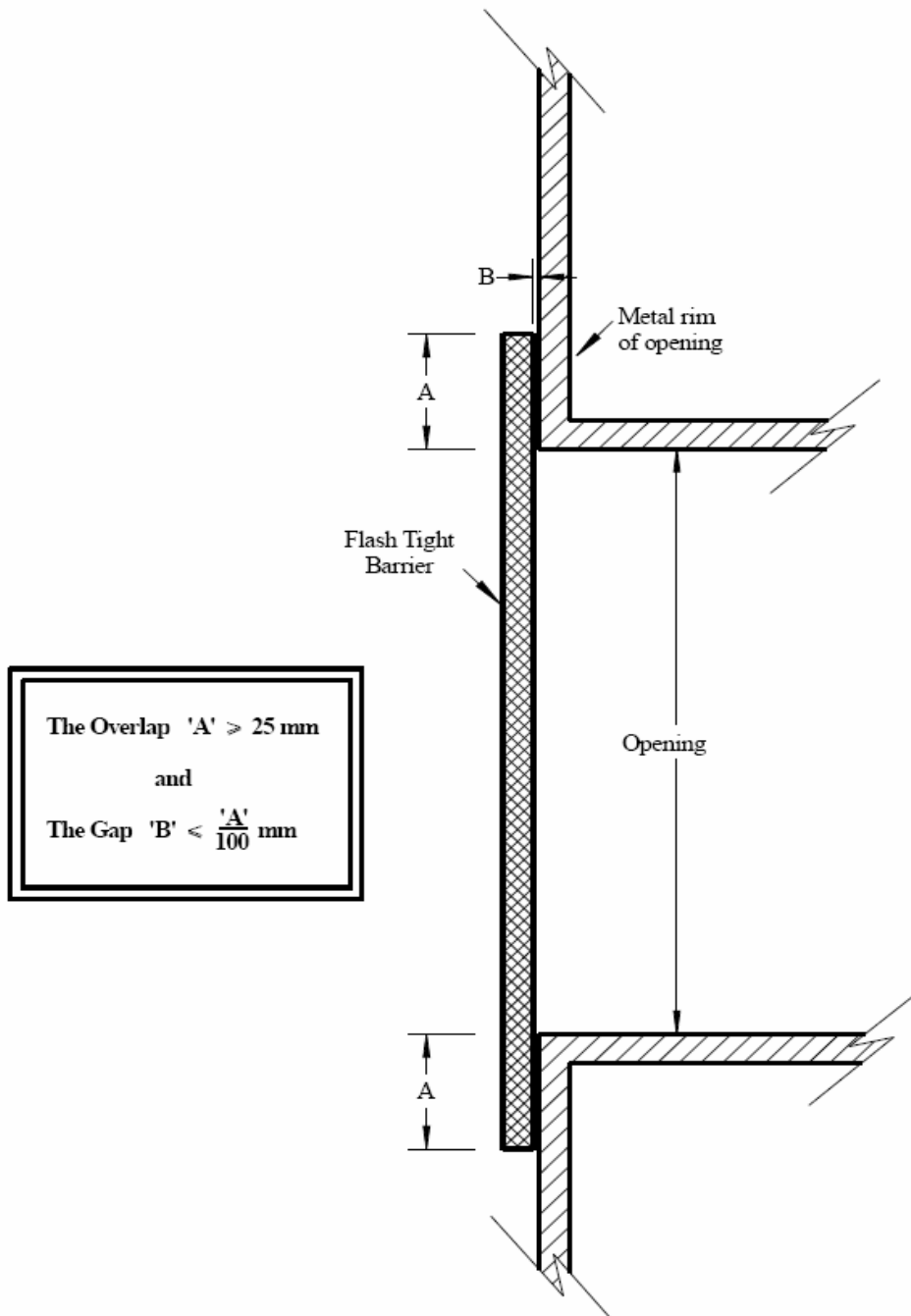
ANNEX E - TYPICAL MAGAZINE CONTENTS BOARD (see contents table below)



Issue 1

Description	Approx. Dimensions(mm)	Material	Remarks
Magazine Designed Capacity List (S285K) holder	320 x 220	Aluminium with Perspex front	To hold Form S285K
Temperature Record Card (S285C) Stowage	130 x 210	Aluminium with Perspex front	To hold Form S285C
Marker holder	100 x 20 x 20	Aluminium	
Max/min thermometer stowage	180 x 65 x 25	Aluminium	Thermometer
Keybox *	Sized to allow easy access to key	Aluminium with pre-scored frangible glass window	
Test drain hose stowage	To suit hose used	Aluminium	—
Backing Plate	X = 550, Y = 450 (guidance only)	Aluminium	

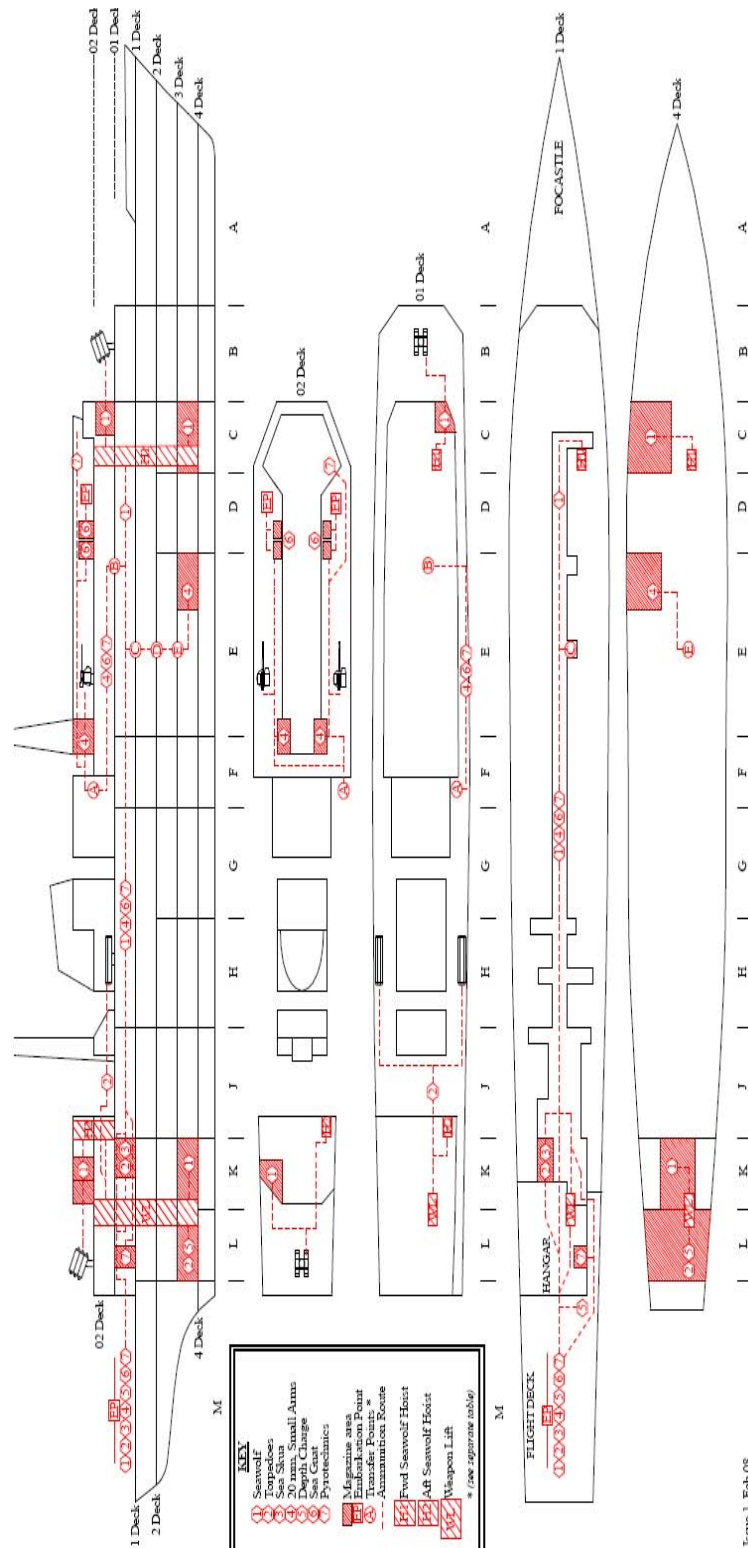
ANNEX F FLASH TIGHT BARRIER



Issue 1

ANNEX G AMMUNITION ROUTES (this table complements the drawing below)

Transfer Position	Explosives Store	Equipment to be rigged	Handling equipment to be used	Rigging Warrant/drawing reference
A 02F flag deck to 01 F Waist	30mm Sea Gnat	1. Davit	1. Cruet 2. Block and Tackle	F127/61 F180/93
	Pyrotechnics Small Arms	None	To be moved by hand	Not Applicable
B 01E Flat to 1E Flat	30mm Sea Gnat	1. Ladder removed 2. Millers Flap employed	1. Cruet 2. Block and Tackle	F127/61 F180/93
	Pyrotechnics Small Arms	None	To be moved by hand	Not applicable
C 1E Flat to 2E Flat	30mm	1. Ladder removed 2. Millers Flap employed	1. Cruet 2. Block and Tackle	F127/61 F180/93
	Small Arms	None	To be moved by hand	Not applicable
D 2E Flat to 3E Flat	30mm	1. Ladder removed 2. Millers Flap employed	1. Cruet 2. Block and Tackle	F127/61 F180/93
	Small Arms	None	To be moved by hand	Not applicable
E 3E Flat to 4E Flat	30mm	1. Ladder removed 2. Millers Flap employed	1. Cruet 2. Block and Tackle	F127/61 F180/93
	Small Arms	None	To be moved by hand	Not applicable



Issue 1 Feb 08

ANNEX H - TECHNICAL SPECIFICATION FOR MMHE FOR USE WITH MUNITIONS

Figure 7 below details the procedure to be used in deciding which MMHE is required for the explosive stores / magazine environments with which it is to be used.

