INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.10

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Guide to the International Ammunition Technical Guidelines (IATG)

UN SaferGuard
Securing ammunition, protecting lives

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Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module details the general, and, in some cases, recommended mandatory requirements, for the design of buildings that are to contain explosives for either storage or processing. Most potential explosion sites (PES) are a *de facto* potential hazard to personnel, other explosives facilities, and other buildings that are in the vicinity. Correct building design, construction and siting is essential in order to make effective use of the quantity distances (QDs) calculated.[4]

This IATG module will describe the potential consequences of explosive events that may occur and the subsequent effects on the building containing the explosives and other nearby buildings. It will also describe how correct building design will mitigate these effects and it provides descriptions and schematics of some typical ammunition storage buildings.

Guide to the International Ammunition Technical Guidelines

1 Scope

This IATG module defines the role of the IATG, their structure, and establishes the guiding principles for their proper use, if appropriate, by national authorities, international organisations and organisations involved with the planning and implementation of conventional ammunition stockpile management processes.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

The IATG mainly follow[3] the ISO layout and process and can be defined as: *'a documented agreement containing technical specifications or other criteria to be used consistently as guidelines, or definitions of characteristics to ensure that conventional ammunition stockpile management processes are safe, effective efficient and fit for their purpose'.*

For the purposes of this module the terms and definitions given in IATG 01.40*Glossary of terms, definitions and abbreviations* shall apply.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

[3] The main variation from the ISO required contents is that terms, definitions and abbreviations are not included in the Annexes of each individual IATG module as this would make them unwieldy and unnecessarily repetitive for field use. All terms, definitions and abbreviations are contained in IATG 01.40 Glossary of terms, definitions and abbreviations.

4 Conventional ammunition stockpile management

The term 'stockpile management' refers to those procedures and activities regarding the safe and secure accounting, storage, transportation, handling, and disposal of conventional ammunition. The objectives of conventional ammunition stockpile management are to reduce and mitigate the risk to personnel and communities from unplanned explosive events and the risk of diversion to illicit markets as well as to ensure optimum usage of scarce resources.

Conventional ammunition stockpile management comprises six complementary groups of activities:

a) ammunition storage.

b) ammunition processing,[4] maintenance and repair.

c) ammunition accounting.

d) ammunition demilitarization or destruction.

e) security of ammunition stockpiles, and

f) transport of ammunition.

A number of other enabling activities are required to support these six components of stockpile management, including: risk assessment and planning, allocation of resources, information management, human skills development and management training, quality management, and the selection and use of effective, appropriate, and safe equipment.

5 Purpose of ammunition technical guidelines

The IATG are designed to assist States to establish national standards and national standing operating procedures (SOPs) by establishing a frame of reference, which can be used, or adapted for use, as a national standard.

In certain situations, and at certain times, it may be necessary and appropriate for the UN, or some other recognised international body,[5] to assume some or all of the responsibilities, and fulfil some or all of the functions, of a national authority. In such cases, the UN will work towards the IATG as the de-facto national standard.

The IATG are not themselves SOPs. They do not define the detailed way in which conventional stockpile management requirements are to be achieved by States, which should be covered in national and local SOPs, rules, instructions, and codes of practice.

The IATG have been developed to improve safety, security, and efficiency and efficacy in conventional ammunition stockpile management by providing guidance, by establishing principles and, in some cases, by referring to other related international requirements and specifications.[6] They provide a frame of reference, which encourages national authorities responsible for conventional ammunition stockpile management to achieve and demonstrate effective levels of safety and security. They provide a common language, are based on sound, and accepted, explosive science, recommend an integrated risk and quality management system, and allow for a progressive, integrated improvement in safety and security in line with available resources.

The IATG have been developed to assist national authorities in the development of national conventional ammunition stockpile management processes and procedures. They have no legal

[4] Including Inspection, Surveillance and Proof.

[5] During, for example, peace operations in areas of conflict where there is no effective governance.

[6] In this case, international requirements and specifications refer to those treaties, international laws and conventions, international agreements, international ISO standards etc. that have already been agreed to by participating nations.

standing except where they have been adopted by a national authority as national standards, or where one or more IATG modules are specified in a contract or some other legal instrument, (such as a Memorandum of Understanding or a Letter of Agreement).

6 Guiding principles

The preparation and application of the IATG are shaped by four guiding principles:

a) the right of national governments to apply national standards to their national stockpiles.

b) the need to protect those most at risk from undesirable explosive events, (e.g. local civilian communities and explosives workers).

c) the requirement to build a national capacity to develop, maintain and apply appropriate standards for stockpile management, and

d) the need to maintain consistency and compliance with other international norms, conventions, and agreements.

6.1 National responsibilities and obligations

The primary responsibility for conventional ammunition stockpile management shall rest with the Government of the State holding the ammunition. This responsibility should normally be vested in an authority, which is charged with the regulation, management, and coordination of conventional ammunition stockpile management. The national authority shall be responsible for establishing the national and local conditions that enable the effective management of conventional ammunition. It is ultimately responsible for all phases and all facets of the stockpile management processes within its national boundaries, including the development of national standards, SOPs, and instructions.

Troop/Police Contributing Countries (T/PCCs) should develop SOPs, alongside their national stockpile management regulations ,for the sound management of the ammunition stockpiles available within their national contingents deployed around the globe. These SOPs necessitate inclusion of, within the national SOPs, the UN safety requirements, and local conditions of the host countries.

6.2 Explosives safety

An accumulation of conventional ammunition presents inherent hazards to local communities in the form of a risk of explosive events in the ammunition storage areas. Ammunition storage area explosions are widespread and increasingly common; more than 623 incidents have been recorded in at least 106 countries and territories between 1979 and December 2019.[7] Often these events result in a large number of casualties, widespread destruction of infrastructure, and the disruption of the livelihood of entire communities.[8]

In order to address these risks in an efficient and effective manner, the IATG contain an integrated risk management process designed to progressively reduce and mitigate risk as more resources become available.

[7] Small Arms Survey Unexpected Explosions at Munition Sites (UEMS) database. www.smallarmssurvey.org/weapons-and-markets/stockpiles/unplanned-explosions-at-munitions-sites.html

[8] An average of more than 737 casualties per year have been recorded during 1979-2019. Source Ibid.

6.3 Capacity-building

In countries with limited national capacity to effectively, efficiently, and safely, manage conventional ammunition stockpiles, the development of national capacity is key to long-term stockpile safety and security. Capacity development is the process by which individuals, institutions, and societies (individually and collectively) perform functions, solve problems, and set and achieve objectives.[9]

At the national level capacity is characterised by a State's ability and willingness to develop and articulate stockpile management policy and practice. It is also about a State's ability to plan, coordinate, manage and sustain a safe, secure, effective, and efficient conventional ammunition stockpile management programme. This includes the technical capability to develop, maintain and apply appropriate national standards for conventional ammunition stockpile management.

Developing States, that may have limited financial and technical resources, may not be able to initially achieve a minimum standard of safe, efficient and effective ammunition stockpile management. [10] The UN may take initiatives to mobilise resources to support such States.

6.4 Other international guidelines, regulations and guides

The IATG are written to be consistent with other international guidelines, and to comply with international regulations, conventions, and treaties. Precedent and norms for workplace and site safety, as well as environmental protection, already exist at the international level. The main 'top level' ones are:

a) Relevant International Labour Organization (ILO) instruments for safety in the workplace.

b) the International Organization for Standardization (ISO) providing guidance on risk management (ISO Guide 51).

c) the application of quality management systems (ISO 9001:2015 series), and

d) environmental management systems (ISO 14001:2015).

Other international protocols and norms describe procedures for the classification and transport of conventional ammunition; these also have application to conventional ammunition stockpile management and are referred to as normative references in the appropriate IATG module.

The IATG have been developed from a wide range of source material by other international organisations, regional organisations, national governments, and individuals. This material has been key to the development of the IATG and acknowledgement for direct use has been attributed within the IATG. Other information has been used as the basis for content within the IATG. A bibliography of the most used sources is at Annex C, and these organisations are thanked for their contributions through the public availability of their documentation.

[9] UNDP Definition at www.undp.org/content/dam/aplaws/publication/en/publications/capacity-development/capacity-development-a-undp primer/CDG_PrimerReport_final_web.pdf.

[10] Level 1. See IATG 01.20 *Index of risk reduction process levels.*

6.5 Risk reduction process levels (RRPL)

Within the IATG modules the different tasks and activities necessary for safe, efficient, and effective stockpile management are considered to equate to one of three Risk Reduction Process Levels (RRPL) (IATG 01.20 *Index of risk reduction process levels*). These are indicated within each IATG module as either **LEVEL 1**, **LEVEL 2** or **LEVEL 3** dependent on risk reduction or mitigation achieved by each task or activity. The basic aim of a conventional ammunition stockpile management organisation should be to make sure that stockpile management processes are maintained at RRPL 1 as a minimum, which will reduce or mitigate risk significantly. Ongoing and gradual improvements should then be made to the stockpile management infrastructure and processes as staff development improves and further resources become available.

7 Framework of IATG

The IATG are divided into generic areas of conventional ammunition stockpile management, which are then further divided into individual modules that address specific activities within that area:

Series	Generic area
01	Introduction and Principles of Ammunition Management
02	Risk Management
03	Ammunition Accounting
04	Explosives Facilities (Storage) (Temporary Conditions)
05	Explosives Facilities (Storage) (Infrastructure and Equipment)
06	Explosives Facilities (Storage) (Operations)
07	Ammunition Surveillance
08	Transport of Ammunition
09	Security of Ammunition
10	Ammunition Demilitarization and Destruction
11	Ammunition Accidents, Reporting and Investigation
12	Small Unit Ammunition Storage

Table 1: Generic areas of IATG

The detailed framework of the IATG is shown at Annex D.

Individual IATG modules will, where appropriate, be divided into levels of ascending comprehensiveness. The first level will include guidelines that present the most expedient ways to apply the basic principles of safe and secure ammunition management. Subsequent levels will detail progressive measures that should be taken to improve stockpile management in the area in question and thereby progressively reduce or mitigate the risk.

Each level will feature, where appropriate, statistics that indicate the degree of risk reduction or mitigation likely to be achieved by following the IATG. Technical drawings and diagrams will be used to support the IATG, where applicable. A qualitative or quantitative risk assessment (QRA) methodology is integrated into the IATG, wherever possible, to estimate the level of risk reduction and/or mitigation that might be achieved through adherence to the IATG.

8 International Organization for Standardization

ISO is an independent, non-governmental international organisation with a membership of over 160 national standards bodies. Its work results in voluntary standards and guides which have been adopted by many countries as part of their regulatory framework. ISO deals with the full spectrum of human activities and some of the tasks and processes that contribute to the stockpile management of conventional ammunition have a relevant standard. A list of ISO standards and guides is given in the ISO catalogue at www.iso.org/standards-catalogue/browse-by-ics.html.

ISO has an international reputation for integrity and neutrality, and it enjoys a special working relationship with international organisations including the United Nations, and with regional organisations including the European Union. The IATG have been developed to be compatible with ISO standards and guides. Adopting the ISO format and language provides some significant advantages including consistency of layout, use of internationally recognised terminology, and a greater acceptance by international, national and regional organisations which are accustomed to the ISO series of standards and guides.

The adoption of the ISO format and language also brings the IATG in line with other complementary standards and guidance, including:

a) International Disarmament, Demobilisation and Reintegration Standards (IDDRS), (www.unddr.org/iddrs).

b) International Mine Action Standards (IMAS), (www.mineactionstandards.org), and

c) Modular Small-arms-control Implementation Compendium (MOSAIC) (www.un.org/disarmament/mosaic).

9 Quality and risk management

The IATG have been developed in line with the recommendations and processes contained within the ISO quality management systems (ISO 9001:2008[11]) and the ISO risk management system (ISO Guide 51[12]). Elements of these systems are contained within the majority of the IATG modules, thereby making the IATG themselves an integrated risk and quality management system. There is still a requirement, however, for national authorities to develop their own specific individual risk and quality management systems for the stockpile management of conventional ammunition.

A guide to the use of risk management in the IATG is contained at IATG 02.10 *Introduction to risk management principles*.

10 Legal requirements

The IATG have no legal standing except where they have been adopted by a national authority as national standards, or where one or more of the IATG modules is specified in a contract or some other legal instrument, (such as a Memorandum of Understanding or a Letter of Agreement). The wording of each contract or agreement should clarify the application of the IATG to each proposed project, and should reflect the national and local circumstances; i.e. the local situation, the authority of government, political will, and the resources available.

[11] ISO 9001:2015(E) *Quality management systems – requirements*. ISO. 2015.

[12] ISO Guide 51:2014 *Safety aspects – Guidelines for their inclusion in standards*. ISO. 2014.

11 Continual review of IATG

The IATG are subject to a formal review on a five-yearly basis. This is to ensure that the IATG are still relevant, accurate, achievable, and appropriate. This does not preclude essential amendments being made within that period for reasons of operational safety or efficiency.

Annex A
(normative)
References

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) ISO Guide 51 *Safety aspects – Guidelines for their inclusion in standards*. ISO. 2014;

c) ISO 9001 *Quality management systems – Requirements.* ISO. 2015;[13] and

d) ISO 14001 *Environmental management systems – Guidelines*. ISO. 2015.[14]

[15] Also known as the *OSPAR Convention*.

[15] Also known as the *OSPAR Convention*.

Annex B
(informative)
Source bibliography

The following informative documents contain primary and secondary source material that was used in the development of the IATG:

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- AAP-06 (Edition 2019), *NATO Glossary of Terms and Definitions*. NATO Standardization Office (NSO) ;

- AOP-38 *Glossary of Terms and Definitions concerning the Safety and Suitability for Service of Munitions, Explosives and Related Products*. (5th Edition). NATO Standardization Office (NSO). June 2009;

- AOP-48 (Edition 2). *Explosives - Nitrocellulose Based Propellants, Stability Test Procedures and Requirements Using Stabilizer Depletion*; NATO Standardization Office (NSO). October 2008;

- AOP-62 (Edition A, Version 1). *In-Service Surveillance of Munitions General Guidance*. NATO Standardization Office (NSO). February 2017.

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- AASTP-3, Edition 1, Change 3, *Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives*. NATO Standardization Office (NSO). August 2009;

- AASTP-4, Edition 1, Change 4, *Explosives Safety Risk Analysis*. NATO Standardization Office (NSO). September 2016. (Note: Part 2 has restricted distribution);

- AASTP-5, Edition 1, Version 3, *NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations*. NATO Standardization Office (NSO). June 2016;

- *The Arms Trade Treaty*, 2013.

- *Assessing people against the Explosive Substances and Articles National Occupational Standards.* Denise Clarke, HSQ Ltd, in SAFEX Newsletter 50, 3rd Quarter, 2014;

- *Best Practice Guidelines for the Implementation of the Nairobi Declaration and the Nairobi Protocol on Small Arms and Light Weapons*. RECSA. Approved 20 – 21 June 2005;

- BS 1722-10:2006, *Fences. Specification for anti-intruder fences in chain link and welded mesh*. BSI. UK. November 2006;

- BS 4449:2005 + Amendment 2 2009 *Specification for carbon steel bars for the reinforcement of concrete.* BSI. UK;

- *Central African Convention for the Control of Small Arms and Light Weapons, their Ammunition, and all Parts and Components that can be used for their Manufacture, Repair and Assembly* (Kinshasa Convention). 2017;

- Test and Evaluation Protocol 09.30, Explosive Ordnance Disposal (EOD) Competency Standards, October 2014

- *Conflict Specific Capital: The Role of Weapons Acquisition in Civil War*' Nicholas Marsh, International Studies Perspectives, Vol.8, 2007;

- *Convention for International Carriage by Rail (COTIF)*. 09 May 1980. Modified by the Vilnius Protocol of 03 June 1999;

- *Convention for the Protection of the Marine Environment of the North-East Atlantic*, 1998;[15]

- *Convention on International Civil Aviation, Annex 18. The Safe Transport of Dangerous Goods by Air*. (Fourth Edition). ICAO. 17 November 2011;

- *Convention on Small Arms,Light Weapons, Their Ammunition and Other Related Materials*. ECOWAS. 2006;

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[15] Also known as the *OSPAR Convention*.

- *Handbook of Best Practices on Conventional Ammunition*. Decision 6/08. OSCE. 2008;
- *IATA Dangerous Goods Regulations (DGR)* (61st Edition). 2019;
- *ICAO Technical Instructions for the Safe Movement of Dangerous Goods by Air*. (Doc 9284);
- *Inter-American Convention Against the Illicit Manufacturing of and Trafficking in Firearms, Ammunition, Explosives and Other Related Materials* (CIFTA). OAS. 1997;
- *International Convention for the Safety of Life at Sea, (SOLAS)*, Chapter VII – Carriage of Dangerous Goods. IMO. 1974;
- *International Maritime Dangerous Goods (IMDG) Code*. (Amendment 37-14). IMO. 2014;
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- ISO 2859 Series[E] *Sampling procedures for inspection by attributes.* ISO*;*
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- ISO 8422:2006[E] *Sequential sampling plans for inspection by attributes*. ISO. 2006*;*
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- National Occupational Standards for Explosives. UK Commission for Employment and Skills (UK CES)[16];

- *OSCE Document on Stockpiles of Conventional Ammunition*. OSCE. 2003;

- *Protocol against the Illicit Manufacturing and Trafficking in Firearms, Their Parts and Components and Ammunition, supplementing the United Nations Convention against Transnational Organized Crime* (Firearms Protocol). 2005;

- *Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All its Aspects.* 2001*;*

[16] Enter the search term 'Explosives' in this website nos.ukces.org.uk/Pages/Search.aspx to obtain all relevant NOS on the explosives sector. The full list is at Annex K.

- *Protocol on Explosives Remnants of War to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which may be deemed to be Excessively Injurious or to have Indiscriminate Effects,* 2003*;*

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- UN General Assembly. A/62/166. *Report of Secretary-General: Problems arising from the accumulation of conventional ammunition stockpiles in surplus*. 2007;

- UN General Assembly. A/61/118. *Report of Secretary-General: Problems arising from the accumulation of conventional ammunition stockpiles in surplus*. 2006;

- *United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. ST/SG/AC.10/30/Rev.6. Geneva. United Nations. 2015;

- *United Nations Manual of Tests and Criteria,* (6th revised edition), ST/SG/AC.10/11/Rev.6, New York and Geneva, United Nations, 2015;

- *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Twenty-first revised edition), ST/SG/AC.10/1/Rev.21, New York and Geneva, United Nations, 2019;

- UFC-3-340-02, *Structures to Resist the Effects of Accidental Explosions*. US Department of Defense. 05 December 2008; Change 2, 1 September 2014;

- UFC 04-020-01*, DoD Security Engineering Facilities Planning Manual, Chapter 3*. US Department of Defense. June 2002 (FOUO – restricted distribution);

- DoD 5100.76-M*, Physical Security of Sensitive Conventional Arms, Ammunition and Explosives.* US Department of Defense. 17 April 2012. http://dtic.mil/whs/directives/corres/pdf/510076m.pdf;

- DoD 6055.09-M Volumes 1- 8, *Ammunition and Explosives Safety Standards*. (Incorporating Change 1 (12 March 2012)). US Department of Defense. 29 February 2008;

- *Usage Manual for Missile and Artillery Armaments, Part 1, Use of Missile and Artillery Armaments by Troops*,[17] *Chapter 4.* USSR[18] MOD. 1989;

- *Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies.* 1996*;*

- *Wassenaar Arrangement on Exports Controls for Conventional Arms and Dual-Use Goods and Technologies Best Practices for Effective Enforcement of Export Controls*. 2000; and

- *Wassenaar Agreement End-User Assurances Commonly Used Consolidated Indicative List*. 2005 (updated).

[17] Appendix 1 to Order of the Chief Commander of the Ground Forces No 5 1988.

[18] Now Russian Federation.

Annex C
(normative)
Framework of the IATG

The IATG are divided into thematic volumes using the ISO layout system. Each volume will address a broad area of stockpile management activity, which will be further divided into modules that address specific activities within that field.

Volume		Module		Contents
#	Area	#	Title	
01	Introduction and Principles of Ammunition Management	01.10	Guide to the International Ammunition Technical Guidelines (IATG)	▪ Purpose ▪ Guiding Principles ▪ Framework ▪ Legal Status
		01.20	Index of Risk Reduction Process Levels within IATG	▪ Risk reduction process levels in one document
		01.30	Policy Development and Advice	▪ Strategic Requirements ▪ Functional Areas of Stockpile Management ▪ Identification of Surplus Stocks
		01.35	Organisational capabilities	Functional Roles Capability enabling lines
		01.40	Glossary of Terms, Definitions and Abbreviations	
		01.50	UN Explosive Hazard Classification System and Codes	▪ Hazard Divisions (HD) ▪ Compatibility Groups (CG) ▪ Hazard Classification Codes (HCC) ▪ Mixing of Compatibility Groups ▪ Types of Tests for UN Hazard Classification
		01.60	Ammunition Faults and Performance Failures	▪ Purpose and rationale ▪ Benefits ▪ Faults ▪ Performance Failures – Immediate Actions ▪ Performance Failures – Investigator’s Actions

Volume		Module		Contents
#	Area	#	Title	
		01.70	Bans and Constraints	▪ Purpose ▪ Definitions ▪ Responsibilities
		01.80	Formulae for Ammunition Management	▪ Gurney Equations ▪ Kingary and Bulmash ▪ Hopkinson/Crans Scaling Law ▪ QD Formulae
		01.90	Ammunition Management Personnel Competences	▪ Competency requirements
02	Risk Management	02.10	Introduction to Risk Management Principles and Processes	▪ Components of risk management ▪ The risk management process
		02.20	Quantity and Separation Distances	▪ Introduction to QD System ▪ Hazards to Personnel ▪ QD for Above Ground Storage ▪ QD for Underground Storage ▪ QD for Transit Areas ▪ QD for Ports ▪ QD to Hazardous (non-explosive) Facilities ▪ Authorised Quantities of Explosives (Non-ASA Storage)
		02.30	Licensing of Explosive Facilities	▪ Licensing Systems
		02.40	Safeguarding of Explosive Facilities	▪ Safeguarding Systems ▪ Mapping ▪ Directional Weapon Maps ▪ Maintenance of Safeguarded Areas
		02.50	Fire Safety	▪ General Responsibilities ▪ Planning ▪ Fire Alarm Systems ▪ Fire Breaks and Vegetation ▪ Water Supplies ▪ Fire Fighting Equipment ▪ Evacuation Distances ▪ Principles of Fire Fighting