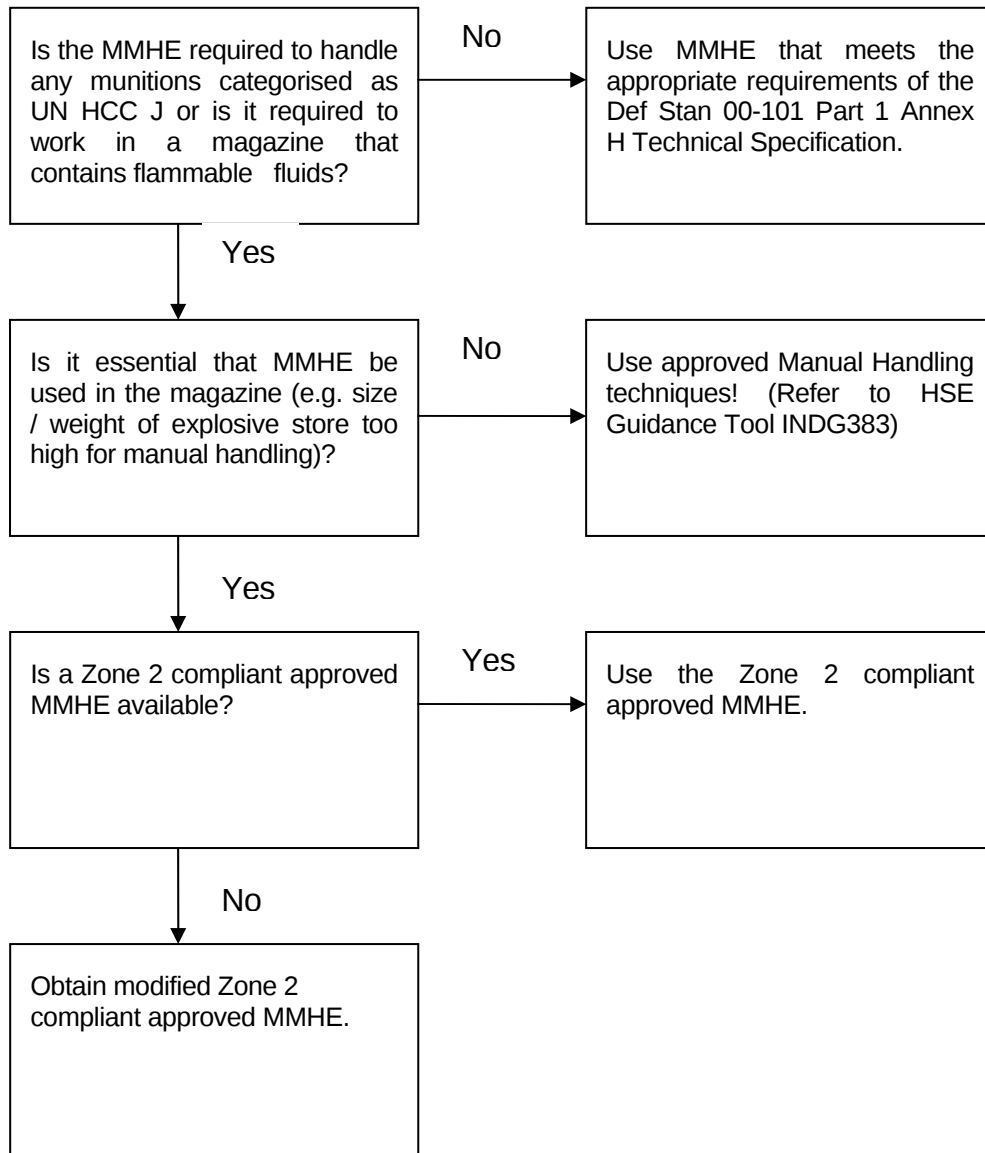


Figure 7 - MMHE Procedure

REQUIREMENT FOR THE PROCUREMENT OF MOBILE MECHANICAL HANDLING EQUIPMENT FOR THE TRANSPORTING OF MUNITIONS ONBOARD SHIPS AND SUBMARINES			
MOD AUTHORITY			
SHIP OR SUBMARINE CLASS OR NAME			
TENDER IDENTITY			
TENDERER IDENTITY			
ITEM NO.	REQUIREMENT	PARAMETERS TO BE MET	GUIDANCE NOTES
1	Compliant with the appropriate industry standards for design & build of MMHE	CE Markings	Machinery, electrical, EMC, etc. See item 9 for EMC
2	Safe Working Load - Suitable for the maximum expected load	<i>Requirement to be inserted by Platform IPT</i>	DDD / Equipment Safety Case to document (References include BR3027: Chapter 6), Def Stan 02-113 and JSP 467 Chapter 16)
3	Single point failures that could result in uncontrolled lowering / drop of load are to be avoided	<i>Requirement to be inserted by Platform IPT</i>	DDD / Equipment Safety Case to document.
4	Zone 2 Compliant	<i>Requirement to be inserted by Platform IPT</i>	Zone 2 compliant MMHE is only required when a magazine is designated as Zone 2.
5	First Aid Fire fighting equipment (onboard MMHE for use with MMHE fires only).		JSP 482 Chapter 16 refers

REQUIREMENT FOR THE PROCUREMENT OF MOBILE MECHANICAL HANDLING EQUIPMENT FOR THE TRANSPORTING OF MUNITIONS ONBOARD SHIPS AND SUBMARINES			
MOD AUTHORITY			
SHIP OR SUBMARINE CLASS OR NAME			
TENDER IDENTITY			
TENDERER IDENTITY			
ITEM NO.	REQUIREMENT	PARAMETERS TO BE MET	GUIDANCE NOTES
6	Maximum Surface Temperature	Maximum Surface Temperature of MMHE to be 135°C	JSP 482 Chapter 16 Annex C and Def Stan 00-101 Part 3 refers
7	Water spray proof	<i>Requirement to be inserted by Platform IPT</i>	Refer to 0 of Def Stan 00-101 Part 3
8	Propulsion	Internal Battery or Diesel engine only.	NOT Petrol or Liquid petroleum gas (LPG)
9	EMC	EMC to meet Def Stan 59-411	
10	Antistatic arrangements	Earthing Straps / Strips. Suitable visible earthing arrangements	Visible to allow for operator to identify excessive wear or damage. Conducting tyres may be a suitable alternative.

REQUIREMENT FOR THE PROCUREMENT OF MOBILE MECHANICAL HANDLING EQUIPMENT FOR THE TRANSPORTING OF MUNITIONS ONBOARD SHIPS AND SUBMARINES			
MOD AUTHORITY			
SHIP OR SUBMARINE CLASS OR NAME			
TENDER IDENTITY			
TENDERER IDENTITY			
ITEM NO.	REQUIREMENT	PARAMETERS TO BE MET	GUIDANCE NOTES
11	Adequate Clearance in doors (lifts, magazines and general access), passageways, limited headroom, lifting pallet on to another pallet in magazine, aircraft operations and any other clearance limitations	<i>Requirement to be inserted by Platform IPT</i>	
12	Clearance over watertight door coamings or temporary coamings access ramps	<i>Requirement to be inserted by Platform IPT</i>	Dimensions of ramp to ensure that the underside of the MMHE does not make contact with the coaming / ramp.
13	Reach into magazine or onto magazine racking	<i>Requirement to be inserted by Platform IPT</i>	
14	Lift Height	<i>Requirement to be inserted by Platform IPT</i>	
15	Types / sizes of loads to be moved	<i>Requirement to be inserted by Platform IPT</i>	Standard pallet or special load. Are adjustable forks required?

REQUIREMENT FOR THE PROCUREMENT OF MOBILE MECHANICAL HANDLING EQUIPMENT FOR THE TRANSPORTING OF MUNITIONS ONBOARD SHIPS AND SUBMARINES			
MOD AUTHORITY			
SHIP OR SUBMARINE CLASS OR NAME			
TENDER IDENTITY			
TENDERER IDENTITY			
ITEM NO.	REQUIREMENT	PARAMETERS TO BE MET	GUIDANCE NOTES
16	Turning Circle	<i>Requirement to be inserted by Platform IPT</i>	Turning circle on ammunition route, into magazine or inside partly filled magazine.
17	Any special Deck and / or ramp surface requirements	<i>Requirement to be inserted by Platform IPT</i>	Flow-Forge stowage system in magazine, non-slip features of ramps, etc.
18	Suitable for lashing	<i>Requirement to be inserted by Platform IPT</i>	To lash vehicle securely when not in use.
19	Maximum Ramp incline / Angle / Wet / Dry	<i>Requirement to be inserted by Platform IPT</i>	
20	Towing Points	Front and Rear towing points to enable recovery of MMHE with maximum load up 'slope requirement to be inserted by Platform IPT'	To allow recovery of MMHE in event of propulsion failure or loss of traction.
21	Speed Limiters	<i>Requirement to be inserted by Platform IPT</i>	Does risk assessment provide a need to limit speed? If so, what speed?

REQUIREMENT FOR THE PROCUREMENT OF MOBILE MECHANICAL HANDLING EQUIPMENT FOR THE TRANSPORTING OF MUNITIONS ONBOARD SHIPS AND SUBMARINES			
MOD AUTHORITY			
SHIP OR SUBMARINE CLASS OR NAME			
TENDER IDENTITY			
TENDERER IDENTITY			
ITEM NO.	REQUIREMENT	PARAMETERS TO BE MET	GUIDANCE NOTES
22	Overhead protection from falling objects / loads for the operator	<i>Requirement to be inserted by Platform IPT</i>	Based upon Platform risk assessment.
23	Operator visibility when reversing	<i>Requirement to be inserted by Platform IPT</i>	Will MMHE be required to reverse when carrying load? Will it need to reverse up or down slopes?
24	Maximum induced vibration level from MMHE into load	<i>Requirement to be inserted by Platform IPT</i>	Munition Safety Case to be checked for any maximum vibration levels
25	Suitable Lighting	<i>Requirement to be inserted by Platform IPT</i>	Forward & reverse travel lights and lighting to allow the operator to observe the load.
26	Protection against RADHAZ	<i>Requirement to be inserted by Platform IPT</i>	
27	Robust Equipment Safety Case	JSP 430 and Def Stan 00-56.	
28	JSP 467		See Def Stan 00-101 Part Appendix 16.1.3

REQUIREMENT FOR THE PROCUREMENT OF MOBILE MECHANICAL HANDLING EQUIPMENT FOR THE TRANSPORTING OF MUNITIONS ONBOARD SHIPS AND SUBMARINES			
MOD AUTHORITY			
SHIP OR SUBMARINE CLASS OR NAME			
TENDER IDENTITY			
TENDERER IDENTITY			
ITEM NO.	REQUIREMENT	PARAMETERS TO BE MET	GUIDANCE NOTES
29	Stability		To avoid dropped load, tilt or topple of MMHE and load.
30	Sea State	<i>Requirement to be inserted by Platform IPT</i>	Platform IPT to determine any limitations in sea state. Def Stan 00-101 Part 1 Appendix 16.1.40 may provide further information on conditions.

ANNEX I ADDITIONAL GUIDANCE ON FIRE FIGHTING ARRANGEMENTS

1.1 Background

1.1.1 This ANNEX and the process map at the end of the Annex sets out additional guidance on how to meet the Performance Requirements at (Appendix 8) that relate to the provision of suitable arrangements for firefighting and munitions thermal protection systems in:

- Magazines;
- Designated Danger Areas (DDAs).

1.1.2 It is recognised that some of the information captured in this ANNEX is a repeat of Appendix 8, however its content and the context in which it may be used is aimed at enabling PDHs to consider an integrated protection approach that utilises:

- The full protection potential of adjacent compartments
- Latest detection technologies
- Latest active fire suppression and munition protection technologies.
- Passive technologies.
- Technologies that improve overall situational awareness.
- Magazine internal boundary cooling using considerably less water than a spray system.
- Armoured magazines boundary's to prevent bullet/fragment attack of stowed munitions.

1.1.3 The specific protection requirements for Magazine Lockers are given in Appendix 6 of this standard.

1.1.4 A Fire Hazard and Munitions Protection Assessment is made to determine the:

- explosives stowage and handling areas onboard ship requiring protection;
- credible fire sources to be considered;
- performance requirements for the methodology and systems employed in their protection to prevent escalation;

As part of the Munitions Protection Strategy described in Appendix 8. This must also be linked with the whole ship fire assessment required by NA Fire in NAR Ch 7.

1.1.5 Whilst design examples based upon existing magazine fire threats, stowage designs and compartment sizes are given, it must be recognised that these may not provide an ALARP solution to future ship designs.

1.1.6 For the optimisation of protection performance and cost effectiveness the designer is encouraged to consider an integrated protection approach that utilises:

- the full protection potential of adjacent compartments;
- newer detection technologies;
- newer active fire suppression and munitions protection technologies;
- passive technologies;
- technologies that improve overall situational awareness;
- optimum matching of munitions of like sensitivities to accordingly protected compartment.

1.1.7 Traditional magazine protection methods require the use of large quantities of water which may lead to ship stability issues and removal of resource from other priority systems. Improvements in the passive fire protection of thermally vulnerable surfaces (of compartment, weapons and associated packaging) can produce large savings in water supply requirements and may even enable the adoption of other suppression technologies to be considered.

1.2 Performance objectives

1.2.1 Five primary performance requirements are to be satisfied in reducing to ALARP both the risk to munitions from fire and risk to the ship from munitions on fire. The essential requirements for fire fighting arrangements in magazines, small magazines and DDAs are:

- To reliably detect the presence of excessive heat or fire in such spaces.
- To react to the fire detection stimuli to provide early warning alarms and for automated systems to activate fire suppression/munitions cooling in a time that prevents escalation of the event.
- To provide effective containment of fire and rapid cooling of heat from an event occurring outside such spaces to prevent an associated event occurring within them for an adequate period of time.
- To provide rapid and effective cooling (munitions) of an event within such spaces to prevent escalation of that event. Wherever possible the fire source should be extinguished; where this is not possible adequate suppression and cooling of munitions, surfaces, boundaries and environment should be achieved to control the event, and continued for an adequate period of time.
- To ensure fire detection, alarm and suppression system designs for such spaces follow a systems engineering approach and that supporting ship systems are integrated with them to ensure the required level of performance.

1.2.2 The measures are to be detailed and justified in the DDD. Advice on developing suitable arrangements for magazines, small magazines and DDAs is given in this Paragraph. General requirements for fire fighting systems, including sea water supply, are given in Def. Stan. 07-204 Pt 1. The key safety points from the DDD should be justified in the Safety Assessment in the platform's Explosives Safety Case.

1.2.3 The fire fighting arrangements in magazines, small magazines and DDAs shall meet the explosives SMS and SSOW requirements of BR 862, other SEMS and other ship Key Hazard Certification requirements. In particular the requirements of Naval

Authority Fire and associated whole ship Fire Safety Certification shall also be met outside magazines and DDAs where applicable. The duty holder shall take measures to ensure that all relevant requirements are satisfied.

1.3 Fire Hazard and munitions protection assessment

1.3.1 A Fire Hazard and Munitions Protection Assessment is made to determine the:

- explosives stowage and handling areas onboard ship requiring protection;
- credible fire sources to be considered;
- performance requirements for the methodology and systems employed in their protection to prevent escalation;

As part of the Munitions Protection Strategy described in paragraph 8 and Annex D. This must also be linked with the whole ship fire assessment required by NA Fire in NAR Ch 7.