Volume		Module		Contents
#	Area	#	Title	
03	Ammunition Accounting	03.10	Inventory Management	▪ Lotting and Batching ▪ Accounting Requirements ▪ Accounting Systems
		03.20	Lotting and Batching	▪ Lotting and Batching Requirements ▪ Batch Key Identities
05	Explosives Facilities (Storage) (Infrastructure and Equipment)	05.10	Planning and Siting of Explosives Facilities	▪ General Considerations ▪ Systems Approach ▪ Siting Boards ▪ Siting Board Requirements ▪ Siting Considerations
		05.20	Types of Buildings for Explosives Facilities	▪ Introduction ▪ Consequences of an Explosives Accident ▪ Protection against Propagation ▪ Building Damage Levels ▪ Types of Buildings ▪ Design Fundamentals
		05.30	Barricades	▪ Functions ▪ Types of Barricade ▪ Position of a Barricade ▪ Geometry of a Barricade ▪ Barricade Materials
		05.40	Safety Standards for Electrical Installations	▪ Categorisation Systems ▪ Electrical Supply and Safety ▪ Electrostatic Safety ▪ Lightning Protection
		05.50	Vehicles and Mechanical Handling Equipment (MHE) in Explosives Facilities	▪ Authority to Enter the ESA ▪ Category and Zoning of PES ▪ Compatibility of Vehicles/MHE and Working Environment ▪ Design Specifications and Construction Requirements of Vehicles/MHE ▪ Operating Limitations

Volume		Module		Contents
#	Area	#	Title	
		05.60	Radio Frequency Hazards	▪ Introduction and Principles ▪ Exposure Levels ▪ Susceptibility Factors ▪ Separation Distances ▪ Safe Distances
06	Explosive Facilities (Storage) (Operations)	06.10	Control of Explosive Facilities	▪ Introduction ▪ Operational Procedures ▪ Controlled Articles and Contraband ▪ Estate Management ▪ Over-flight Restrictions ▪ Isolation and Segregation of Stocks ▪ Maintenance of Operational Capability ▪ Chemical Stability and Temperature Limitations ▪ Protection from Moisture and Ventilation
		06.20	Storage Space Requirements	▪ Calculation of Storage Space and Requirements
		06.30	Storage and Handling	▪ General Handling Advice ▪ Stacking of Ammunition ▪ Use of Racking ▪ Stack Tally Cards ▪ Use of Lifting Gear and Slings ▪ Storage Temperatures
		06.40	Explosives Packaging and Marking	▪ International Marking of Packaging Requirements ▪ Palletisation ▪ Sealing of Packaging
		06.50	Specific Safety Precautions	▪ Breakdown Operations ▪ Certification of Free From Explosive (FFE) ▪ Dangerous Chemicals and Phosphorous Ammunition ▪ Permits to Work ▪ Changing Environmental Conditions ▪ Health Hazards ▪ Surveillance of Nitrate Esters

Volume		Module		Contents
#	Area	#	Title	
		06.60	Works Services (Construction and Repair)	▪ Introduction ▪ Permits to Work ▪ Impact on Explosives Limit Licences (ELL) ▪ Explosives Safety Brief ▪ Control of Equipment
		06.70	Inspection of Explosives Facilities	▪ Purpose ▪ Types of Inspection ▪ Scope of Inspections ▪ Inspection Criteria
07	Ammunition Surveillance	07.10	Surveillance and in-service proof	▪ Purpose ▪ Definitions ▪ In-Service Proof ▪ Chemical Stability ▪ In-Service Stability Surveillance Systems
		07.20	Inspection of Ammunition	▪ Purpose ▪ Types of Inspection ▪ Inspection Criteria
		07.30	Ammunition processing operations - Safety and, risk reduction and mitigation	▪ Introduction ▪ Man Limits ▪ Safe Systems of Work ▪ PPE ▪ Control of Equipment ▪ Cleanliness of Process Building ▪ Supervision and Competency

Volume		Module		Contents
#	Area	#	Title	
08	Transport of Ammunition	08.10	Transport of Ammunition	▪ Refer to United Nations Recommendations on the Transport of Dangerous Goods Model Regulations (Fifteenth revised edition). ▪ Refer to European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). ▪ Refer to International Ordinance on the Transport of Dangerous Goods by Rail (RID), (Appendix I to the International Agreement on Rail Freight Transport). ▪ Refer to IATA Dangerous Goods Regulations (DGR) (51st Edition). ▪ Refer to Convention on International Civil Aviation, Annex 18, The Safe Transport of Dangerous Goods by Air. (Ninth Edition). (Doc 7300/9). IACO. 2006. ▪ Refer to IACO Technical Instructions for the Safe Movement of Dangerous Goods by Air. (Doc 9284). ▪ Refer to International Maritime Dangerous Goods (IMDG) Code. (Amendment 34-08). IMO. 2008. ▪ Refer to International Convention for the Safety of Life at Sea (SOLAS), Chapter VII - Carriage of dangerous goods. 1974. (Entered into force on 25 May 1980. IMO.
09	Security of Ammunition	09.10	Security Principles and Systems	▪ Introduction ▪ Principles ▪ Access Controls ▪ Control of keys ▪ Patrolling ▪ Perimeter Security ▪ ACTO Explosives
10	Ammunition Demilitarization and Destruction	10.10	Demilitarization and Destruction of Conventional Ammunition	▪ Open Burning and Detonation (From IMAS 11.20) ▪ Industrial Demilitarization (From MOSAIC 05.51:2010(E))

Volume		Module		Contents
#	Area	#	Title	
11	Ammunition Accidents, Reporting and Investigation	11.10	Ammunition accidents and incidents: unit reporting and technical investigation methodology	▪ Purpose ▪ Competencies ▪ General Approach ▪ Assistance from Other Agencies ▪ Jurisdiction ▪ Initial Response ▪ Initial Investigation ▪ Preservation of Evidence ▪ Witnesses ▪ Technical Investigation ▪ Classification of Accidents ▪ Ammunition Details ▪ Drills and Procedures ▪ Inspection Points ▪ Qualifications, Authorization and Orders ▪ Skills and Experience ▪ Circumstances and Conditions ▪ Trials Accidents
		11.20	EOD Clearance of Ammunition Storage Area Explosions.	▪
12	Ammunition Operational Support	12.10	Ammunition on Multi-National Operations	▪ Ammunition technical support to force generation and technical survey. ▪ Applicable IATG.
		12.20	Small Unit Ammunition Storage	▪ Explosive Limits and Licences ▪ References to IATG Clauses

To assist in the application of the IATG, key IATG implementation support tools are available for immediate use by ammunition experts to improve ammunition safety at www.un.org/disarmament/unsaferguard :

Risk Management tools:

Create an Explosives Limit Licence[19]

Explosion Consequence Analysis (ECA)[20]

Risk Reduction Process Levels[21]

Quantity-Distance Map[22]

[19] https://www.un.org/disarmament/un-saferguard/explosives-limit-license/

[20] https://www.un.org/disarmament/un-saferguard/explosion-consequence-analysis/

[21] https://www.un.org/disarmament/un-saferguard/risk-reduction-process-levels/

[22] https://www.un.org/disarmament/un-saferguard/map/

Technical Calculators:

Kingery-Bulmash Blast Parameter Calculator[23]

Gurney Equations for Fragment Velocity[24]

Hopkinson-Cranz Scaling Law[25]

Noise Prediction Calculator[26]

Detonation Pressure Calculation[27]

Explosion Danger Area Calculator[28]

Vertical Danger Area Calculator[29]

[23] www.un.org/disarmament/un-saferguard/kingery-bulmash/

[24] www.un.org/disarmament/un-saferguard/gurney/

[25] /www.un.org/disarmament/un-saferguard/hopkinson-cranz/

[26] /www.un.org/disarmament/un-saferguard/noise-prediction/

[27] www.un.org/disarmament/un-saferguard/detonation-pressure/

[28] www.un.org/disarmament/un-saferguard/explosion-danger-area/

[29] www.un.org/disarmament/un-saferguard/vertical-danger-area/

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 2021	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.20

Third edition
March 2021

Index of risk reduction process levels (RRPL) within IATG

UN SaferGuard
Securing ammunition, protecting lives

IATG 01.20:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Within the IATG modules the different tasks and activities necessary for safe, efficient and effective stockpile management are considered to equate to one of three Risk Reduction Process Levels (RRPL). These are indicated within each IATG module as either **LEVEL 1**, **LEVEL 2** or **LEVEL 3** dependent on risk reduction and mitigation achieved by each task or activity. The basic aim of a conventional ammunition stockpile management organisation should be, to make sure that stockpile management processes are maintained at RRPL 1 as a minimum, which will reduce or mitigate risks significantly. Ongoing and gradual improvements should then be made to the stockpile management infrastructure and processes as staff development improves and further resources become available.

It is not desirable to write each individual IATG module in such a way that they flow from Level 1 to 2 to 3, as this would mean a lot of repetition and the document would not flow in a logical manner. Therefore, this IATG module acts as a one document source, which identifies tasks and activities by each RRPL. The current RRPL of a single stockpile, e.g. a building, compound or depot, can be determined using the RRPL Checklist tool[3] that can be found in the IATG Implementation Support Toolkit.

[3] www.un.org/disarmament/un-saferguard/risk-reduction-process-levels

Index of Risk Reduction Process Levels (RRPL) within IATG

1 Scope

This IATG module provides a consolidated index of the Risk Reduction Process Levels (RRPL) contained within each individual IATG.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this guideline the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Risk Reduction Process Levels (RRPL)

Within the IATG the different tasks and activities necessary for safe, efficient and effective stockpile management are considered to equate to one of three Risk Reduction Process Levels (RRPL).

<table>
<tr><th>RRPL</th><th>Meaning</th></tr>
<tr><td>LEVEL 1</td><td>
▪ Basic safety precautions are in place to reduce the risk of undesirable explosive events during ammunition storage, but fatalities and injuries to individuals in local civilian communities may still occur.
▪ Although some potential causes of such explosions have been addressed (external fires, smoking, mobile phones etc.), others remain (propellant instability, handling, lightning strike).
▪ Risk of explosion still remains as routine physical inspection of the ammunition does not occur and the capability to determine the chemical stability of ammunition during storage has not been acquired.
▪ Basic security precautions are in place to reduce the risk of theft by external actions.
▪ Basic safety precautions, in the form of appropriate Quantity Distances, have been implemented to mitigate the risk of fatalities and injuries to individuals within local communities to a tolerable level.
▪ Ammunition has been accounted for by quantity, and a basic system of identifying loss or theft is in place.
▪ A minimal investment of resources has taken place in organisational development, operating procedures and storage infrastructure.
</td></tr>
<tr><td>LEVEL 2</td><td>
▪ Appropriate hazard division Separation and Quantity Distances, have been implemented to mitigate the risk of fatalities and injuries to individuals within local communities to an acceptable level.
▪ Significant damage to ammunition stocks and storage infrastructure should still be expected as inadequate protection remains in terms of infrastructure robustness and safe internal separation distances.
▪ Ammunition can be identified down to type, lot or batch number, but surveillance and/or in-service proof systems are not yet in accordance with international best practices. Explosions due to chemical stability of ammunition may still be expected.
▪ Medium level investment of resources has taken place in organisational development, staff technical training, storage and processing infrastructure.
</td></tr>
<tr><td>LEVEL 3</td><td>
▪ A safe, secure, effective and efficient conventional ammunition stockpile management system is in place that is fully in line with international best practices.
▪ A significant investment of resources has taken place in organisational development, staff technical training, storage and processing infrastructure.
▪ Organisational capabilities to sustainably manage ammunition are in place.
</td></tr>
</table>

Table 1: RRPL meanings

Where appropriate, clauses within each IATG module are indicated as either being a **LEVEL 1**, **LEVEL 2** or **LEVEL 3** dependent on the risk reduction or mitigation achieved by or resources required for each task or activity. To be fully compliant with the appropriate **LEVEL,** stockpile management organisations shall ensure that the systems, processes, procedures or equipment referred to in the clause are in place.

The basic aim of a conventional ammunition stockpile management organisation should be to make sure that stockpile management processes are maintained at RRPL 1 as a minimum, which will reduce risks significantly. Ongoing and gradual improvements should then be made to the stockpile management infrastructure and processes as staff development improves and further resources become available.

5 Index of Risk Reduction Process Level 1 activities within each IATG module

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
01.50	UN Explosive Hazard Classification System and Codes	**6.1**	**Hazard divisions**	▪
		6.1.1	**Fire divisions**	▪
		6.2	**Compatibility groups**	▪
		7	**Storage of compatibility groups**	▪
		7.2	**Ammunition requiring separate storage**	▪
01.90	Ammunition Management Personnel Competences	**All**	**Competences and competency standards**	▪
02.10	Introduction to Risk Management Principles and Processes	**8.2.1**	**Probability estimation of an unplanned or undesirable explosive event**	▪
		8.2.1.1	Example probability estimate model (historical)	▪
		8.2.1.2	Example probability estimate model (qualitative)	▪
		10	**Risk reduction and mitigation**	▪
		11	**Risk acceptance**	▪
		12	**Risk communication**	▪
		Annex D	**Example qualitative risk assessment methodology**	▪
		Annex F	**Risk management and IATG software**	▪
02.20	Quantity and Separation Distances	**6.1**	**Inside quantity distances (IQD)**	▪
		6.2	Outside quantity distances (OQD)	▪
		7	Rules for use of quantity distances (above ground storage)	▪
		10	Hazard division quantity distance matrices	▪
		11	Hazard division quantity distance tables	▪
		Annex C	**Symbols for QD concept**	▪ **Annex C**
		Annex D	**Hazard division 1.1 QD matrix (above ground storage)**	▪ **Annex D**
		Annex E	**Hazard division 1.1 QD tables (above ground storage)**	▪ **Annex E**

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		Annex F	**Hazard division 1.2.1 QD matrix (above ground storage)**	▪ **Annex F**
		Annex G	**Hazard division 1.2.2 QD matrix (above ground storage)**	▪ **Annex G**
		Annex H	**Hazard division 1.2 QD tables (above ground storage)**	▪ **Annex H**
		Annex J	**Hazard division 1.3.1 QD matrix (above ground storage)**	▪ **Annex J**
02.40	Safeguarding of Explosives Facilities	4.2	System requirements	▪
02.50	Fire Safety	**5**	**Principles**	▪
		6.1	**Fire safety plan**	▪
		7	**Fire alarm systems**	▪ More technical systems would be RRPL 2.
		8	**Fire breaks and vegetation**	▪
		9	**Fire practices**	▪
		11.2	**Fire signs and symbols**	▪
		11.3	**First aid firefighting appliances (FAFA)**	▪
		12.1	**Unit immediate actions**	▪
		12.2	**Briefing to senior fire officer**	▪
		Annex C	**Fire signs**	▪
03.10	Inventory Management	**7**	**Types of ammunition stockpile**	▪
		10	**Ammunition storage unit responsibilities**	▪
		14.1	**Ammunition accounting requirements**	▪ Also some RRPL 2 activities.
		14.2	**Accounting systems**	▪
		14.5	**Stack tally cards**	▪
		14.6	**Stocktaking and audits**	▪
05.10	Planning and Siting of Explosive Facilities	**4.1**	**Quantity distances**	▪
		8	**Approval of facilities**	▪
05.30	Barricades	**8**	**Earth traverses**	▪
		9	**Other materials compared with earth**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		9.2	**Other traverse types**	▪
05.40	Safety Standards for Electrical Installations	**6.1**	**Safety precautions** **Commissioning and testing of electrical equipment (safety precautions)**	▪
		8.4	**Lightning hazard to personnel**	▪
		8.4.2	**Making safe the explosives facility in the event of a thunderstorm**	▪
		9.2.6	**Relative humidity (RH)** **Sources of static (relative humidity (RH))**	▪
05.50	Vehicles and MHE in Explosive Facilities	**4.3**	Vehicles authorised to enter a potential explosion site (PES)	▪
		4.3.1	**Standard vehicles in a PES**	▪
		4.3.2	**Standard vehicles in an explosive area but not a PES**	▪
		4.3.3	**Identification of MHE**	▪
		6	**Safe working load (SWL)**	▪
		7.2.2	**Maintenance (modifications)**	▪
		7.2.3	**Maintenance (fire-fighting equipment)**	▪
		7.4	**Speed limits**	▪
		7.7	**Refuelling of vehicles and MHE**	▪
		7.9	**Battery charging and battery maintenance**	▪
05.60	Radio frequency (RF) hazards	4	Exposure to RF and exposure levels	▪
		5	Susceptible items	▪
		6	Safety and separation distances	▪
06.10	Control of Explosive Facilities	**4**	**Personnel employed in explosive facilities**	▪
		5.1	**Security (patrolling and guarding)**	▪
		5.2	**Security (control of entry)**	▪
		5.3	**Security (contraband)**	▪
		5.3.2	Smoking materials and designated smoking areas	▪
		5.3.3	**Firearms**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		5.3.4	**Food and drink**	▪
		5.3.5	**Battery powered devices**	▪
		5.4	**Searching of personnel**	▪
		5.5	**Magnetic therapy products**	▪
		5.6	**Spark, flame or heat producing items**	▪
		5.7	**Lighting of fires**	▪
		5.9	**Other controlled items**	▪
		6.1	**Site plans**	▪
		6.6	**Vermin control**	▪
		6.7	**Vegetation and crops**	▪
		6.7.1	Control measures and a three area plan	▪
		6.7.2	Site risk assessment	▪
		6.8	**Control of trees and shrubs**	▪
		6.9	**Cut vegetation**	▪
		6.10	**Agriculture and agricultural chemicals**	▪
		6.11	**Livestock**	▪
		7	**Fire and first aid**	▪
		7.1	**Fire**	▪
		7.2	**First aid equipment**	▪
		9.1	**PES (cleanliness)**	▪
		9.2	**PES (action on vacating)**	▪
		9.4	**Thunderstorms**	▪
		Annex C	**Suggested contraband notice**	▪
06.30	Storage and Handling	**4.1**	**Safety**	▪
		4.2	**Classification of ammunition**	▪
		4.4	**Physical handling of ammunition**	▪
		4.5	**Damaged packaging**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		5.5	**Specific stacking requirements**	▪
		7	**Stack tally cards and pallet contents sheets**	▪
		8	**Use of lifting equipment and slings**	▪
		9.2	**Temperature recording**	▪
06.40	Ammunition Packing and Marking	**4.1**	**Packaging requirements**	▪
		4.2	Design and safety of explosive packaging	▪
		4.4	Physical handling of ammunition packages	▪
		4.5	Temporary packaging	▪
		4.10	Empty ammunition packaging	▪
		5.4	Damaged pallets/banding material	▪
		6	Sealing of ammunition packaging	▪
		7	Ammunition in transit	▪
06.50	Specific Safety Precautions	**4.1.1**	**Stacking and storage (Dangerous chemicals)**	▪
		4.1.2	**WP and RP filled ammunition (Dangerous chemicals)**	▪
		4.1.3	**Leakage (Dangerous chemicals)**	▪
		4.1.4	**First aid instructions for WP (Dangerous chemicals)**	▪
		4.2	**Phosphide filled munitions**	▪
		5	**Metal powders and explosives containing metal powders**	▪
		6	**Health hazards associated with explosives**	▪
		6.1	**Information on the toxic effects of explosives**	▪
		Annex C	**Treatment of WP and RP burns**	▪
06.60	Work services (construction and repair)	**4.3**	Head of the establishment and post holder duties	▪
		4.4	Role of the safety monitor	▪
		6	Minor Works	▪
		7.1	Working on or in a PES	▪
06.70	Inspection of explosives facilities	**4**	Inspecting an explosives facility	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		5.1	Internal inspection	▪
		6	Small units	▪
08.10	Transport of Ammunition	**9**	**Security during transport**	▪
09.10	Security Principles and Systems	**7**	Stockpile risk assessment	▪
		8.1	**Development of physical security systems**	▪
		8.2	**Security regulations**	▪
		8.3	**Security plan**	▪
		8.4	**Staff selection and vetting systems**	▪
		8.5.1	**Access control – keys**	▪
		8.5.3	**Entry to ammunition storage areas**	▪
		8.6.1	**Doors and gates**	▪
		8.6.2	**Windows**	▪
		8.6.3	**Locks and padlocks**	▪
		8.7.1.2	**Class 1 security fencing**	▪
		8.7.1.3	**Class 2 security fencing**	▪
		8.7.1.7	**Drainage**	▪
		8.7.5	**Patrols and dogs**	▪
		Annex C	**Model for a security plan**	▪
10.10	Demilitarization and Destruction	**9.1**	**Open burning (OB) and open detonation (OD)**	▪
11.10	Ammunition Accidents: Reporting and Investigation	**4**	**General**	▪ Rationale for investigations and appropriate remedial action.
		7	**Reporting of ammunition accidents**	▪ Information requirements.
		8	**Actions by user unit**	▪ User responsibility.
		9	**Investigating authority**	▪ Responsibilities.
		10	**Actions of the technical investigator**	▪ Role and responsibilities.
12.10	Ammunition on Multi-National Operations	**All**	**All**	▪ Designed to ensure explosive safety of deployed forces.

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
12.20	Small Unit Ammunition Storage	**All**	**All**	▪ Designed to support the small-scale storage of ammunition by units.