1.3.2 Knowledge of the munitions' reaction to various heating regimes (as described in Part 4 of this standard, STANAG 4439, STANAG 4240 and STANAG 4382) and the operational environment is required to determine:

- The maximum time available in which to achieve the performance objectives as described in 1.2 from onset of a given stimuli. Within this period the detected species must be transported from the source to the detector head at a detectable level (alarm threshold); be confirmed by similar transport to another device; raise alarm; initiate the protection system(s); and manage the event to a point where escalation is not possible. Each of these stages requires a finite time, the sum total of which must not exceed the 'critical' value and during which key parameters, such as munitions temperature, must not be exceeded.
- The sensitivity of munitions to radiative heating from a shared boundary with an on-fire compartment.
- The sensitivity of munitions to accidental discharge of each considered suppression/cooling technology media.
- Protection priorities in accordance with munitions sensitivity (Detection) as described in 1.3.3.
- Protection priorities in accordance with munitions sensitivity (Suppression) as described in 1.3.5.

1.3.3 From knowledge of the munitions' reaction to various heating regimes (as described in Part 4 of this standard, STANAG 4439, STANAG 4240 and STANAG 4382) and the operational environment, the selection of an appropriate detection system shall require:

- An understanding of the parameters that describe; the burning event (such as smoke, heat, gas and flame emissions (IR/UV/visible)); the timescales over which they are produced in the early stages of the event; and quantities of each produced.
- The minimum size fire that must be detectable by the installed system.
- The maximum allowable time for a confirmed alarm response to trigger an automatic protection system.

- The storage arrangements of munitions within the protected compartment.
- An understanding of the protection priorities in accordance with munitions sensitivity. Fires can start by many mechanisms and manifest in many different forms of varying size (heat); growth rate, visibility (flaming) and emissions (such as smoke). Whilst all munitions will be sensitive to a greater or lesser degree to large fires, some may be sensitive to small fires, particularly where localised flaming may be capable of intense local heating of munitions by direct flame impingement, but may not be of a size to produce much smoke or raise the temperature of a large compartment to alarm thresholds.

1.3.4 Selected detection parameters must be carefully considered in conjunction with the geometric configuration of the protected compartment, deckhead design detailing, storage arrangements and installed HVAC systems. Timely detection of gas bourn species such as smoke, heat and carbon monoxide can be impeded by high deckhead heights, deckhead features such as beams and obstructions that may 'channel' gases, large volumes, and the operation of ventilation systems. Line-of-sight detectors, such as IR devices, whilst immune to the aforementioned vulnerabilities associated with gas bourn species detectors, may be impeded by complex stacking arrangements that limit viewing areas, and fuels with low IR signatures. It may be necessary to detect more than one species to adequately detect events that may develop in a number of ways from onset.

1.3.5 From knowledge of the munitions' reaction to various heating regimes (as described in Part 4 of this standard, STANAG 4439, STANAG 4240 and STANAG 4382) and the operational environment, the selection of an appropriate **active fire suppression and munitions protection system** shall require:

- An understanding of the protection priorities in accordance with munitions sensitivity. Depending upon the passive fire resisting capabilities of the munitions the need for thermal security of the munitions (cooling) will need to be considered against the urgency for fire suppression. Suppression systems vary in their capabilities in respect of rapidity of fire extinguishment and ability to cool surfaces and to this end the system must be carefully chosen. Depending upon the findings of the Fire Hazard and Munitions Protection Assessment more than one system may require deployment to meet the performance objectives.
- The maximum fire size that must be managed by the installed system(s)
- The maximum allowable deployment time of the system from receipt of a confirmed detection signal
- The storage arrangements of munitions within the protected compartment
- Details of specific vulnerable parts of larger stored munitions

1.3.6 Active fire protection of stored items can be optimised where stacking arrangements are formalised in a system that is coherent with the operation and function of the fire protection system. Whilst this may limit flexibility in the use of the protected compartments it represents good practice and should be considered wherever possible; particularly where more sensitive munitions are stored.

1.3.7 From knowledge of the munitions' reaction to various heating regimes (as described in Part 4 of this standard, STANAG 4439, STANAG 4240 and STANAG 4382)

and the operational environment, the selection of appropriate **passive fire protection systems** shall require:

- An understanding of the maximum fire size that may result in all adjacent compartments
- The sensitivity of munitions to radiative heating from a shared boundary with an on-fire compartment
- The inherent passive resistance of the stored munitions and, if applicable, its packaging, to an applied fire source

1.3.8 From knowledge of the munitions' reaction to various heating regimes (as described in Part 4 of this standard, STANAG 4439, STANAG 4240 and STANAG 4382) and the operational environment, the selection of appropriate **1st aid fire fighting equipment** shall require:

- details of the likely initial burning characteristic of the stored munitions;
- knowledge of the presence of liquid fuels (missile propellants)
- knowledge of material hazards of associated handling equipment

1.3.9 Munitions fire characteristics. The primary information on characteristics of munitions is the type and quantity of the energetic materials used in the munitions and how the energetic material reacts to the Fast Heating and Slow Heating safety tests in each specific munitions design. In principle the Fast Heating test characterises the munitions' reaction to a fire where the munitions is insulted rapidly with intense heat. The Slow Heating test indicates the munitions' reaction at the other end of the continuum of thermal input where the input is progressive over a long period of time. The two forms of heat input cause differing forms of chemical change within the energetic materials and hence often lead to different end events.

1.3.10 As an example, in a non-IM munitions the response to both Slow and Fast Heating could be a Type I reaction. Alternatively it could be that its slow heating response is more benign than the fast heating reaction or indeed the reverse could apply. The munitions design and nature of the energetic materials will determine what the end events are for both tests. It is important to recognize that the tests only characterize the munitions' reaction to somewhat idealized test scenarios. In practice the heat input from a real fire in a magazine is likely to lie somewhere between Fast and Slow, but closest to Fast, particularly if large quantities of propellant are involved or where torching occurs. It is also important to note that some energetic materials, particularly propellants, can react violently when they are subjected to temperatures of circa 70/80°C for periods as short as 10 minutes. This temperature is significantly below the typical Temperature of Ignition of 160/180°C for propellants. The result illustrates how chemical changes in the energetic material accelerate with potentially severe consequences if the materials are not "kept cool". Therefore, in order that the risks can be deemed as ALARP, it is best practice to design the fire fighting arrangements based on the "worst case" situation which will be the time to reaction in the Fast Heating test.

1.3.11 Further information on Fast and Slow Heating tests is given in Part 4 of this standard, STANAG 4439 and STANAG 4240 (Liquid Fuel Fire Test for Munitions) and STANAG 4382 (Slow Heating Test for Munitions). The assessed or test results for these cases should be stated in the munitions (OME) safety case and summarised in the

SEXSSI. This should be related to the generic type of energetic materials e.g. propellant, high explosive, pyrotechnic, liquid fuel etc and the NEQ for each material.

1.3.12 As Insensitive Munitions (IM) are introduced progressively, the reaction to both tests for IM munitions embarked should be a Type V, i.e. “no worse than burning”. However this does not equate to absence of risk. The important parameter is the “time to reaction”. Under Slow Heating test conditions munitions have a time to reaction in excess of 10 hours and typically the time is some 30 hours. It follows that the key parameter for the design of magazine fire fighting arrangements is the result of the Fast Heating test coupled with an understanding of the amount of energy or heat generated. It is also important to know the configuration of the munitions when it was subjected to the test and relate this to the state when it is in the magazine and/or DDA (i.e. whether packaged or unpackaged, whether part of a Unit Load, an individual item or part of a munitions).

1.3.13 Figure 1 shows the range of times to reaction for a typical sample of 56 munitions likely to be embarked on ships. The following deductions follow from Figure 1

- a) Mean Value of reaction time 3.3 minutes.
- b) Standard Deviation of reaction time 3 minutes.
- c) Of the 6 munitions with a reaction time less than 1 minute the reaction times range from 1 second to 58 seconds with a mean value of 44 seconds.

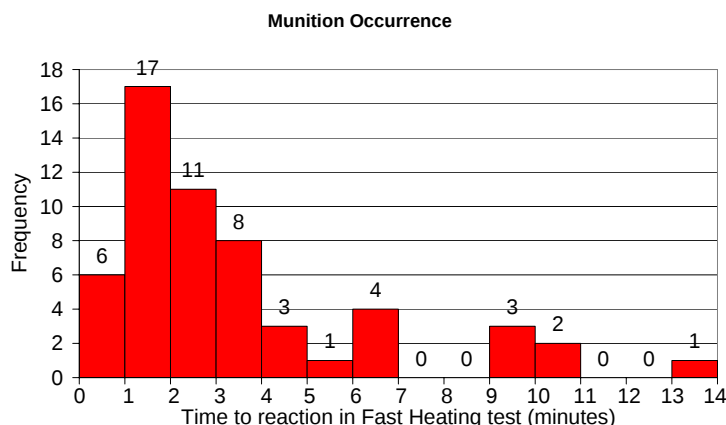


Figure 1 - Munitions time to react to fast heating

1.3.14 Once alight and with a reaction “no worse than burning”, the energetic material will release its heat energy quickly, although the rate of release will be very dependant upon the degree of confinement. In their design mode propellants and high explosives burn extremely rapidly but if their casings are disrupted through, for example fragment attack, then the burn rate will be lower. Figure 2 shows the heat energy released against time per unit kg of a typical energetic composition. The following observations are made.

- a) Propellants typically have a calorimetric value in the range 3.2 to 4.9 MJ/Kg.

- b) TNT has a calorimetric value of 4.1 MJ/Kg with most other HE materials slightly higher.
- c) An NEQ of 1 kg of typical energetic material will generate some 4 MJ of energy. The power (rate of energy release) will be dependant on the period of time over which this energy is released.

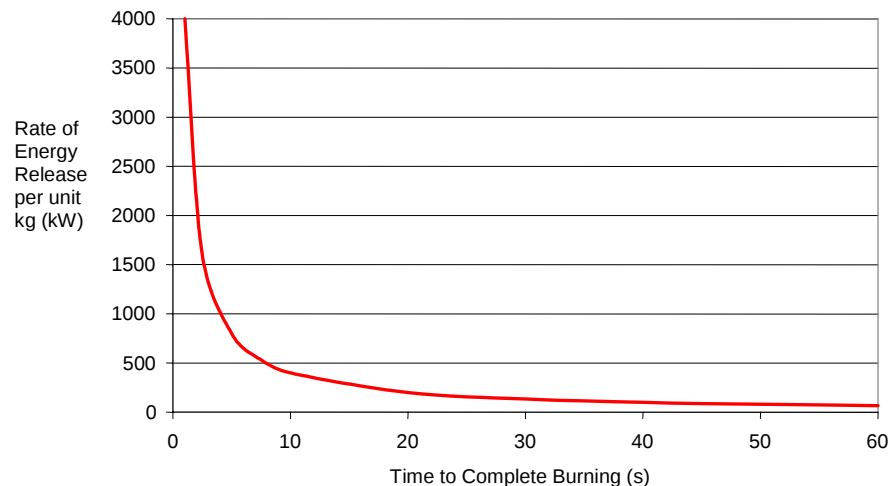


Figure 2 - Heat energy released against time per unit kg of a typical energetic composition

1.4 Common principles for protection systems

1.4.1 The selection of detection equipment shall be coherent with the hazard signatures associated with events within the compartment, whether it be the magazine or adjacent space.

1.4.2 The selection of detection equipment shall be coherent with the design and operation of the enclosure; in particular, its volume, height, deckhead detailing and operation of HVAC systems.

1.4.3 The selection of detection equipment employed for the triggering of active systems shall be coherent with the selected active protection system(s) and its mode of operation; total flooding, or zoned.

1.4.4 The selection of active protection system(s) shall be coherent with the required mode of operation; total flooding, or zoned.

1.4.5 The selection of active protection system(s) shall be coherent with the burning properties of the stored munitions and the hazards presented from adjacent enclosures.

1.4.6 The selection of active protection system(s) shall be coherent with the sensitivities of the stored munitions to the suppression/cooling media employed.

1.4.7 The selection of passive protection will be coherent with the protection requirements of the stored munitions; the protection requirements of adjacent compartments; and the active protection system function.

1.5 Compartmentation (as a protection 'system')

1.5.1 The requirements for adjacent compartments are given in Paragraph 10 and Paragraph 8 of this document.

- Appropriate measures are to be taken to reduce risks to munitions from adjacent compartments to ALARP in MOD ships (1.2.1)
- Risks from munitions to adjacent compartments are also to be reduced to ALARP as described in Paragraph 8 (1.2.2)

1.5.2 Historically magazines become involved in events through fire-spread from adjacent compartments and as such, carefully considered, these spaces may be designed to create a high level of protection for the magazine.

1.5.3 Subject to consideration of fires starting within the magazine, protection of adjacent compartments may enable simplification of the in-magazine protection systems. Mechanisms that may be employed include:

- detection;
- specification of 'inert content' within the adjacent space (fire break principle);
- active protection of adjacent spaces on the basis that a lesser specified system used in advance of the magazine is a more efficient mechanism of protection;
- the use of active 'passive' systems such as low oxygen inerting of normally unoccupied spaces;
- the creation of passive boundaries to alleviate the need for boundary cooling and reduce the likelihood of radiated exposure of munitions from fires in adjacent compartments.

1.5.4.1.1 Traditional magazine protection methods require the use of large quantities of water which may lead to ship stability issues and removal of resource from other priority systems. Improvements in the passive fire protection of thermally vulnerable surfaces can reduce the manpower effort and water supply resource applied to boundary cooling activities thereby improving crew safety and optimising resource usage. Passive protection products include:

- Fire Barrier Insulation (FBI) as described in Def Stan 02-703/NES 703
- Cavity barriers
- Sprayed intumescent coatings (surface coatings that swell to a substantial insulating layer upon heating)

1.5.5 Passive protection products must be compatible with the stored munitions, other protection systems, the likely fire development routes as defined in the Fire Hazard and Munitions Protection Assessment, and all other naval requirements (such as shock).

1.6 Detection

1.6.1 Detection systems are employed to:

- give notification of events that may lead to fire; often referred to as 'precursor' signs which might include build up of heat, smoke, or equipment malfunction;
- give notification of a likely fire to personnel by audible and visual alarms;
- operate an active protection system(s).

Each of these requires differing levels of sensitivity to accommodate the differing consequences of a false alarm. To this end it is not uncommon to simultaneously operate a number of detection systems/methodologies to avoid degrading 'first notification' to the least sensitive system (generally one that automatically operates a protection system).

1.6.2 The requirement for the detection system shall be determined from the Fire Hazard and Munitions Protection Assessment (1.3) and Performance Objectives (1.2).

1.6.3 Selected detection parameters must be carefully considered in conjunction with the geometric configuration of the protected compartment, deckhead design detailing, storage arrangements and installed HVAC systems. Timely detection of gas bourn species such as smoke, heat and carbon monoxide can be impeded by high deckhead heights, deckhead features such as beams and obstructions that may 'channel' gases, large volumes, and the operation of ventilation systems. Line-of-sight detectors, such as IR devices, whilst immune to the aforementioned vulnerabilities associated with gas bourn species detectors, may be impeded by complex stacking arrangements that limit viewing areas, and fuels with low IR signatures. It may be necessary to detect more than one species to adequately detect events that may develop in a number of ways from onset.

1.6.4 Detailed Guidance on best practice relating to detection is contained in Def Stan 02-603. Where systems are used that are not covered in Def Stan 02-603 or this document, alternative appropriate standards should be sought, or the manufacturer's installation guidance should be used and sufficient supporting evidence of function supplied to NAEXP for approval.

1.6.5 Def Stan 02-603 states that fire detectors are to be installed in all magazines, adjacent compartments (except low fire risk compartments) and in DDAs (see also Paragraph 10 of this standard for additional information).

1.6.6 Triggering of an automatic protection system will require a valid signal from 2 or more point detectors.

1.6.7 'Point' detectors should be sited just below the deckhead and distributed across the deckhead, taking into account the layout of the magazine, potential gas flow distribution, channels and obstructions, and the relationship of its boundaries to the potential risk from the adjacent compartment/area, where applicable.

1.6.8 Where features, such as beams, within the deckhead can act to channel detected gas species or form reservoirs that may delay detection, the point detection devices shall be positioned in accordance with these features. Overall detector numbers shall not be less than would be employed on an unimpeded ceiling.

1.6.9 Any single detector signal should activate audible/visible alarms, both locally and remotely in the SCC/HQ1, or other locations appropriate to the ship's protection organization. The alarms are to operate independently of controls to activate the spray system.

1.6.10 Where the detectors are linked to a control system that initiates the active protection system, the control system should be located outside the magazine. The control system should be provided with interlocks and remote testing facilities that permit routine testing and maintenance to be carried out without hindering the operation of the system.

1.6.11 When the detection and control system is activated separate audible and visual alarms should be operated locally outside the magazine and at appropriate remote positions throughout the ship. Where a visual alarm could be seen from off board, darkened ship facilities are to be provided.

1.6.12 In ships where the SCC or ship's protection organization is not continually manned, additional alarms should be fitted next to the Officer of the Watch position at sea, and next to the Quarter Masters position in harbour.

1.6.13 The detection system control unit may read all point detectors simultaneously or poll each in turn. In the latter case each sensor should be polled not less than once every 100 milliseconds.

1.6.14 The detection system control unit should have an internal operating delay commensurate with the overall suppression / cooling medium full flow time requirements as determined by the Fire Hazard and Munitions Protection Assessment 1.3 and Performance Objectives 1.2. This is likely to be in the order of 0.1 second on receipt of a valid detection to produce a control output to the power operated valve.

1.6.15 The detection system control unit should have facilities to enable "self test checks" of the sensors to be carried out as part of the routine maintenance procedures.

1.6.16 **Smoke detection.** Many systems exist for the detection of fire by smoke including:

- Point detectors (optical and ionisation)
- Beam detectors (optical)
- Aspirated systems
- Video recognition systems

The most appropriate device for the application will be determined from the Fire Hazard and Munitions Protection Assessment 1.3 and Performance Objectives 1.2. Where systems are not adequately covered in Def Stan 02-603, alternative appropriate standards should be sought.

1.6.17 To achieve an acceptable level of protection the minimum number of point smoke detectors should be determined on deckhead area, based on the following guidance:

- Deckhead area $< 12 \text{ m}^2$: 1 sensor fitted
- Deckhead area 12 m^2 to 25 m^2 : 2 sensors fitted
- then, 1 extra detector for every additional 50 m^2 (or part thereof)

1.6.18 Smoke detection is not considered a suitable means of detection for the activation of zoned protection systems (1.10.10).

1.6.19 **Heat detection.** Many systems exist for the detection of fire by heat including:

- Electronic point detectors
- Thermally sensitive devices (such as sprinkler bulbs)
- Linear detectors
- IR video systems

The most appropriate device for the application will be determined from the Fire Hazard and Munitions Protection Assessment (1.3) and Performance Objectives (1.2). Where systems are not adequately covered in Def Stan 02-603, alternative appropriate standards should be sought.

1.6.20 The alarm threshold value for heat detection devices should be close to but no lower than 30°C above the highest anticipated ambient temperature of the compartment.

1.6.21 To achieve an acceptable level of protection the minimum number of point heat detectors should be determined on deckhead area, based on the following guidance:

- the maximum spacing between sensors shall be 3 metres;
- the maximum distance between a sensor and bulkhead shall be half the sensor spacing.

1.6.22 The heat detectors may either provide a continuous readout of temperature that the system control unit can electronically process, or be of the form where the device triggers or activates at a preset temperature.

1.6.23 Detectors should be of low thermal inertia capable of sensing and responding to extremely steep temperature/time gradients of at least 25°C per second.

1.6.24 Each detector must be capable of individually sensing and responding to heat stimuli; i.e. the system should not be configured with combined detector loops.

1.6.25 Consideration should also be given to the fitting of detectors that detect the rise in bulkhead temperature due to fire in an adjacent compartment.

1.6.26 The additional requirements as described in 1.10.10 should be followed where the size of the magazine requires the spray system to be configured into zones.

1.6.27 Where there is a potential fire risk, adjacent compartments should also be fitted with heat detection measures, for early warning of a fire incident, paragraph 10 provides additional details.

1.6.28 **Flame detection.** Installation and performance requirements for flame detectors (IR / UV / Thermal imaging) will be determined from the Fire Hazard and Munitions Protection Assessment (1.3) and Performance Objectives (1.2). Where systems are not adequately covered in Def Stan 02-603, alternative appropriate standards should be sought.

1.7 Fire suppression & munitions cooling systems

1.7.1 The Fire Hazard and Munitions Protection Assessment will identify the requirement for active suppression systems in and adjacent to:

- magazines;
- compartments adjacent to magazines;
- small magazines;
- magazine lockers;
- ammunition routes;
- ammunition handling equipment;
- DDAs

1.7.2 Many active systems exist for the suppression of fires and the protection of involved items from heat including:

- Water spray & sprinkler systems
- Water mist systems
- Gaseous systems

Each has their own strengths and weaknesses in terms of fire suppression and surface cooling capability but could be considered singularly; in combination with each other; or in combination with passive systems and methodologies; depending upon the outcome of the Fire Hazard and Munitions Protection Assessment (1.3) and Performance Objectives (1.2).

1.7.3 Water spray & sprinkler systems. Water spray systems may take several forms and may be used for general compartment protection by discharging water through sprinkler or spray heads at a high level or object protection by using directional spray nozzles. Water spray system operation and control may take two basic forms:

- a) Sprinkler or spray deluge systems, discharging water over a pre-designated area or zone through open nozzles. Control of these systems may be:
 1. automatic, in response to a signal from a fire or overheat detection system connected to a control valve. Automatic deluge spray systems may also be manually operated at the control valve and at remote locations if specified. The Rapid Reaction Spray Systems (RRSS) is a form of automatic deluge system that has been developed to deliver water to the sprayers with a minimum delay time between detector activation and water discharge; or
 2. manually only, by opening a control valve (or throwing a switch at a remote location and thereby opening a control valve) and discharging water over a pre-designated area through open nozzles.
- b) automatic sprinkler or spray system which:
 1. discharge water from individual sealed sprinkler heads or spray heads or sprayers in response to heating of the individual sprinkler, spray heads or sprayers; or
 2. automatically discharging water from individual sealed sprinkler heads or spray heads, with the option of manually remotely activating the sealed sprinklers in pre-designated groups. These are usually referred to as Metron Activated Spray Systems (MASS);

Water spray systems are effective fire suppression and object cooling systems; have been used as the preferred system for the protection of magazines in the past; and may be suitable for use in a 'zoned' configuration (see 0).

1.7.4 Water mist systems. Water mist systems have proved successful at suppressing liquid fuel fires in closed compartments. Fire extinguishment using water mist is achieved by a process of reducing the oxygen level around the fire site to a level that will no longer support combustion. Water mist is capable of extinguishing large fires (relative to the size of the compartment) quickly but may have difficulty in suppressing small, deep seated or shielded fires. They are unsuitable for use on fires involving chemicals containing oxygen available for combustion such as cellulose nitrate. Water mist is ineffective at cooling hot surfaces as the water flux rates are insufficient. Water mist systems have been developed for protection of machinery spaces (see DEF STAN 02-XX) but have not previously been used for protection of magazines. The most likely use of water mist would be in combination with other forms of protection and are not suitable for use in a 'zoned' configuration (see 1.10.10). Further research would be required before they could be used for the protection of magazines or weapons.

1.7.5 Gaseous systems. Gaseous fire extinguishing systems can be effective in closed compartments. Carbon dioxide and inert gas systems extinguish fires by the reduction of the oxygen in the compartment to a level that will no longer support combustion. Gaseous fire extinguishing systems may fail to extinguish deep seated fires and will fail to extinguish fires involving chemicals containing oxygen available for combustion such as cellulose nitrate. Gaseous systems provide little or no surface cooling and to this end their most likely use would be in combination with other forms of protection. They are not suitable for use in a 'zoned' configuration (see 1.10.10). Carbon dioxide discharges are known to produce electrostatic discharges which under certain circumstances could cause a spark.

1.7.6 For guidance, the remainder of this Annex concentrates on describing water spray and sprinkler systems which have historically been the preferred option. Where information is not readily available for other systems, an appropriate alternative standard should be sought together with the manufacturer's design guidance for submission to NAEXP.

1.7.7 Water spray system equipment selection and system design. Nozzle selection - A variety of nozzles are available for use in water spray systems, the selection of which depends on the intended use and the nature of protection required. For general compartment protection the following may be appropriate:

- a) For deluge systems including RRSS
 1. open sprinkler heads;
 2. open spray heads;
 3. open directional sprayers producing a mixture of water droplets (within the small to medium size range) and a water distribution having a defined cone angle or distribution pattern, which will vary with the nozzle entry pressure;
 4. open swirl chamber nozzle sprayers producing a mixture of water droplets (with a high proportion of large droplets) with a water distribution having a defined cone angle or distribution pattern (sometimes referred to as high velocity spray nozzles);

b) for automatic sprinkler and spray systems

1. glass bulb or solder link (sealed) sprinkler heads;
2. glass bulb or solder link (sealed) spray heads;
3. glass bulb or solder link (sealed) directional sprayers with a defined cone angle;
4. glass bulb sprinkler, spray or sprayers with an electrically triggered gas generator actuator (sometimes referred to as a Metron actuator). Sealed head nozzles with an actuator provide a means of electrically operating individual nozzles or group of nozzles remotely. When used in an automatic sprinkler or spray systems the system may also be operated as deluge systems and is referred to as a Metron Activated Spray System (MASS)

1.7.8 Sprinkler heads, spray heads and sprayers are available in a number of different orifice sizes which are frequently defined by a 'k' factor. A 'k' factor allows the flow through a nozzle to be calculated for a known nozzle entry water pressure, the relationship is expressed by the equation:

$$k = \frac{Q}{\sqrt{P}}$$

where

P is the nozzle entry pressure in bar (bar)

Q is the flow rate in litres per minute (l/min)

1.7.9 The maximum operating pressure of sprinkler heads, spray heads and sprayers will be identified in the supplier's data sheet, but should not be less than 12 bar. The effective operating pressure range for fire suppression and cooling purposes will be specified by the supplier and will vary depending on the product, positioning and performance requirement.