Table 2: Index of Risk Reduction Process Level 1 within IATG

6 Index of Risk Reduction Process Level 2 activities within each IATG module

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
01.50	UN Explosive Hazard Classification System and Codes	**6.2**	**Compatibility groups**	▪
01.60	Ammunition Faults and Performance Failures	**4**	**General**	▪
		6	**Reporting of ammunition faults and performance failures**	▪
		7	**Actions by user unit (faults)**	▪
		8	**Actions by user unit (performance failures)**	▪
		9	**Investigating authority**	▪
		10	**Actions of the technical investigator**	▪
01.70	Bans and Constraints	**6**	**Bans**	▪
		7	**Constraints**	▪
02.10	Introduction to Risk Management Principles and Processes	**8.2.2**	**Physical effects estimation of an unplanned or undesirable explosive event**	▪
		8.2.3	**Individual risk estimation**	▪
		10	**Risk reduction and mitigation**	▪
		13.2	**Separation and quantity distances**	▪
		13.3	**Explosion consequence analysis**	▪
		13.4	**Explosion safety cases**	▪
		15	**Cost benefit analysis**	▪
		15.1	**Expected monetary values**	▪
		Annex D	**Example qualitative risk assessment methodology**	▪
		Annex E	**Example ECA methodology**	▪
		Annex F	**Risk management and IATG software**	▪
		Annex G	**Explosive Safety Case (ESC) Format**	▪
		Annex H	**Expected Monetary Value Estimation**	▪
02.20	Quantity distances	**12**	**Marshalling yards and transit areas**	▪
		13	**Underground storage**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		14	**Ports**	▪
		15	**IATG software and adjustment of quantity distances**	▪
		Annex M	**Hazard division QD matrix (underground storage)**	▪
		Annex N	**Hazard division QD tables (underground storage)**	▪
		Annex P	**Hazard division QD matrix (ports)**	▪
		Annex Q	**Hazard division QD tables (ports)**	▪
02.30	Licensing of Explosive Facilities	5	**Risk management**	▪
		6	**Types of explosive limits licences (ELL)**	▪
		7	**Licensing criteria**	▪
		8	**Management of ELL**	▪
		8.4	**Validity of ELL**	▪
02.40	Safeguarding of Explosives Facilities	4.3	**System components**	▪
		5	**Maintenance of the safeguarded area**	▪
02.50	Fire Safety	10	**Evacuation of personnel**	▪
		11.1	**Emergency water supplies**	▪
		12.3	**Major fires**	▪
03.10	Inventory Management	5	**Inventory management functions**	▪
		6	**Through life management**	▪ Also some RRPL 3 activities.
		6.2	**Munitions life assessment (MLA)**	▪ Also some RRPL 3 activities.
		6.2.2	**Requirements for MLA**	▪
		6.2.4	**Ammunition management policy statements (AMPS)**	▪
		8	**Ammunition stockpile management system requirements**	▪ Including use of standardised nomenclature and descriptions.
		9	**Stockpile management organisation responsibilities**	▪
		11	**Ammunition technical inspection unit responsibilities**	▪
		12	**Ammunition training unit responsibilities**	▪
		14.1	**Ammunition accounting responsibilities**	▪ Also some RRPL 1 activities.

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		14.3	**International accounting principles and standards**	▪
		15	**Stock location in explosive storehouses**	▪
		16	**Storage space issues**	▪
		17	**Ammunition descriptive asset codes (ADAC)**	▪
		18	**Condition classification of ammunition**	▪ Also some RRPL 3 activities.
		19	**Ammunition procurement and stockpile levels**	▪
03.20	Lotting and Batching	**6**	**Lotting and batching system responsibilities**	▪
		7	**Lot and batch numbering system**	▪
		8	**Lotted or batched and governing components**	▪
		9	**Availability of ammunition technical data**	▪
04.20	Temporary Storage	**5**	**Risk acceptance**	▪
		6	**Temporary storage areas**	▪
		7.1	**Mixing rules**	▪
		7.4	**Quantity and separation distances (TD)**	▪
		7.4.2	**Reduced inside quantity distances (TD)**	▪
		7.4.3	**Reduced outside quantity distances (TD)**	▪
		7.5	**Barricades**	▪
		9	**Surveillance and in-service proof**	▪
		11	**Security**	▪
05.10	Planning and Siting of Explosive Facilities	**5**	**Types of facilities within a depot**	▪
		6	**Underground storage**	▪
		7	**Smaller facilities**	▪
		10	**Handover and takeover procedures for new or modified facilities**	▪
05.20	Types of Buildings for Explosive Facilities	**10**	**Design considerations**	▪
		10.1	**Protective buildings for personnel**	▪
		10.2	Design of pressure release structures	▪
		10.3	Frangible materials and their properties	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		10.4	Ammunition requiring special consideration	▪
		10.5	Construction to contain fragments and prevent lobbing	▪
		10.6	Protection against projected objects	▪
		11.4	**Brickwork**	▪
		11.5	General comments on building materials not specified	▪
		11.6	**Roofs**	▪
		11.7	**Floors**	▪
		11.8	**External and internal walls**	▪
		11.9	**Drainage**	▪
		11.10	**Doors**	▪
		11.10.1	**Fire doors**	▪
		11.11	**Windows and other glazing**	▪
		11.12	**Ventilation and air conditioning**	▪
		11.13	**Heating and utilities**	▪
		11.14	**Lifting equipment**	▪
		12	**Electrical requirements**	▪
05.30	Traverses and Barricades	**5**	**Functional types of barricade**	▪
		6	**Location of barricade**	▪
		7	**Barricade materials**	▪
		9.1	**Wall barricades**	▪
		9.2.4	**Unitization**	▪
		10	**Design of barricades and their variable functions**	▪
05.40	Safety Standards for Electrical Installations	**4**	**Electrical categories**	▪
		4.1	**Mixed category areas**	▪
		4.3	**Selection of electrical category**	▪
		4.5	**Category B**	▪
		4.6	**Category C**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		4.7	Category D	▪
		4.11	Electro-magnetic compatibility (EMC)	▪
		4.11.1	Compatibility levels in storage buildings	▪
		5.2	Fixed and portable electrical equipment	▪
		5.3.1	Air conditioning, heating and humidity control equipment	▪
		5.3.2	Light fittings	▪
		5.3.3	CCTV, communications and alarm systems	▪
		5.3.4	Heat sealing equipment	▪
		5.4.1	Items which emit (RF) radiation	▪
		5.4.2	Mains operated portable equipment	▪
		5.4.3	Equipment containing batteries	▪
		5.4.6	Personal medical equipment	▪
		5.5.1	Cathode ray tube (CRT) displays	▪
		5.5.2	Printers, display screen and other peripherals	▪
		5.6	Vehicles and MHE	▪
		6.1.1	Electrical safety	▪
		6.2.1	Qualified personnel	▪
		6.2.2	Frequency and test requirements	▪
		7.2	Location of power generation and distribution equipment	▪
		7.3	Internal power supply in explosives buildings	▪
		8	Lightning protection systems (LPS)	▪
		8.1.3	Facilities which may not require protection	▪
		8.3	Internal protection	▪
		9	Operation of conducting and anti-static regimes	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		9.2.1	**Personnel**	▪
		9.2.2	**Equipment**	▪
		9.2.3	**Benches**	▪
		9.2.4	**Racks**	▪
		9.2.5	**Specialist equipment**	▪
		9.2.7	**Hazardous area personal test meter (HAPTM)**	▪
		9.3	**Anti-static regime and precautions**	▪
		9.4	**Conducting regime and precautions**	▪
		9.6	**Safety of personnel and safety checks**	▪
		9.7	**Electrical bonding of anti-static and conductive flooring**	▪
05.50	Vehicles and MHE in Explosive Facilities	**4**	Categorisation of vehicles and MHE and permissibility in explosives areas	▪ **4**
		4.1	**Vehicles permitted in categorised areas**	▪
		4.2	**Vehicle compatibility and categorised areas**	▪
		4.3.4	**MHE vehicles and fuel standards**	▪
		4.3.5	**Tyres and ancillaries**	▪
		4.3.6	**Electro-magnetic compatibility (EMC)**	▪
		5	**Lifting equipment not in regular use**	▪
		7	**Management and control of MHE in explosive areas**	▪
		7	**Storage, processing and transport**	▪
		7.2	**Transportation**	▪
		Annex C	**EED and firing circuit sensitivity**	▪
06.10	Control of Explosive Facilities	**4**	**Personnel employed in explosive facilities**	▪
		4.2	**Special conditions of employment**	▪
		4.3	**Specific employment conditions**	▪
		5.8	**Vehicle tracker devices**	▪
		5.9.1	**Vehicle radio key fobs**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		6.2	**Works services**	▪
		6.3	**Surplus facilities**	▪
		6.4	**Roads and drainage**	▪
		6.5	**Railway lines**	▪
		8	**Aircraft overflight**	▪
		8.1	**Helicopters**	▪
		9.4	**Thunderstorms**	▪
		9.5	**Tools, materials and equipment permitted in PES**	▪
		10.1	**ESH and open bay storage**	▪
		10.2	**Ready use ammunition**	▪
		11.1	**Covered storage**	▪
		11.2	**Open storage**	▪
		11.6	Ammunition and ammunition packaging	▪
		11.7	**Commercial explosives and fireworks**	▪
		11.11	**Rail and vehicle transit and staging facilities**	▪
		12.1	**Stock turnover**	▪
		12.2	**Prevention of deterioration of explosives**	▪
		13	**Underground storage**	▪
06.20	Storage space requirements	**4**	**Unit of space (UOS)**	▪
		5	**UOS estimation factors**	▪
06.30	Storage and Handling	**4.3**	**Approval to store**	▪
		5.2	**General criteria**	▪
		5.3	**Loose packaged ammunition**	▪
		5.4	**Unpackaged ammunition**	▪
		6	**Use of racking**	▪
		9	**Storage temperatures**	▪
06.40	Ammunition packaging and marking	**4.3**	Change of hazard division	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		4.6	Special packaging	▪
		4.7	Marking of ammunition and its associated packaging	▪
		4.8	Colour coding of ammunition and its associated packaging	▪
		4.9	Fraction packages	▪
		5.5	Identification of palletised ammunition	▪
		5.6	Movement of palletised ammunition	▪
		6.1.1	Authenticity sealing	▪
06.50		**6.2**	**Safety precautions when storing or handling explosives**	▪
		7	**Explosives area management precautions (CFFE)**	▪
		8	**Emergency arrangements**	▪
		9	**Safe to move and handle**	▪
		10	**Storage temperatures**	▪
06.60	Work services (construction and repair)	**4**	Specific responsibilities	▪
		4.3.3	Safety briefing and permits to work	▪
		5	Major works	▪
06.70	Inspection of explosives facilities	**5.1.1**	PES log book and temperature and humidity records	▪
		5.1.2	Fire fighting equipment, alarms and drills	▪
		5.1.3	Security alarm and public address (PA) systems	▪
		5.2	External inspection and subsequent grading	▪
		5.3.1	Specialist inspections	▪
		7	Suspended or withdrawn licences	▪
07.10	Surveillance and In-Service Proof	**6**	**Responsibilities for in-service proof and surveillance**	▪
		10	**Surveillance**	▪ Surveillance for propellant should begin at level 2, although it is accepted that a fully effective surveillance system may not be complete until level 3.
		13.2	**Propellant stability tests**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		15	**Stability surveillance system**	▪
		Annex C	**Guidance on the physical inspection of ammunition**	▪
07.20	Inspection of ammunition	**6**	Condition classification of ammunition	▪
		9	Common inspection points	▪
		Annex C	Guidance on physical inspection of ammunition	▪
07.30	Ammunition Processing: Safety and Risk mitigation and Reduction	**4**	**Risk assessment**	▪
		6.1	**Explosive limits**	▪
		6.2	**Man limits**	▪
		7.2	**Exposed ammunition and explosives**	▪
		7.4	**Personal protective equipment (PPE) and clothing**	▪
		7.6	**General procedures**	▪
		8.1	**Accident procedures**	▪
		8.2	**Thunderstorms**	▪
		8.3	**Unsafe ammunition**	▪
		10.5	**Items not to be heated**	▪
		10.7	**Difficult items**	▪
		5	**Safe systems of work**	▪
		6.3	**Lower risk operations**	▪
		6.4	**Restricted tasks**	▪
		6.5	**Work instructions**	▪
		6.6	**Supervision and competency**	▪
		7.1	**Processing facility**	▪
		7.3	**Remote operations**	▪
		7.5	**Authorised tools and equipment**	▪
		10	**Breakdown of explosive items**	▪
		10.1	The requirement for breakdown	▪
		10.2	Inspection of stocks awaiting disposal	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		10.3	Risk assessing and planning breakdown of ammunition	▪
		10.3.1	Plan of operation	▪
		10.4	Machinery and tools for breakdown operations	▪
		10.6	Sensitive components	▪
		10.8	Breakdown procedures	▪
08.10	Transport of Ammunition	**All**	**All**	▪ Compliance with international agreements is deemed to be a RRPL 2 activity. ▪ Clause 9 (Security) is a RRPL 1 activity.
09.10	Security systems and principles	**8.7.1.4**	**Class 3 security fencing**	▪
		8.7.1.6	**Clear zones**	▪ Basic and inexpensive technology is included as RRPL 2.
		8.7.2	**Perimeter illumination**	▪
10.10	Demilitarization and Destruction of Conventional Ammunition	**9.2**	**Industrial demilitarization**	▪ More advanced technology included as RRPL 3.

Table 3: Index of Risk Reduction Process Level 2 within IATG

7 Index of Risk Reduction Process Level 3 activities within each IATG module

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
01.50	UN Explosive Hazard Classification System and Codes	**8**	**Types of tests for UN hazard classification**	▪
01.90	Ammunition Management Personnel Competences	**All**	**Competences and competency standards**	▪
02.10	Introduction to Risk Management Principles and Processes	**10**	**Risk mitigation and reduction**	▪
		13.1	**Tests**	▪
		Annex F	**Risk management and IATG Software**	▪
03.10	Inventory Management	**6**	**Through life management (TLM)**	▪ Also some RRPL 2 activities.
		6.2	**Munition life assessments (MLA)**	▪ Also some RRPL 2 activities.
		6.3	**Improvement of in-service life for ammunition**	▪
		13	**Ammunition inspectorate responsibilities**	▪
		18	**Condition classification of ammunition**	▪ Also some RRPL 2 activities.
		20.1	**Financial accounting systems**	▪
03.20	Lotting and Batching	**7.8**	**Special case – logistic batching**	▪
04.20	Temporary Storage	**9**	**Surveillance and in-service proof**	▪
05.20	Types of Buildings for Explosive Facilities	**11.2**	**Reinforced concrete**	▪
		11.3	**Structural steel**	▪
		11.5.1	**Spark resistant materials and equipment fixing**	▪
		11.12	**Ventilation and air conditioning**	▪
05.40	Safety Standards for Electrical Installations	**4.2**	**Sublimating explosives**	▪
		4.4	**Category A and associated electrical standards**	▪
		4.8	**Combined Category A and B areas**	▪
		4.9	**Surface temperature of equipment**	▪
		4.10	**Electrical protection specific to category A zones**	▪
		5.1	**Index of protection (IP)**	▪
		5.4.4	**Environmental monitoring equipment**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		5.4.5	**Equipment for testing electro-explosive devices (EED)**	▪
		5.5.3	**Asset tracking devices**	▪
		7.1	**External supply and overhead power lines**	▪
		7.3.1	**Earthing of explosive facilities**	▪
06.10	Control of Explosive Facilities	**10.3**	**Captured enemy ammunition and foreign explosives**	▪
		10.4	**Process buildings**	▪
		11.5	**Dangerous goods and explosive stores filled with dangerous goods**	▪
		11.8	**Experimental explosives**	▪
		11.9	**Special stores**	▪
		11.10	**Isolation and segregation of stocks**	▪
		11.12	**Storage conditions**	▪
		Appendix 1 Annex D	**UXO recoveries – classification list**	▪
		Annex E	**Ventilation – equipment and procedures**	▪
07.20	Inspection of ammunition	**6**	Condition classification of ammunition	▪
07.30	Ammunition Processing: Safety and Risk Reduction and mitigation	**9**	**Heating explosives during processing**	▪
		10.3.2	**Breakdown under precautions**	▪
		11.1	**STM certification – post explosion hazards**	▪
		Annex E	**Guidance on processing tools and equipment**	▪
07.10	Surveillance and In-Service Proof	**9.2**	**Proof schedule**	▪
		9.3	**Recording proof results**	▪
		12	**Environmental monitoring and recording**	▪
		Annex D	**Example proof report**	▪ IATG Form 07.20
09.10	Security Principles and Systems	**8.5.2**	**Combination locks**	▪
		8.6.4	**Intrusion detection systems**	▪
		8.7.1.5	**Class 4 security fencing**	▪

IATG REFERENCE	IATG TITLE	CLAUSE	CLAUSE TITLE	REMARKS
		8.7.3	**Perimeter intrusion detection systems**	▪
		8.7.4	**Visual surveillance systems**	▪
10.10	Demilitarization and Destruction of Conventional Ammunition	**9.2**	**Industrial Demilitarization**	▪
		9.2.6	**Pollution Control Systems**	▪
		9.2.7	**Recovery, recycling and reuse (R3)**	▪
		11	**Quality management**	▪
		Annex F and Appendix 1	**Stockpile demilitarization and ISO 9001:2008.**	▪

Table 4: Index of Risk Reduction Process Level 3 within IATG

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of Terms, definitions and abbreviations*

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[4] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[4] Where copyright permits.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 2021	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.30

Third edition
March 2021

Policy development and advice

IATG 01.30:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Stockpile management is a wide-ranging term when applied to ammunition and explosives, as it also covers areas such as the determination of stockpile size, the types of stockpiles and the management of ammunition in service. These areas are in addition to the specific technical areas of security and safety of stockpiles.

Ammunition and explosives may deteriorate or become damaged unless they are correctly stored, handled and transported, with the effect that they may fail to function as designed and may become dangerous in storage, handling, transport and use. Stockpile management in accordance with best practices is an important component in ensuring that a national authority fulfills its 'Duty of Care' in ensuring that an ammunition stockpile is correctly looked after.

Safe, effective and efficient stockpile management can also enhance security capability as it ensures that best 'value for money' is obtained from ammunition, which is an expensive commodity in bulk. Stockpile management is an important national responsibility and one of the most effective mechanisms for optimizing safety in storage and reducing security risks of loss, theft, leakage or proliferation. It is therefore important that national authorities adhere to basic principles, and that improvements in stockpile management, where needed, are made in an integrated and graduated manner as resources become available.

Effective stockpile management is as much about developing appropriate procedures, processes and systems as it is about storage and security infrastructure. Infrastructure is expensive, but significant improvements in safety and security can be made at minimal costs with system and process improvements. Changes of attitude and the development of an ethos of explosive safety can have a major impact on reducing the global number of undesirable explosive events within ammunition storage areas. A similar approach to the security of ammunition stockpiles would make a major contribution towards reducing the risks of illicit diversion of ammunition.

The other IATG modules provide detailed guidelines for the safety, security and destruction of ammunition and explosives, whilst this module concentrates on the principles and strategic overview of stockpile management in terms of wider ammunition management responsibilities.

Policy development and advice

1 Scope

This IATG module introduces the principles and requirements of a safe, efficient and effective conventional ammunition stockpile management system and provides guidelines on policy development and advice. It contains information that policy makers at the strategic level should be aware of when dealing with conventional ammunition stockpile management issues.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this guideline the following terms and definitions, as well as the more comprehensive list given in 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition stockpile management activities.*

The term ‘stockpile management’ refers to those *procedures and activities regarding safe and secure accounting, storage, transportation and handling of ammunition and explosives*.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 International instruments and standards

There is a limited range of international or supra-national legislation and international standards that are applicable to the management of conventional ammunition.

4.1 Ammunition destruction

4.1.1. Anti-Personnel Landmine Ban Convention[3]

Article 4 of this convention, which entered into force on 01 March 1999, requires that, *except as provided for in Article 3, each State Party undertakes to destroy or ensure the destruction of all stockpiled anti-personnel mines it owns or possesses, or that are under its jurisdiction or control, as soon as possible but not later than four years after the entry into force of this Convention for that State Party.*

4.1.2. Convention on Cluster Munitions[4]

Article 3(2) of this convention, which entered into force on 01 August 2010, requires that State Parties shall *destroy or ensure the destruction of all cluster munitions referred to in paragraph 1 of this Article as soon as possible but not later than eight years after the entry into force of this Convention for that State Party. Each State Party undertakes to ensure that destruction methods comply with applicable international standards for protecting public health and the environment.*

4.2 Counter-proliferation

4.2.1. UN Firearms Protocol[5]

Article 6 of the UN Firearms Protocol requires that States that have ratified the treaty *shall adopt, within their domestic legal systems, such measures as may be necessary to prevent illicitly manufactured and trafficked firearms, parts and components and ammunition from falling into the hands of unauthorized persons by seizing and destroying such firearms, their parts and components and ammunition unless other disposal has been officially authorized, provided that the firearms have been marked and the methods of disposal of those firearms and ammunition have been recorded.* These requirements, already agreed upon by many States, are a core component of this IATG module for illicitly manufactured and trafficked ammunition that may be seized.

4.2.2. Arms Trade Treaty[6]

Article 3 of the Arms Trade Treaty requires States Parties to *establish and maintain a national control system to regulate the export of ammunition/munitions fired, launched or delivered by the conventional arms covered under Article 2 (1), and shall apply the provisions of Article 6 (Prohibitions) and Article 7 (Export and Export Assessment) prior to authorizing the export of such ammunition/munitions*.

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[3] *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction*. Ottawa. 18 September 1997.

[4] *Convention on Cluster Munitions*. Dublin. 30 May 2008.

[5] United Nations General Assembly Resolution A/RES/55/255. *Protocol against the illicit manufacturing of and trafficking in firearms, their parts and components and ammunition supplementing the United Nations Convention against Transnational Organized Crime*. 08 June 2001. 'The Firearms Protocol'. (Entered into Force on 03 July 2005).

[6] The Arms Trade Treaty (ATT) is an international treaty that regulates the international trade in conventional arms and seeks to prevent and eradicate illicit trade and diversion of conventional arms by establishing international standards governing arms transfers. The Treaty came into force on 24 December 2014.

4.3 Environmental

4.3.1. International environmental legislation

Ammunition and explosives are considered to be hazardous or industrial waste and as such fall under the remit of international treaties that have been signed and ratified:

a) *London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter,* 29 December 1972;

b) *the 1996 Protocol to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (Amended 2006);* and

c) *Convention for the Protection of the Marine Environment of the North-East Atlantic,* 1998.[7] [8]

Ammunition and explosives shall therefore not be dumped at sea by States that have ratified and signed the above treaties and should not be dumped at sea by States not party to these agreements.

The United Nations shall not support any ammunition disposal activities that utilise deep sea dumping.

4.3.2. Supra-national environmental legislation

Supra-national legislation that covers emissions into the atmosphere from the incineration of hazardous waste is the European Union Council Directive 2000/76/EC: *The incineration of waste,* 04 December 2000, amended by Regulation (EC) No 1137/2008 of 11 December 2008.

European Union Council Directive 2008/98/EC *Waste*, 19 November 2008 contains provisions on the management of waste. These should be applied to industrial ammunition demilitarisation processes.[9]

The directives provide a comprehensive standard and are in use by all European Union countries and those countries with associate status. States should reflect the requirements of these directives in their own national environmental legislation where it relates to the destruction of ammunition.