1.7.10 The minimum nozzle entry pressure of installed sprinkler heads, spray heads and sprayers providing general area protection will depend on the 'k' factor of the nozzle(s), the water flux rate required in litre/min/square metre (l/min/m²) or (mm/min) and the area of coverage required per sprinkler or sprayer. The minimum nozzle entry pressure of any nozzle within an array should be either:

a) not be less than that determined by the equation:

$$P = \left(\frac{A \cdot d}{k} \right)^2$$

Where

P is the nozzle entry pressure in bar (bar)

A is the nozzle coverage area in square metres (m²)

d is the specified water flux rate required in litres per minute per square metre (l/min/m^2)

Or

b) the nozzle suppliers specified minimum operating pressure

whichever is the greater of the two values.

- 1.7.11 Automatic sprinkler, spray or sprayer heads with a thermally sensing sealing device which releases to discharge water for fire fighting (such as glass bulb or solder link) shall be chosen with a temperature rating close to but no lower than 30°C above the highest anticipated ambient temperature. They shall have a thermal sensitivity rating of either “quick” or “special” response in accordance with BS EN12259-1.

NOTE. Quick response heat sensitive elements are more thermally sensitive than special response heat sensitive elements and should be considered to be the preferred choice. Special response nozzles may be slightly more robust than quick response nozzles and may be the preferred choice where they may be susceptible to shock or vibration.

- 1.7.12 Where nozzles have thermally sensing sealing devices and are located in an area where they may be susceptible to mechanical damage, they should be protected by purpose made guards that do not adversely influence their water spray pattern.

1.7.13 The selection of water spray system operation will be influenced by the outcome of the Fire Hazard and Munitions Protection Assessment. The likely rate of fire development and the susceptibility of magazine's content to fire and heating will provide the basis for determining the detection system to employ and whether the water spray system should be operated automatically on receipt of and alarm of fire or manually.

1.7.14 Where there is a threat of a rapidly developing fire and/or overheating of weapons presents an immediate hazard an automatic deluge system, such as the Rapid Reaction Spray system (RRSS) should be employed. RRSS protection consists of an automatic deluge spray system connected to the HPSW, although the flow immediately after operation of the system is supplied from a pressurized FW pressure tank. Providing the water supplies of the HPSW is both adequate and immediately available at all times, without the need to start pumps, an additional pressure tank water supply (as required by the RRSS) may not be necessary. A full description of RRSS is given in DEF STAN 07-204 Part 3 (NES 119 Part 3).

NOTE. Where differences exist between DEF STAN 07-204 and this standard, the requirements of this standard should take precedence.

1.7.15 Where there is a threat of a fire and/or overheating which presents a hazard requiring prompt action but also requires a level of protection against spurious operation of a deluge system, consideration should be given to employing an automatic sprinkler system with MASS capabilities, which can be zoned, and operated manually

1.7.16 Where a relatively slow rate of fire development is anticipated because;

- a) of the absence of exposed of combustible materials; and

- b) exposure of the contents of the magazine to heat does not present an immediate threat, due to for example non combustible packaging or fire resisting materials protecting weapons or ammunition; and where
- c) It is anticipated that there will be sufficient time to carry out an inspection of the compartment;

the following forms of protection may be appropriate:

1. manually operated deluge water spray systems; or
2. automatic sprinkler systems;

NOTE automatic sprinkler systems will only operate if fire is present in the compartment or magazine they are installed to protect and will be insensitive to fires originating in adjacent compartments. Automatic sprinkler systems also preclude the possibility of manual control unless the system is a Metron Actuated Spray System (MASS).

1.7.17 Where munitions are palletized, in transport containers or boxes and are considered suitable to be stowed in blocks of storage, a high level deluge sprinkler or spray system may provide adequate suppression and cooling.

1.7.18 Where open nozzles are used they should be located close to the underside of the deck head, to provide cooling at the deck head.

1.7.19 Sealed sprinkler, spray and sprayer heads should be located with the deflector between 0.075 and 0.15m below the deckhead for detection purposes.

1.7.20 Consideration should also be given to positioning of nozzles relative to high level obstructions such as pipework, cabling, structure and other systems which could adversely influence the water droplet distribution over the stored munitions below. Additional nozzles may be necessary below some obstructions to ensure both deck head cooling and adequate coverage of the stored munitions.

1.7.21 Clearance between the nozzles and top of the storage is important to allow the water distribution pattern to be formed. Clearances therefore determine the horizontal spacing between nozzles under the deckhead to achieve an acceptable water distribution. The relationships between the maximum spacing of nozzles and clearance between the top of the storage and the nozzle shall be maintained in accordance with the supplier's data sheet and Table 21.1, whichever gives the smallest spacing. A minimum clearance of 300 mm is highly desirable and should be observed where possible. Clearances down to 250 mm may be permissible for some applications providing adequate water distribution can be achieved. The area at reduced clearance shall be limited to a maximum of 25% of the total storage area and preferably dispersed throughout the storage rather than over a single area. Clearances less than 300 mm shall be justified to NA Exp at the design stage.

Table 1 Maximum horizontal spacing between nozzles vs. clearance between top of storage and the nozzles for high level compartment spray magazine protection

	Maximum spacing between nozzles		
	m		
Clearance between to top of storage and the nozzle ¹ mm	Open sprinkler and spray heads	Glass bulb or solder link (sealed) sprinkler and spray heads with actuators ²	Glass bulb or solder link (sealed) sprinkler and spray heads without actuators ³
≥ 500	2.5	2.5	2.5
< 500 ≥ 300	2.0	2.0	⁴
< 300 ≥ 250	1.5	1.5 ⁵	⁴

NOTES

1. Measured from the underside of the nozzle deflector or swirl chamber outlet to the top of storage

2. Glass bulb and solder link (sealed) sprinkler and spray heads which may open individually under the influence of heat or may be operated remotely using an electrically activated actuator (MASS). Nozzles may be operated singly or in predetermined groups, remotely.

3. Glass bulb and solder link (sealed) sprinkler and spray heads opened individually by heat

4 Unsuited for use at clearances less than 500 mm

5. Sealed sprinklers and sprayers spaced at less than 2.0m spacing may wet adjacent heads and may either delay or prevent their operation due to cooling of the heat sensitive element(s). Cooling by adjacent nozzles should not prevent operation by MASS.

1.7.22 Glass bulb and solder link (sealed) sprinkler and spray heads minimum spacing between adjacent heads should not be less than 2.0m.

1.7.23 The maximum distance of nozzles to bulkheads and any boundaries requiring cooling should be no more than half the design spacing between nozzles. The whole of the bulkhead should be sprayed including the deckhead joint.

NOTE. When a boundary is the ships side, compartment or tank where the obverse side is wetted with water, cooling may not be required providing it can be established that the surface will be wetted during a fire. Where munitions are stored close a boundary not requiring cooling it is necessary to comply with the half spacing requirement to achieve the required flux rate over the storage

1.7.24 Where directional sprayers are required to protect bulkheads and boundaries, in addition to high level compartment spray protection; water spray should be applied by the directional sprayers at a flux rate of 10 l/min/m² over the whole area to be protected. The flux rate calculations shall be exclusive of any run down.

1.7.25 Where compartments or zones are protected only by high level water spray protection located beneath the deck head, water flux rates applied by high level protection shall be not less than 40 l/min/m² at over any area of the area of protection.

1.7.26 Cooling at lower levels within blocks of storage may be achieved by run down through the storage block for munitions which are not considered sensitive to heating. Relying on water rundown may not provide ALARP for some munitions such as torpedoes, depth charges and guided weapons. Consideration should be given to spraying water, using directional sprayers, onto the surfaces of sensitive munitions, in addition to the high level compartment spray protection. All surfaces of the exposed munitions should be sprayed with a water flux rate of 10 l/min/m² (without reliance on water run down or compartment high level spray protection) to provide cooling. Where both high level protection is provided and sensitive weapons are protected by directional spraying onto the surface of the weapons the general high level water spray protection may be provided at a flux rate of not less than 30 l/min/m².

1.7.27 The time for water delivery through spray systems shall be determined by estimation and calculation at the design stage. The appraisal should include the following time elements:

- a) where systems are initiated manually;
 - the time from a first alarm of fire to initiation of the system,
- b) for automatic and manually operated systems;
 - the time from activation of the system to discharge of water from the nozzles;
 - time to start any pumps and deliver water at the flow and pressure necessary for the protection to deliver water at the specified flux rate.

1.7.28 For RRSS full water flow should be achieved within 12 s, measured from activation of the spray system.

NOTE The 12 s time to full water flow for RRSS is based on past practice.

1.7.29 Where magazines are large and zoned systems are employed, the total number of zones shall not exceed four.

1.7.30 The deluge system pipework sizing and the system water supply capacity shall be capable of supplying the demand of all zones in a compartment operating simultaneously.

1.7.31 Compartment drainage should be designed such that surface water is retained on the deck to provide surface cooling and also allow for its quick removal when required.

1.7.32 Control valves for each automatic sprinkler, spray or sprayer system or zone shall be located outside the protected compartment close to access to the magazine. Clear indications of the valves open and shut positions shall be provided. The valve shall be normally strapped and locked in the open position.

1.7.33 A system isolating valve shall also be fitted between the strainer and the fresh water priming connection, adjacent to the strainer. The isolating valve shall only be operable at the valve location and shall be strapped and locked open. A lock key shall be housed in a breakable glass fronted key box in close proximity to the isolating valve.

1.7.34 If additional isolating valves, which may interrupt the flow of water to the sprayers, are present in the system, they are to be locked open and their keys held in accordance with the NBCD requirements.

1.7.35 Pipework within the magazine shall have sufficient flanged or screw cone union fittings to enable the system to be dismantled for repair. Other than fittings to allow pipework removal and for nozzles, pipe connections shall be brazed in accordance with DEF STAN 02-743 (NES 743) or BR 3013.

1.7.36 For flushing and draining purposes, a 65 mm instantaneous hose connection with a 40 mm bore stop valve shall be fitted on a short branch between installation control valve and the flow alarm.

1.7.37 Each automatic sprinkler or spray system shall have a 12.7 mm lockable ball valve fitted at the extremity of each terminal range or branch pipe to enable air bleeding, testing and flushing. The valve shall have a fitting suitable for connecting a flexible hose to allow for the safe disposal of water.

1.7.38 Where nozzles are fitted with thermally sensing sealing devices and a gas generator actuator (such as MASS), the actuators shall be operated by a control box outside the magazine in an access lobby or passageway.

1.7.39 Electrically operated triggering devices such as MASS shall be suitably protected against RADHAZ to prevent spurious operation.

1.8 Control of water spray & sprinkler protection systems

1.8.1 Control of automatic deluge systems such as RRSS. The system control unit shall be located in a readily accessible position adjacent to the magazine access.

1.8.2 Each automatic spray deluge system shall be provided with a manual local control facility (LCF) linked to the control unit. The LCF shall be sited in a readily accessible position adjacent to the magazine access.

NOTE: It should not be sited within another compartment or on a different deck.

1.8.3 Each automatic spray deluge system shall be provided with a remote control facility (RCF) sited in the SCC/HQ1 or other location appropriate to the ships protection organisation. The RCF's for all the ships magazines should be co-located if practicable.

1.8.4 At least one deck or main watertight bulkhead should separate the RCF from the LCF.

1.8.5 Where the Fire Hazard and Munitions Protection Assessment indicates that a third emergency operating position is justified, this position shall be fully independent of the other manual operating positions. It shall be sited on the weather deck and shall have its own emergency back-up power supply.

1.8.6 In order to minimise the possibility of inadvertent operation of spray systems at either the local, remote or emergency operating positions, suitable interlock arrangements shall be provided in accordance with the security requirements given at Appendix 14.

1.8.7 If a key control system is provided as part of the inter-lock arrangements, spare keys shall be stowed in frangible fronted red key boxes sited close to the local, remote and emergency control positions.

1.8.8 Where the local, remote and emergency control facilities are by means of electrical control panels operation shall be by key operated switch. A key for each electrical control cabinet shall be stowed in a frangible fronted red key box sited close to the control panel.

1.8.9 All controls shall be clearly marked on the outside of each cabinet and instructions for operating the controls shall be clearly indicated inside the cabinet.

1.8.10 Electrical control panels on the weather deck shall be housed in a cabinet complying with BS EN 60529 degrees of protection IP65/IP67.

1.8.11 Automatic deluge control valves shall be provided with a means of enabling the control valve to be operated/released manually. Suitable measures and operating procedures shall be implemented to ensure that manual operation of the valve is only carried out under authorised conditions.