4.3.3. International environmental standards

ISO 4220 (E) Measurement of air pollution

ISO 4220 (E)lays down internationally accepted standards for the determination and measurement of air pollution from industrial processes. These standards should apply to any pollution control systems used during industrial demilitarisation operations, (www.iso.ch), but only in terms of the measurement of emissions. The standard does not provide any guidance on what the overall emission limits should be; this remains the responsibility of the national authority.

ISO 9612: (E) Acoustics

ISO 9612 *Determination of occupational noise exposure – Engineering method* may be applied to open detonation destruction operations.

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[7] Also known as the *OSPAR Convention*.

[8] Entered into force on 25 March 1998 and replaced the *1972 Oslo Convention*.

[9] Article 2, Paragraph 1(e) of the subsequent European Union Council Directive 2008/98/EC *Waste and repealing certain Directives*, 19 November 2006 excluded explosive waste from the provisions of Directive 2008/98. However, non-explosive hazardous waste products from the processing of explosives during demilitarization operations would be covered by this directive.

5 Functional areas of ammunition stockpile management

The national authority should implement a conventional ammunition stockpile management system that ensures that policy, organisations, resources and operating procedures are developed and made available for the requirements shown within the functional areas at Table 1. The IATG module that contains the appropriate guidance to support these requirements is also listed in the table.

Functional Area	Requirements	IATG
Ammunition Management	▪ Inventory Management ▪ Risk Management Principles and Processes ▪ Procurement System and Procedures ▪ UN Explosive Hazard Classification System and Codes Accident, Fault and Performance Failure Investigation Capability, Bans, Constraints and Procedures ▪ Ammunition Surveillance and In-Service Proof	▪ IATG 03.10 ▪ IATG 02.10 ▪ N/A[10] ▪ IATG 01.50 ▪ IATG 01.60, 01.70, 11.10 and 11.20 ▪ IATG 07.10
Ammunition Storage	▪ Depot Storage Procedures and Operations ▪ Safe Depot Storage Infrastructure ▪ Unit Storage Procedures and Operations ▪ Small Unit and Multi-National Operations Safe Storage	▪ IATG 06 Series ▪ IATG 05 Series ▪ IATG 06 Series ▪ IATG 12 Series
Ammunition Processing	▪ Ammunition Inspection Capability, Procedures and Risk Reduction ▪ Ammunition Maintenance Capability and Procedures ▪ Ammunition Repair Capability and Procedures ▪ Ammunition Process Building Infrastructure	▪ IATG 06 Series and 07 Series ▪ IATG 06 Series and 07 Series ▪ IATG 06 Series ▪ IATG 05 Series
Ammunition Disposal	▪ Identification of Ammunition for Disposal Methodology ▪ Disposal Technology and Infrastructure ▪ Disposal Capability and Procedures	▪ IATG 03.10 ▪ IATG 10.10 ▪ IATG 10.10
Ammunition Security	▪ Physical Security Infrastructure of Explosive Storage Areas ▪ Security System Capability and Procedures ▪ Vetting System for Staff	▪ IATG 09.10 ▪ IATG 09.10 ▪ IATG 09.10
Ammunition Transport	▪ Transport Procedures in accordance with International and National Legislation ▪ Intrinsically Safe Vehicles	▪ IATG 08.10 ▪ N/A[11]

Table 1: Functional areas of conventional ammunition stockpile management

6 Philosophy and principles of ammunition stockpile management

The national authority for conventional ammunition stockpile management should ensure that the following philosophy and principles are adhered to at all levels of planning and operational activity. They are designed to contribute to safe, secure, effective and efficient conventional ammunition stockpile management.

[10] National responsibility.

[11] In accordance with international legislation contained within IATG 08.10:*Transport of ammunition*

6.1 Philosophy

The philosophy of a safe, secure, effective and efficient conventional ammunition stockpile management system should be to *ensure the implementation of certain minimum protection criteria for personnel and property, whilst maintaining effective security and control of ammunition and explosives*.

6.2 Protection criteria principles

The principles of minimum protection criteria shall be:

a) to expose the minimum number of persons to ammunition and explosives;

b) to ensure that such persons are physically exposed to ammunition and explosives for the minimum amount of time;

c) to ensure that all personnel responsible for, and participating in, the stockpile management of ammunition and explosives receive appropriate technical training;

d) to ensure that all operational activities are supported by an effective risk management process;

e) to ensure that ammunition and explosives are maintained in a physically and chemically safe condition; and

f) to maintain the quantity of ammunition and explosives at the minimal level commensurate with national security needs.

6.3 Security and control principles

The principles of effective security and control shall be that:

a) physical security systems should be derived from an effective risk assessment process;

b) physical security should be built into new storage facilities at the design stage;

c) an effective perimeter security infrastructure shall be in place;

d) access shall be controlled at all times;

e) access shall be restricted to authorised personnel only;

f) only trusted individuals, who have been security cleared, shall be nominated as authorised personnel to work within the facility;

g) temporary personnel should be accompanied at all times; and

h) effective inventory management systems should be implemented.

7 Risks and safety management principles

7.1 Overview of risk

Inadequately managed conventional ammunition stockpiles constitute a significant danger to public safety and security. While it is the prerogative of each State to determine the system of stockpile management that is most suited for its national defence and security purposes, the issue has been of growing concern to the international community because of: 1) the impact on social and economic development; and 2) the cross-border consequences of poorly managed stockpiles.

The most salient risk posed by the accumulation of conventional ammunition surpluses is that of explosive events in ammunition storage areas. More than half of the world's countries have experienced an ammunition storage area explosion over the past few decades, resulting in severe humanitarian and socioeconomic consequences. These events can result in large numbers of casualties, widespread destruction of infrastructure, and the disruption of the livelihood of entire communities. In addition to the immediate human suffering, such explosions can have terrible effects on the environment. In States with limited means to finance the technically challenging clean-up costs, local populations, especially children, are exposed to the risk of injury or death due to explosive ordnance that tends to litter large areas for extended periods of time after the explosion.

Improper ammunition management is also at the root of diversion of ammunition to illicit markets and onward proliferation thus fueling armed conflict, terrorism and crime.

Stockpile management organisations should therefore develop and implement an integrated and graduated risk management process designed to progressively reduce or mitigate risk as more resources become available. (See IATG 02.10 *Risk management principles and processes).*

7.2 Safety management principles

Safety management systems should be derived from the risk management process and should be designed to achieve tolerable risk by constantly improving safety. Although improving safety demands investment of time and resources, even a relatively modest effort can increase safety levels significantly. Practical measures need to remain realistic and affordable, and thus can be developed in a graduated manner. The following safety management principles should be applied:

a) a formal safety management system (SMS) should be developed and implemented. This includes the organisational structure, processes, procedures and methodologies used to direct and control stockpile management activities;

b) a formal safety management plan should be developed and promulgated to all levels. It should define the organisational structure of the SMS and explain how safety is to be achieved; and

c) a set of safety requirements or procedures should be established that conform to legislation, policy and the appropriate international or national standards.

8 Types of stockpiles

There may be a range of individual ammunition and explosive stockpiles within a country, that are under the control of separate organisations (such as the police, military (both active and reserve), border guards, ammunition production company holdings etc), but each may have the following generic parts:

a) operational ammunition and explosives;[12]

b) war reserve ammunition and explosives;[13]

c) training ammunition and explosives;[14]

d) experimental ammunition and explosives (if a producing nation);[15]

[12] The ammunition and explosives necessary to support the routine operations of military, police and other security agencies over an agreed period of time. This also includes ammunition for use during Internal Security operations.

[13] The ammunition and explosives necessary to support the operations of military, police and other security agencies during external conflict or general war over an agreed period of time, (usually 30 days at intensive expenditure rates).

[14] The ammunition and explosives necessary to support the routine training of military, police and other security agencies. This will usually be an agreed percentage of the war reserve holdings, (which could be up to 15% of the war reserve).

[15] These holdings will be minimal but must be included for intellectual accuracy.

e) production ammunition (if a producing nation);[16] and

f) ammunition and explosives awaiting disposal (unsafe or surplus stocks).[17]

The total of all these generic parts should be referred to as the 'national stockpile'. The management of stocks of small arms ammunition in the possession of civilians or retailers should be determined in accordance with MOSAIC 03.30 *National controls over the access of civilians to SALW*, and not in accordance with this IATG module.

9 Ammunition management policy issues

9.1 Introduction

Ammunition is an expensive commodity, which could be regarded as an 'insurance' policy for the nation. It is hoped that it will never be needed, but long production lead times and national security commitments mean that it must be procured in advance in order for it to be available on demand. This all comes at a cost, which means that the inventory management systems should not only be capable of accounting for ammunition in great detail to support explosive safety and assist in the timely and reliable detection of diversions, but should also be designed to ensure that best 'value for money' is obtained from the ammunition.

9.2 Ammunition management policy statements

One means of ensuring that 'value for money' is obtained, as well as supporting safety, is the development of an Ammunition Management Policy Statement (AMPS) for each type of ammunition. AMPS may be used to define policy for the management of an item of ammunition or explosive throughout its service life and should list support information to assist staff with the maintenance and final disposal of the ammunition or explosive. This forms part of the inventory management process. (See IATG 03.10 *Inventory management).*

9.3 Stock accounting systems

An essential component of stockpile safety is having the ability to know where each item of ammunition is stored (down to lot, batch and/or serial number level and component parts).[18] The lot or batch is a means of identifying ammunition items that contain parts or explosives manufactured under homogenous conditions at the same time and place. This means that should there be a fault, which impacts on safety, all ammunition of that type can be rapidly identified, a ban may be placed on its issue and remedial action taken. Without this level of detail the technical surveillance and in-service proof of ammunition is ineffective and unsafe ammunition cannot be identified. Consequently, users are placed at unnecessary risk, and there is a possibility of undesirable explosive events taking place within the ammunition storage areas.

The ability to rapidly detect inadvertent inaccuracy, loss, theft, leakage or diversion from the national stockpile is also a key control measure of effective stockpile management. Ineffective stock accounting systems significantly increase the risks of proliferation.

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[16] The ammunition and explosives that have been produced and are awaiting sale under the control of the manufacturer. These may be available to the military during general war but would not form part of the war reserve as their availability cannot be guaranteed.

[17] The ammunition and explosives that have been identified as unserviceable, unstable or surplus to requirements.

[18] Further details on lotting and batching are at IATG 03.10 *Inventory management* and IATG 03.20 *Lotting and batching.*

9.4 Financial accounting systems

The national authority should also develop financial accounting systems to identify the true costs of procuring, maintaining and final disposal of the defence stockpile. These costs[19] will include:

a) initial procurement costs, (which will include research, development and purchase costs);

b) additional training requirements;

c) stockpile security costs[20];

d) stockpile storage costs;

e) stockpile maintenance and repair costs; and

f) final disposal costs.

Once the ammunition has reached the end of its useful shelf life it may well be the case that disposal of the ammunition is a cheaper option, in the mid to long-term, than continued storage. The financial accounting system should be sophisticated enough to enable management to make such decisions.

9.5 Ammunition classification and shelf life

All ammunition and explosives should be classified[21] as to their condition, which will require a surveillance and in-service proof system.[22] The ammunition condition is used to define the degree of serviceability of the ammunition and the degree of any constraints imposed on its use.[23]

Policy makers should also be aware that ammunition 'shelf life' is an indication of the performance capability of the ammunition, and not its safety or stability in storage; only physical inspection and ammunition surveillance can determine this.