1.8.12 Control of manually activated spray systems. Controls for manual operated deluge systems shall be located close to the magazine access.

1.8.13 For upper deck launchers the control valve shall be located in close proximity to the launcher but within the ship's structure.

1.8.14 Each manually controlled system shall also be capable of remote operation. The remote operation shall be separated from the local control by one deck or a main water tight bulkhead from the local position.

1.8.15 A 65 mm instantaneous hose connection with a 45 mm bore shall be fitted on a short branch between the system control valve and the strainer for flushing, draining and testing purposes.

1.9 Water supplies for water spray and sprinkler protection systems

1.9.1 Seawater supplies for spray systems. Automatic spray systems shall be fed from two separate sections of the ship's HPSW main (for RFAs this may be the spray or fire main)/FW reservoir to achieve a degree of redundancy for these safety critical systems. If this is not possible an ALARP justification will be required to satisfy NAEXP that SW supply redundancy options have been considered and all available design options reviewed.

1.9.2 Each supply branch is to be fitted with an isolating valve close to the seawater main. An indicator at the valve should show clearly whether the valve is 'OPEN' or 'SHUT'.

1.9.3 To reduce the likelihood of sediment finding its way into the spraying system, each branch is to be led away from the sea water main with an upward tilt and a strainer is to be fitted close to and on the sea water main side of the alarm unit, in a horizontal portion of the branch and in an accessible position for ease of maintenance. In large ships (nominally over 5000 tonnes displacement) a second strainer is to be fitted on the downstream side of the locked open system control valve where the distance between the system control valve and the alarm unit makes this necessary.

1.9.4 For RFAs strainers shall be fitted whenever the spray supply is taken from the fire main or general sea water system. Where a completely separate spray system is

fitted throughout the ship or holds, strainers need only be fitted adjacent to the spray pump. An additional isolating valve may be required on the seawater side of the strainer to assist draining and periodic maintenance/cleaning, where the length of the supply branch is considerable.

1.9.5 Spray systems should be provided with a pressurised reservoir where there is insufficient water readily available in the SW main to meet the spray system flow rate requirements or reaction times.

1.9.6 Where a reservoir is fitted, the system should be designed to prevent sea water ingress into the primed fresh water side of the system.

1.9.7 Where the seawater main cannot provide an adequate water supply, automatic spray systems - with or without FW reservoirs - should have additional SW pump(s) started automatically to meet the spray system flow rate requirements.

1.9.8 It is acceptable in RFA Ship Defence, NAV's and MWV's Magazines, fitted with automatic spray systems, to have manual fire pump start up on receipt of a signal from an early warning detection system, where no fully pressurised SW main/firemain is fitted.

1.9.9 Where the spray system is normally pressurised, the design of the system should include arrangements for priming the spray grid with fresh water. See guidance in paragraph 1.9.10.

1.9.10 Fresh water reservoirs/pressure tank. For automatic spraying systems where the magazine requires large volumes of water instantly and where SW pumps are not continuously running, the spray grid is to be fed initially from a pressurized fresh water reservoir and subsequently from a branch capable of being fed from two separate sections of the sea water main. SME advice on pressurised reservoir design and where necessary HP air supply systems is available in WSA/DopsE from MFFM and MXS sections, this expertise should be consulted wherever possible to assist achievement of MOD requirements.

1.9.11 The water in the supply branch from the sea water system is to be separated from the fresh water in the spray grid and reservoir outlet piping by a non-return valve.

1.9.12 Each fresh water reservoir is to be located to allow access for inspection and maintenance and where fitted, to allow quick replacement of the pressure diaphragm. A fresh water filling/draining connection and an overflow pipe fitted with a stopcock, is to be provided for each reservoir. A non-return valve is to be fitted in the discharge line.

1.9.13 If air pressure is required, it should be provided to each reservoir by means of HP air bottles charged at 275 bar. Pressure reduction is to be achieved in two stages, reducing pressure to 70 bar and then to the operational requirement of 7 bar. One stage pressure reduction may be accepted subject to design approval.

1.9.14 The air bottles are to be charged from the ships HP air system with air driers and filters fitted as necessary to ensure the proper functioning of the pressure controllers.

1.9.15 For RFAs all pressurised reservoir systems shall be acceptable to both MOD and MCA.

1.9.16 All valves and cocks etc. are to be fitted with suitable locking arrangements and clear indication of open and shut positions.

1.9.17 Freshwater pressure tanks should be sized to provide a water supply for at least the duration estimated for the SW supply to provide the pressure and flow required by the spray system.

1.9.18 NOTE. Ideally the pressure tank capacity should be sufficient to supply the system demand for at least 2.5 X the estimated time for the SW main to provide the pressure and flow. Where systems are zoned the demand should be based on two zones operating simultaneously for the duration

1.10 Instrumentation & signalling for water spray and sprinkler protection systems

1.10.1 Water flow and pressure sensors shall be fitted at appropriate places in all spray systems.

1.10.2 The electrical supply to the sensors should be from the ships normal electrical supply, with an alternative back-up supply provided.

1.10.3 Deluge spray system, including RRSS. Visual and audible alarms fitted with a mute facility to enable quiet testing, shall be provided at the local control panel and at the SCC/HQ1. For RFAs and NAVs additional sensor alarms shall be provided either in the Bridge area or at any other control station that is provided with direct communication with the Bridge.

1.10.4 Automatic sprinkler and spray systems including MASS: Visual and audible alarms, fitted with a mute facility to enable quiet testing, shall be provided adjacent to the magazine. In MWVs and RFA magazines for self defence munitions, audible alarms shall also be provided on the weatherdeck. In ships where the SCC or ship's protection organisation is not continuously manned, additional alarms shall be fitted next to the OOW position at sea and next to the Quarter Master's position in harbour. In NAVs and other ships not manned by Naval personnel, the additional alarms shall be centralised either on the Bridge area or at any other suitable control station that is provided with direct communication with the Bridge.

1.10.5 Grinnell type Alarm System or equivalent. Where a Grinnell type Alarm System or equivalent is installed each installation shall comprise of a flow alarm valve, local alarm and diaphragm switch or switches, with associated electrical circuits to the local alarm and to the NBCD HQ/SCC.

1.10.6 The flow alarm valve is to be fitted in the nearest convenient passageway, lobby or unlocked compartment and not in the magazine.

1.10.7 The test and drain pipe from the flow alarm valve is to terminate into the nearest scupper.

1.10.8 The action of water flowing through the flow alarm valve operates the diaphragm switch or switches. Operation of the diaphragm switch gives immediate indication at the spray VCS or Machinery Control and Surveillance (MCAS) unit in the NBCD HQ/SCC for that magazine.

NOTE Provided that the flow of water to the diaphragm switch or switches is maintained for longer than 12 seconds the local alarm (YODALARM) will then activate between 9 and 12 seconds after initial closing of the diaphragm switch.

1.10.9 Provision of Drains in Spray System Pipework. Dry spray systems such as Deluge spray, including RRSS, shall have a suitable facility fitted in the branch pipe immediately down stream of the spray control valve to indicate if the control valve is allowing water to pass downstream of the control valve.

NOTE. In automatic sprinkler and spray systems with sealed sprinklers and sprayers such as MASS, the installation control valve is normally open and the downstream pipework is water filled to the sprinklers or spray heads, therefore no drain facility is required.

1.10.10 The drain facility should be identified by a notice, displayed in a prominent position, with the words 'DRAIN' in BLACK text on a WHITE background together with a BLACK arrow.

1.11 Zoning

1.11.1 Where the magazine is large, and the stored munitions may be susceptible to damage by the employed extinguishing media, consideration may be given to configuring the protection system(s) into zones such that the suppression system does not act on the whole magazine when a fire/heat source is confined to a small area. The use of zoned systems must be justified to DSS NAEXP.

1.11.2 Careful consideration must be given to the choice of detector employed in zoned systems since the parameter detected is expected to describe the location of the fire. Heat detectors operate at a temperature threshold that is high in comparison to ambient temperatures and to this end the detector that operates first is likely to be the one closest to the fire/heat source. Smoke detectors alarm at very low threshold levels since smoke is not a normal constituent of air and to this end, in any given enclosure, smoke detectors in all zones might operate almost simultaneously making location difficult. Additionally, heat moves vertically upwards from a fire in a well defined plume whereas smoke, being particulate, has a greater propensity for spreading horizontally out from the plume making its deckhead signature less clear. IR/UV detection is a common choice for the activation of zoned protection systems in industrial applications.

1.11.3 Zoning of protection systems using gas parameter type detectors (heat, smoke, CO etc.) is unlikely to be suitable for compartments with active HVAC systems or very high deckhead heights.

1.11.4 The number of detectors employed in a zone should be calculated in accordance with 1.6, treating each zone as a separate compartment.

1.11.5 Where confirmation of detection with a second device is stipulated to activate the protection system, the detectors should be doubled up and co-located.

1.11.6 The suitability of active protection systems for zoning needs careful consideration. Systems whose dominant mechanism of extinguishment is by oxygen depletion, such as gaseous and water mist systems, are unlikely to be suitable for implementation on a zoned basis.

1.11.7 For active protection systems that are deemed suitable for zoning, extinguishing media must be available in sufficient quantities to supply all zones operating

simultaneously to cater for escalation of the event outside the zone of origin and where fires occur at zone boundaries.

1.11.8 Where fires occur on a zone boundary the detection system will be expected to activate protection systems on all 'sides' of the event.

1.11.9 When zoning is employed, where possible stored munitions should be located in the centre of the zone as this represents the position where protection will be optimised and single zone management of the event is most likely to succeed. Ideally the deck will be marked to show zone boundaries and preferred storage locations (see 1.12).

1.12 Signage

1.12.1 Magazine spray system signs/notices. Spray system signs/notices are to be in accordance with the requirements of Def Stan 02-784/NES 784.

1.12.2 A mandatory sign should be sited adjacent to all alarms with the legend:

xx xx xx Magazine Inform OOW/OOD If Alarm Activates
--

1.12.3 Each spray control/isolating valve and operating position for any manually operated system is to have a clearly visible sign adjacent to it which identifies the magazine being served, and its normal system line-up position.

1.12.4 Signs at manual spray control operating positions are also to include whether it is the 'local' or 'remote' operating position, e.g.

xx xx xx Magazine Spray System Control/Isolating Valve Local/Remote Operating Position
--

1.12.5 System isolating valves are to have a clearly visible sign adjacent to it that identifies the magazine being served and its normal state i.e. open or shut.

xx xx xx Magazine System Isolating Valve

1.12.6 Special area protection identification. Where protection systems have been designed to specifically protect particular munitions in part or in whole (such the warheads of Torpedoes, Depth Charges and Guided Weapons), the designated areas should be marked accordingly with details of the munitions and storage orientation (if applicable).

1.12.7 Zoning signage. In large magazines and DDAs where protection systems are zoned, the zone boundaries should be marked. Ideally, the preferred storage locations within zones should also be marked (zone centres) to optimise the potential benefits of zoning without jeopardising protection performance.

1.12.8 Adjacent compartment signage. Where adjacent compartments have been employed as part of the integrated methodology for the protection of an adjoining magazine appropriate signage shall be located within the compartment describing any limitations that may be placed on its use to preserve its protection role.

1.13 1st Aid Firefighting equipment for magazines and DDAs

1.13.1 Fire Extinguishers. To provide first aid extinguishers for early attack of fires of non explosive nature magazines are normally provided with 2 in No. 9 litre AFFF extinguishers placed one inside and one outside the magazine. For weather deck magazines the extinguishers are placed inside the magazine for protection against the elements. The precise number of extinguishers provided should take into consideration the size of the magazine and the potential risks involved. For example an additional 9 litre AFFF extinguisher should be provided when hydraulic handling machinery using flammable oil is fitted in a magazine, or when liquid fuel is contained in a missile. The purpose of the extinguishers is to provide at least one ready use first aid extinguisher inside to be available when the magazine is occupied; and an extinguisher outside to be available for the first person arriving on the scene to investigate an alarm. Provision of 2 extinguishers also harmonises with best practice in NATO. A DDA should have at least one extinguisher readily available.

1.13.2 Fire Hydrants and Hoses. In the event of a fire in a compartment adjacent to a magazine or DDA, the ships fire/emergency party will attempt to provide boundary cooling irrespective of whether the temperature within the magazine has risen sufficiently to initiate the spray system, or to threaten a munitions in a DDA. Services are therefore required to facilitate this 'manual' boundary cooling. As a minimum, a fire hose should be sited within or very adjacent to a magazine for this purpose, with larger magazines also provided with a hydrant off the Salt Water Main. Similarly DDAs should have a hose and hydrant available in the near vicinity. Where the DDA is not equipped with a spray system, the hose and hydrant should be within the DDA.

1.13.3 Fire Monitors. Weapon Parks should be provided with Fire Monitors to provide cooling to all the weapons in the park, or to assist in fighting fires. They may operate with water or AFFF, although the former is preferred for efficient cooling of weapons. Coverage should include adjacent areas where these may be cut off by fire. Where the weapon park or preparation areas are internal then a suitable manual or automatic spray system should be provided depending on the assessed risk. Consideration should also be given to providing fire monitors in other appropriate DDAs. Fire Monitors need to be capable of both local and remote operation in the event of a serious conflagration. Ideally they should be linked with a CCTV system covering the area for remote observation.

1.14 Fire fighting arrangements in silo magazines

1.14.1 Where vertical launch missiles are stowed in a silo magazine, a Rapid Reaction Spray System (RRSS) is to be fitted. In addition the following are also to be provided:

- a) A spray system capable of drenching the exterior of each missile container. Where warhead shielding/mitigation is provided between canisters care must be taken to ensure that all parts of the canisters are drenched fully.
- b) Where missile launch canisters are fitted with integral deluge nozzles, provision is to be made for a suitable connection to the ship's HPSW / fire main.

1.15 Fire fighting arrangements in DDAs (including vehicle decks and weapon parks)

1.15.1 The requirements for smoke and heat detectors in DDAs are detailed in Appendix 8.

1.15.2 In the compartments listed at Paragraph 9.4 and in other DDAs where smoke and heat detectors are employed, they are to activate audible and visible alarms, both locally and remotely in the Ships Control Centre (SCC)/HQ1 or other location appropriate to the ship's protection organisation. More detailed guidance is given below.

1.15.3 Where the smoke and heat detectors are linked to a control system that initiates the spray system, the control system should be located outside the DDA and provided with interlocks and remote testing facilities that permit routine testing and maintenance to be carried out without hindering the operation of the system. More detailed guidance is given below.

1.15.4 The number of smoke and heat detectors employed should be based on compartment size and the need to prevent delayed detection due to the distance between a fire source and a detector. See Def Stan 02-603 for further guidance on fire detection best practice.

1.15.5 A water spray system is to be fitted within the DDA compartment, connected to the ship's fire main, which delivers water in sufficient quantity and coverage to deal with all credible fire scenarios and prevent escalation of the event.

1.15.6 Where the DDA compartment is large; consideration should be given to configuring the system into zones such that a whole area is not "wetted" when the spray system is activated.

1.15.7 Guided weapon hoist trunks and weapon lifts, which may be used in wartime for stowage of missiles and weapon preparation areas, sited adjacent to magazines, should be fitted with the same type of spray system as the magazines.

1.15.8 Package Examination Rooms may be fitted with a manual spray system.

1.15.9 Vehicle decks and LPD/LSD(A) dock areas, where munitions may be stowed in vehicles as part of an Embarked Military Force, should be fitted with manually operated spray arrangements in accordance with Def Stan 07-204/NES 119 section 4.11.4

and taking into account the requirements and guidance in BR1754 (Regulations for POL Safety).

1.15.10 Vehicle Decks and LPD/LSD(A) dock area spraying systems should be capable of being sub-divided, so that different sections on each deck may be sprayed individually, and operate with either FW or SW mixed with Aqueous Film Forming Foam (AFFF).

1.15.11 Weapon Parks should to be provided with Fire Monitors capable of laying down a large quantity of water or AFFF on the complete park and surrounding area. Where the weapon park is covered, spraying arrangements may be a suitable alternative to monitors.

1.15.12 Fire Monitors or weapon park sprays should be capable of both local and remote operation.

1.15.13 Upperdeck launchers and launch canisters, normally loaded with torpedoes or guided weapons, are to be provided with permanently fitted manually operated spray systems. The nozzles should be sited such that when activated they fully drench the launchers, containers or barrels.

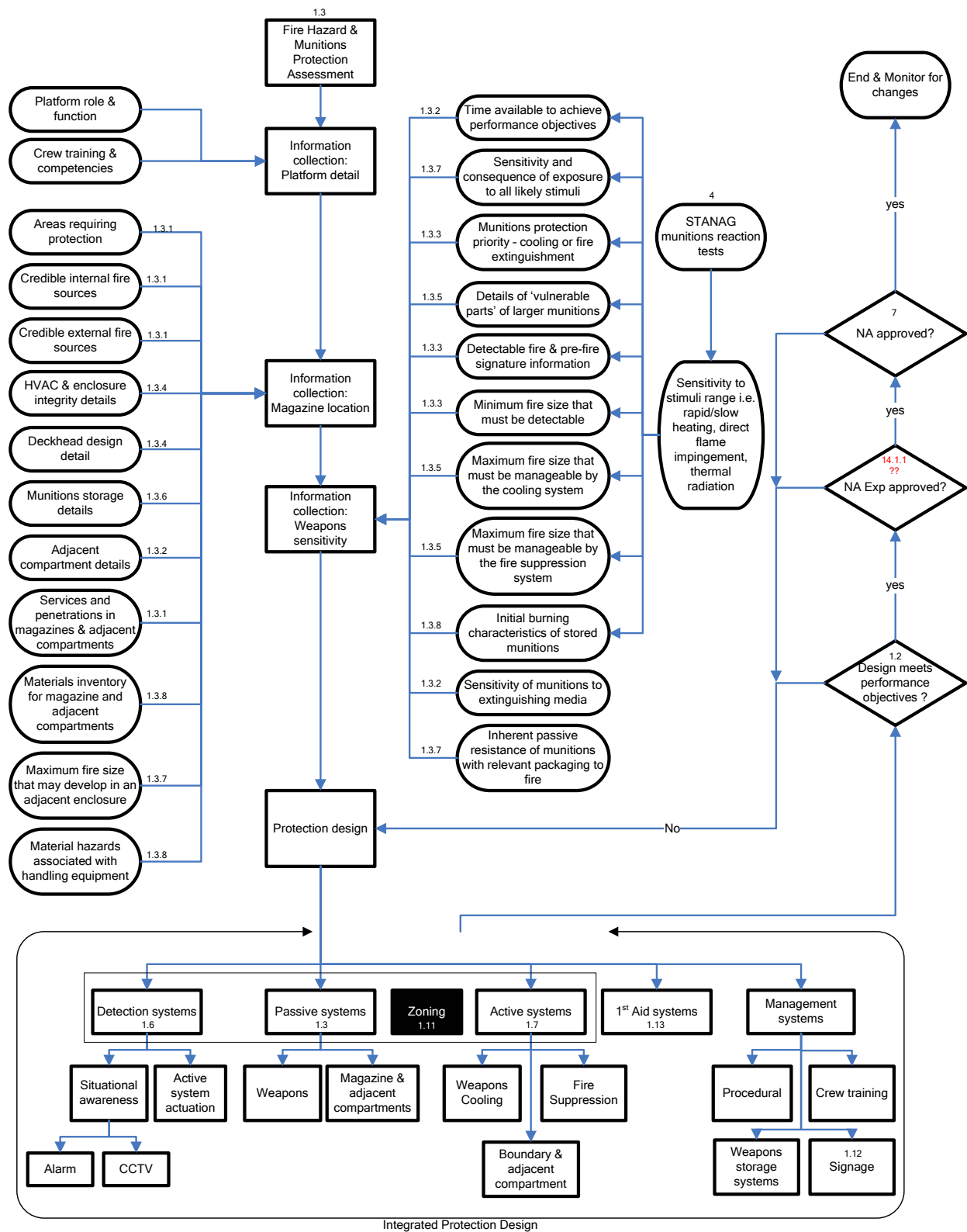
1.15.14 Unless otherwise stated in this standard, areas where temporary stowage of munitions is likely to occur should to be provided with either a hose connection or be fitted with a manual spray system.

1.16 Fire fighting arrangements in Naval Armament Lighters

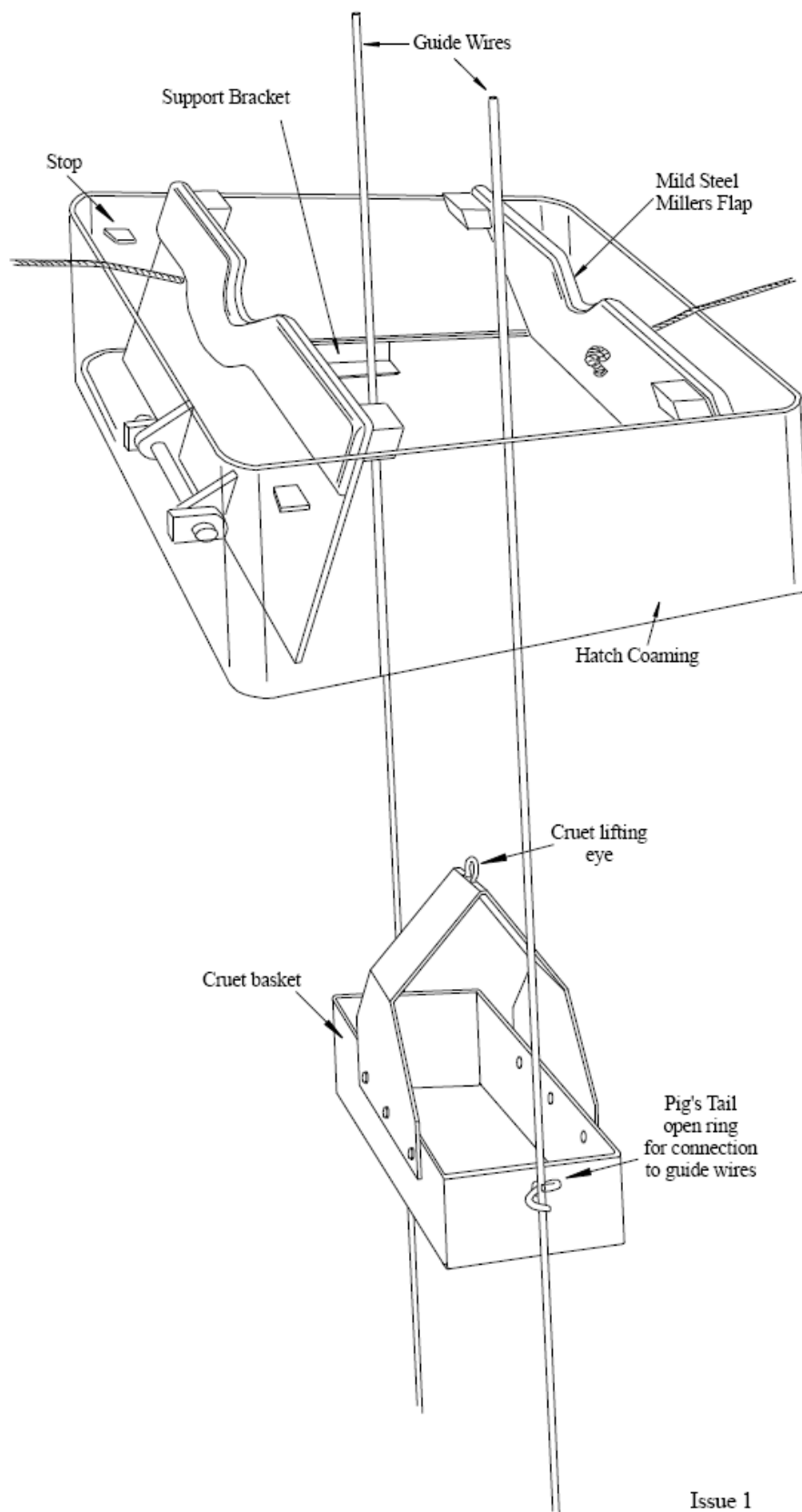
1.16.1 Appropriate measures are to be taken to allow the rapid spraying or flooding of the hold of a Naval Armament Lighter (NAL) in the event of fire.

1.16.2 Use of fire detection (heat and/or smoke) within the hold with audio/visual upper deck and towing vessel linked alarms is encouraged. This could be considered best practise in support of any ALARP risk based argument despite limited time at risk. A significant proportion of each NAL movement is with the hold and NAL itself unmanned, and so early warning of any event, however minor, could be critical. 1.16.3 If the NAL is not fitted with a pressurised fire main, a dry spray grid should be fitted to allow water from an outside source to be used, i.e. when being towed and alongside a warship/RFA. The system should be capable of connection to the source of supply by hoses via instantaneous couplings on deck. The locations of these should be clearly marked and visible from associated vessels. Any isolating valves fitted should be clearly labelled and normally locked open. Sufficient spray heads should be fitted within the hold at the correct height and with the correct spacing to provide spray coverage to all stowed munitions in accordance with the manufacturer's nozzle data.

1.16.4 Sufficient portable 9 litre AFFF extinguishers (with spare charges and a charge holder) should also to be provided in convenient positions at both ends of the vessel.

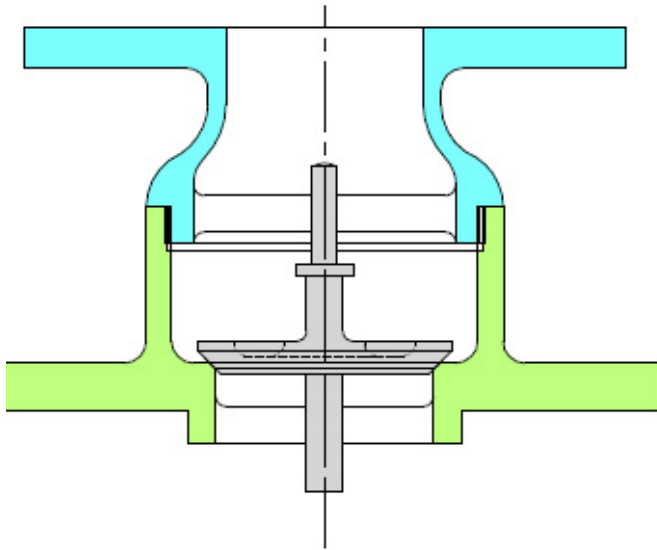


ANNEX J MILLERS FLAP



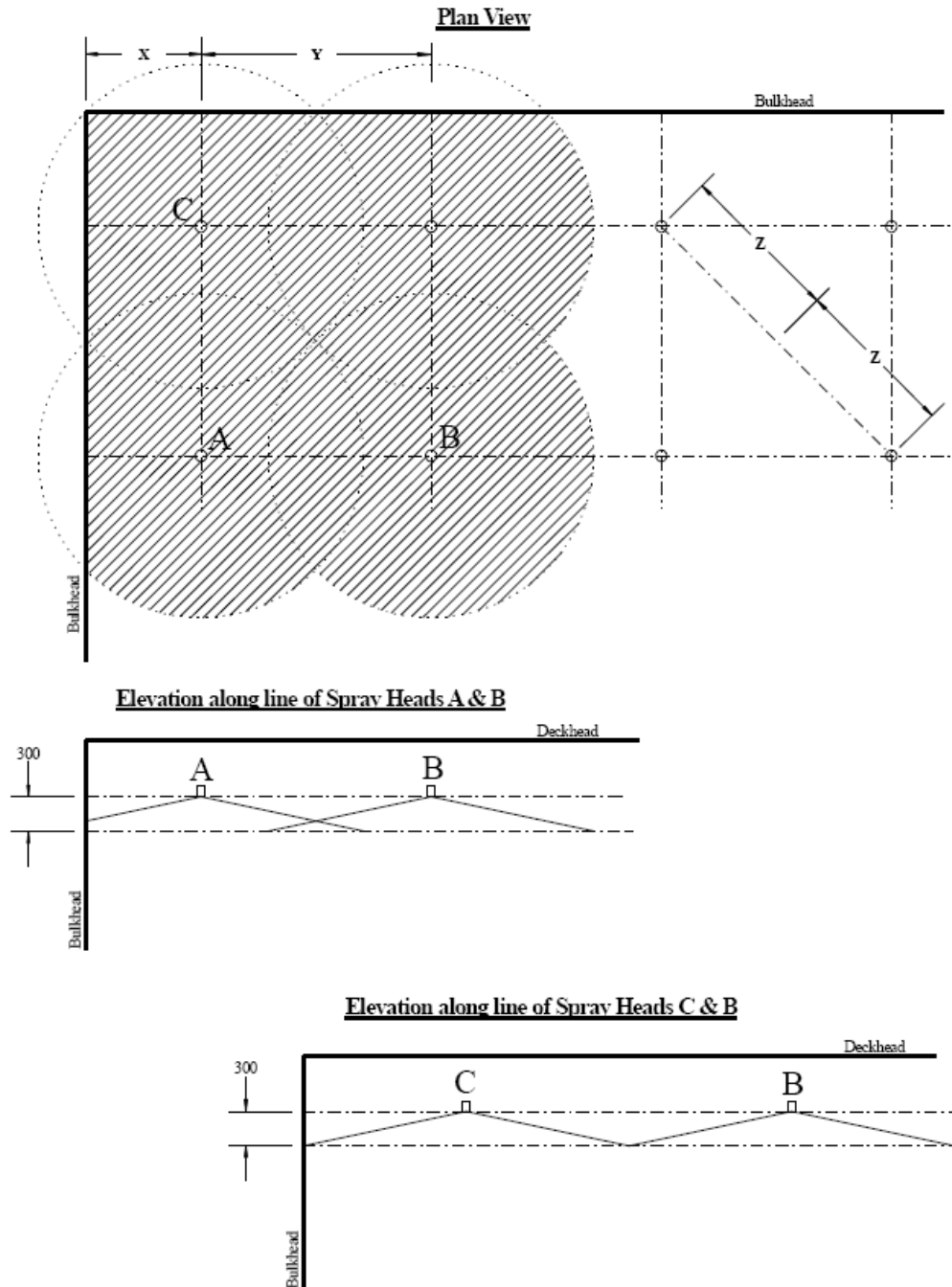
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ANNEX K AUTOMATIC AIR ESCAPE. More details can be found in (NAN) EXP/03



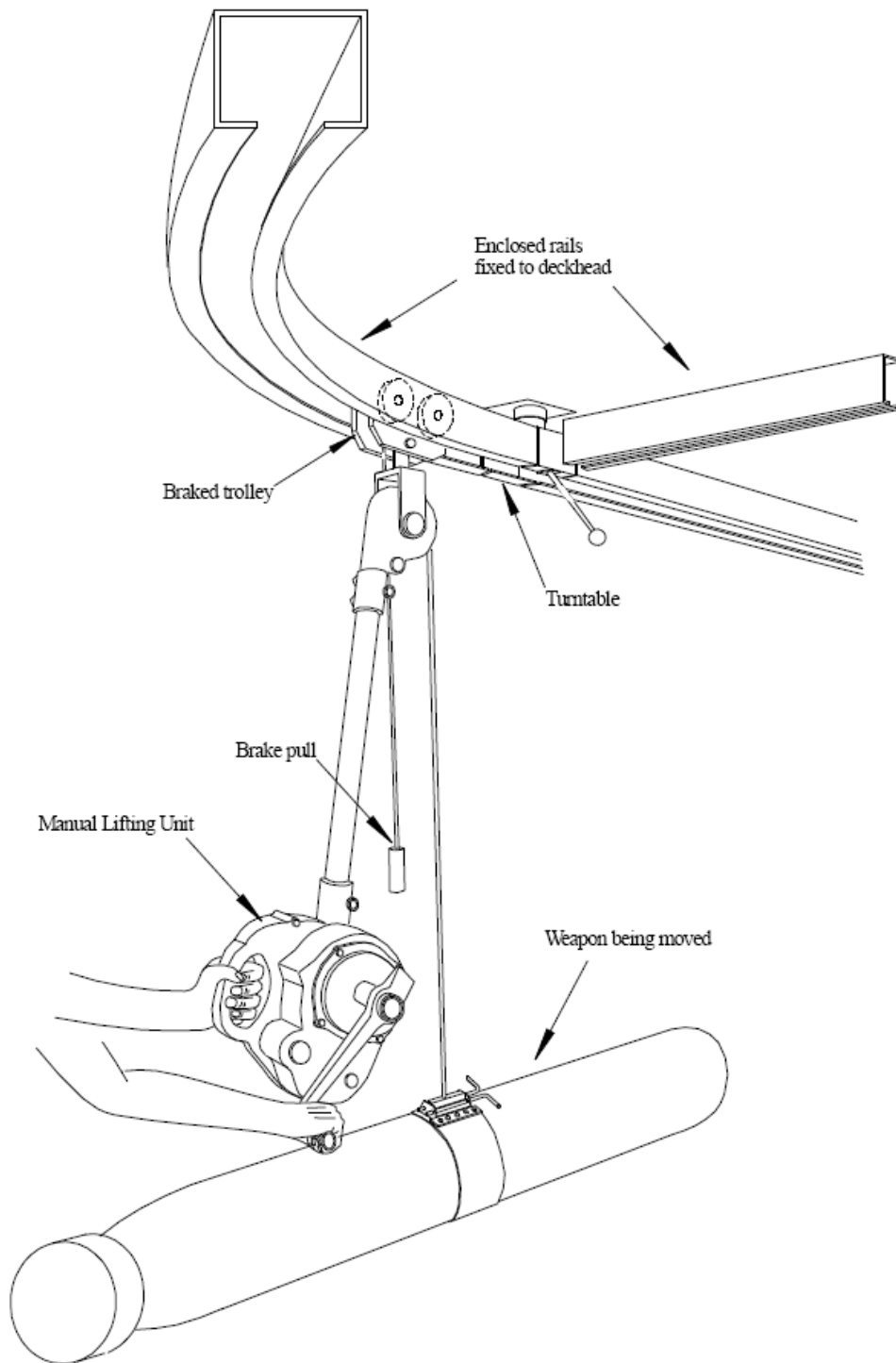
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ANNEX L Typical Sprayhead layout showing coverage 300mm below the Spray Nozzle.



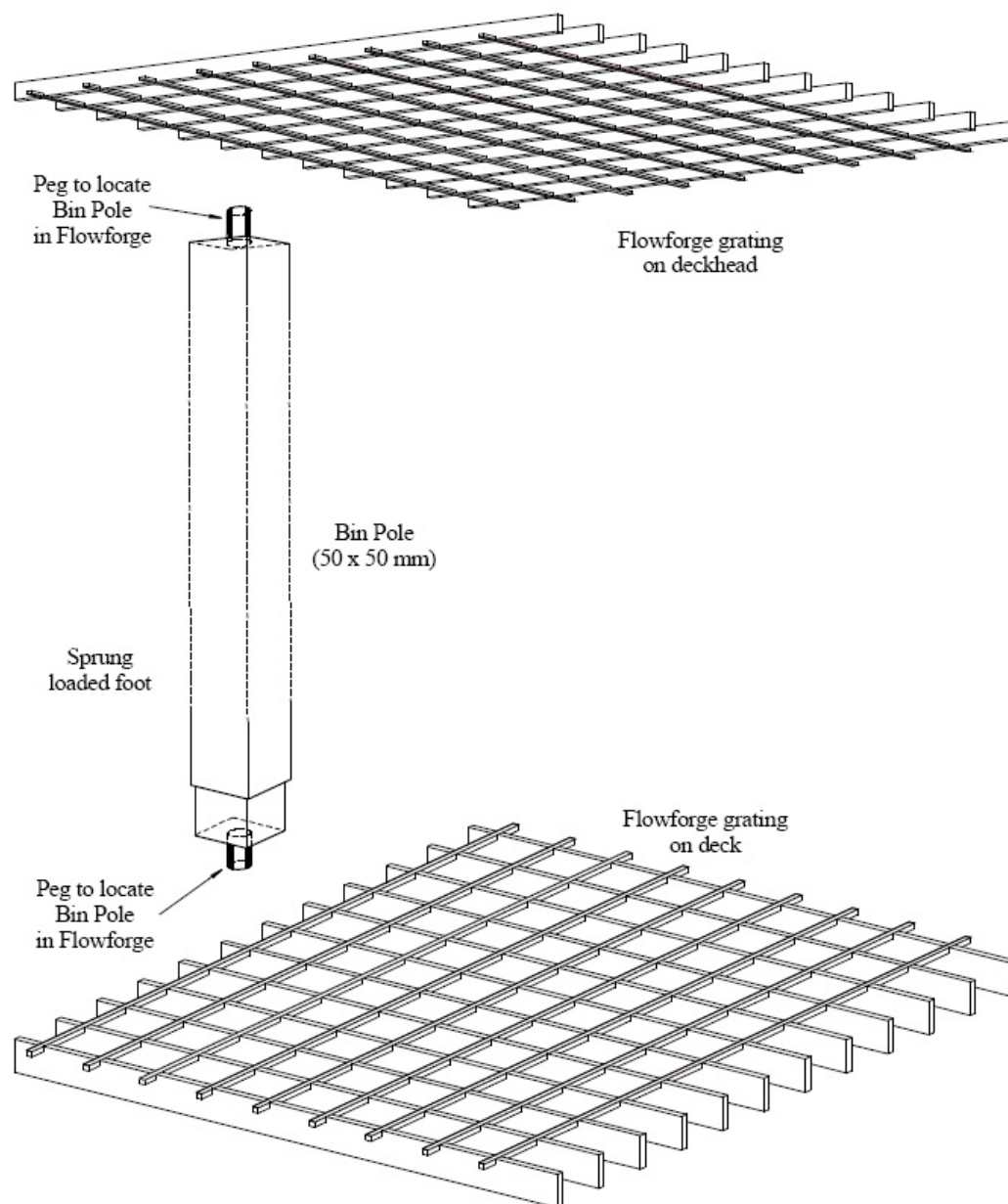
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ANNEX M DISBURY HOIST



Issue 1

ANNEX N FLOWFORGE



Issue 1

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DStan Helpdesk

Tel 0141 224 2531/2
Fax 0141 224 2503
Internet e-mail enquiries@dstan.mod.uk

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