National authorities should therefore develop a system that allows the condition of the ammunition to be clearly defined, as it is only in this way that safe storage conditions may be maintained, and subsequent disposal or destruction can be prioritised.

10 Storage infrastructure issues

The purpose of ammunition storage infrastructure is to:

a) protect the ammunition from explosive events in neighbouring explosive storehouses (ESH);

b) mitigate the effects on the local environment of an internal explosion within the ESH;

c) protect the ammunition from harsh environmental conditions, thereby allowing it to either achieve or prolong its designed service life; and

d) maintain a secure environment in which ammunition may be protected from external theft or other forms of diversion.

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[19] To include infrastructure, depreciation of infrastructure, operating and staff costs over the anticipated life of the ammunition.

[20] To include infrastructure, depreciation of infrastructure, operating and staff costs over the anticipated life of the ammunition for each sub-clause item.

[21] Best ammunition management practice also recommends that ammunition should also be classified by their Dangerous Goods Classification and UN Serial Number, Hazard Division, Compatibility Group and Hazard Classification Code. (See IATG 01.50 *UN Explosive hazard classification system and codes* for further details)

[22] See IATG 07.10 *Surveillance and proof* for further details.

[23] See IATG 03.10 *Inventory management* for further details.

Although one of the purposes of ammunition storage infrastructure is to mitigate the effects of an internal explosion, protection of the local area is also achieved by the imposition of separation or quantity distances.[24] The robustness and design of the storage infrastructure, together with the type of exposed site, will then determine the appropriate separation distance to be applied for the safety of that exposed site. The less robust the storage infrastructure the greater the separation distance required, until a maximum separation distance required for the storage of ammunition in the open (in effect field storage) is reached.

Ammunition may be stored under temporary storage conditions if appropriate danger areas and security are applied, but such storage will inevitably reduce the in-service life of the ammunition. This will mean that replacement stocks will need procuring earlier than anticipated, and therefore, as many types of ammunition are expensive, cost benefit analysis may prove that storage infrastructure improvements are the most cost-effective solution over the longer term.

Designs, drawings and specifications are widely available for high standard explosive storehouses (ESH), such as the NATO standard 'earth-covered magazine or "igloo" as they have been called historically, but these are resource-expensive and beyond the current means of many national authorities. In such cases explosion consequence analysis (ECA) should be conducted to evaluate the risks to local communities, and then appropriate remedial action[25] taken until more effective storage infrastructure is available.

11 Surplus ammunition indicators and procedures

11.1 Introduction

Each State shall be responsible for deciding the type and quantity of ammunition necessary for its security forces[26] to achieve their constitutional or legally mandated tasks, although such stockpile levels should be necessary, reasonable and justifiable. It therefore follows that each State shall decide when stockpiled ammunition is surplus to its national security requirements.

In order to decide on surplus stockpile levels the national authority should have a system in place that identifies surpluses; without such systems States may not even realise that they are paying for the unnecessary maintenance and storage of redundant stocks of conventional ammunition.

11.2 Planning criteria

National defence and security strategies or policies should provide the basic planning assumptions that determine military, policing and security tasks, the operational concepts and hence the size, organisational structure and equipment requirements of the security forces.

Stockpile surpluses may occur and should be identified when:

a) there are major changes to the national security and/or defence strategy or policy (threat, politically, technology or financially led);

b) security sector reform activities involve the restructuring and downsizing of security forces;

c) major organisational changes are made to security forces;

d) weapons and/or ammunition fail to reach desired performance requirements;

e) ammunition becomes unsafe in storage; and

[24] See IATG 02.20 *Quantity and separation distances* for further details.

[25] This may include: 1) storage infrastructure improvements; 2) a temporary or permanent reduction of stock levels at the site; 3) closure of the site; or 4) political acceptance of the risk to the local community.

[26] Military, Police, Gendarmerie, Border Guards and other security agencies.

f) re-equipment programmes make weapons obsolete or obsolescent, hence there is no longer a need for the ammunition.

11.3 Parameters for equipping security forces

The following parameters should determine the types and quantities of weapons in the national stockpile, from which ammunition requirements can be calculated:

a) the number of personnel in the security forces;

b) the organisation of the security forces;

c) the national perception of a given security environment;

d) the equipment needs of the security forces, based on capability requirements and logistical procedures;

e) current holdings of weapons and their effectiveness for future tasks;[27] and

f) available financial resources.

11.4 Calculation requirements

Advice on the calculation of weapon requirements may be found in MOSAIC 05.20 *Stockpile management; Weapons* (Clause 11.4 and Annex F).

Ammunition requirements to support the security forces may be estimated by use of the Daily Ammunition Expenditure Rate (DAER) system. The advantage of such a system is that it may be used by all levels of the security forces during peace and on operations. It can be used as an operational combat supplies planning tool (by all unit types and size) as well as a simple means of determining required national stockpile levels.

11.4.1. Daily ammunition expenditure rates (DAER)

The Daily Ammunition Expenditure Rate (DAER)[28] for a specific type of ammunition is the estimated amount of ammunition that a single equipment (such as an artillery gun) will use in one day of combat or conflict at a certain intensity. These figures are usually classified and should be determined by operational analysis. For example, the DAER for a 152mm Gun, at intensive war rates, may be 300 rounds per day, therefore to sustain an Artillery Battery of 8 Guns, over a 30 day-period at intensive war rates would require 72,000 rounds of ammunition. An example spreadsheet to calculate this may look like this:

EQUIPMENT	DAER				FORCE EQPT LEVEL	DAYS	FORCE DAER SUSTAINABILITY REQUIREMENT			
	IS[29]	PSO[30]	GW (L)[31]	GW (I)[32]			IS	PSO	GW (L)	GW (I)
Rifle 5.45mm Ball	5	20	60	120	600	30	9000	360K	1.08M	2.16M
Rocket A/Tk RPG 7	0	1	4	20	100	30	0	3,000	12K	60K
Mortar 60mm HE	0	1	10	20	40	30	0	1,200	12K	24K
152mm Gun HE	0	0	50	200	20	30	0	0	30K	120K

[27] For example, can operational weapons be transferred to reservist weapons?

[28] More information on the use of a DAER system is in IATG 03.10 *Inventory management*.

[29] Internal Security Operations.

[30] Peace Support Operations.

[31] General War (Light Rates).

[32] General War (Intensive Rates).

Table 2: Example DAER calculation

The defence stockpile may then be calculated from an analysis of the DAER sustainability requirements to support the national defence and security strategy. For example, it may be decided that the initial defence stockpile should be made of the following DAER components:

a) Operational Stocks (Police) - 30 DAER at Internal Security Operations rates;

b) Operational Stocks (Military) - 10 DAER at General War (Light) Rates;[33]

c) War Reserve - 25 DAER at General War (Intensive) Rates; and

d) Training Stocks - up to 15% of War Stockpile

The rate of ammunition usage at training, or on operations, and the condition of the ammunition over a period of time will then determine the restocking requirements of the defence stockpile. National authorities may choose to select a percentage reorder level, at which point new stocks are procured, whilst surplus stocks are then disposed of.

11.5 Surplus ammunition

Surplus ammunition[34] should therefore be the total of:

a) ammunition that exceeds the stockpile level requirements of the national stockpile for in-service weapon systems;

b) ammunition that is now obsolete or obsolescent;

c) ammunition for which weapon systems are no longer held;

d) ammunition that has exceeded its serviceable life and has been declared for disposal by the national authority.

This surplus ammunition should be:

a) officially declared as surplus to national security or defence requirements;

b) taken out of service;

c) recorded by type, lot, batch and/or serial number;

d) stored separately; and preferably destroyed or demilitarized (in accordance with IATG 10.10 Ammunition demilitarization and destruction).

12 Planning for Support to UN Operations

In December 2015, the General Assembly adopted a resolution[35] that welcomed the continued application of the IATG in the field, including the implementation software and training materials, and encourages, in this regard, the safe and secure management of ammunition stockpiles in the planning and conduct of peacekeeping operations, including through the training of personnel of national authorities and peacekeepers, utilizing IATG.

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[33] With PSO ammunition coming from this stockpile.

[34] There are no extant international legislation, instruments or agreements that define surplus weapons. The planning criteria in this Clause have been derived from suggested surplus indicators within the *OSCE Document on SALW* of 24 November 2000.

[35] UN General Assembly (UNGA) Resolution A/RES/72/55, *Problems arising from the accumulation of conventional ammunition stockpiles in surplus*.

IATG 12.10 provides basic planning guidance for Troop/Police Contributing Countries (T/PCC) by detailing key Force-level explosives safety and risk management roles and responsibilities, and required competencies. It establishes the minimum IATG requirements that should be applied to ensure the safety of unit personnel and the public by providing a table that points to appropriate IATG modules and clauses to at least meet RRPL 1, and higher RRPL if possible. The module additionally requires that all T/PCC providing ammunition certify that their ammunition deployed in support of a UN multi-national operation is 'safe to deploy'.

In order for T/PCC supporting UN operations to more effectively implement IATG 12.10 requirements when operating on a UN base, national efforts are required to develop awareness and understanding of such requirements. Developing capability and trained personnel as part of a national program is critical to successful operations and the safe management of ammunition.

Annex A
(normative)
References

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

a) IATG 01.40 *Terms, glossary and definitions*. UNODA. 2015;

a) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA. 2015*;*

b) IATG 02.20 *Quantity and separation distances*. UNODA. 2015:

c) IATG 03.10 *Inventory management*. UNODA. 2015*;*

d) IATG 07.10 *Surveillance and proof*. UNODA 2015; and

e) IATG 08.10 *Transport of ammunition*. UNODA. 2015.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[36] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[36] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) *Handbook of Best Practices on Conventional Ammunition*. Decision 6/08. OSCE. 2008;

b) MOSAIC 03.30 *National controls over the access of civilians to SALW*. UNODA. 2015; and

c) MOSAIC 05.20 *Stockpile management; Weapons*. UNODA. 2012.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[37] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[37] Where copyright permits.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.35

Third edition
March 2021

Organisational capabilities

IATG 01.35 2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Sustainable, safe, secure, effective and efficient through life management (TLM) of ammunition is a multi-layered process. Besides ammunition technical expertise, it requires a whole array of capabilities at different levels, which allow this expertise to be applied, further developed, transferred and/or institutionalised as required. This framework, which enables an organisation (e.g. military, police) to perpetuate its expertise, is also known as organisational capabilities.

Organisational capabilities involve three different dimensions, which need to interact proficiently to establish the required overall framework. The three dimensions are (i) processes, (ii) functional roles and (iii) capability enabling lines.

Organisational capabilities are capabilities that apply to all items of equipment owned by an organisation (e.g. police, military). While temporary management of ammunition may be conducted without these broader considerations, sustainability in ammunition management, however, is highly dependent on properly established capabilities and organisational structures. Additionally, due to the specific hazards related to ammunition, the three dimensions need to be adequately adapted for ammunition management.

Organisational capabilities

1 Scope

This IATG module introduces and explains the aspects related to organisational capabilities. Organisational capabilities reflect an organisation's ability to manage and allocate resources. Related to this IATG module, they involve processes, functional roles and capability enabling lines (CEL). The module also describes the interaction between the three dimensions, linking the CEL to procedural steps and functional roles.

Organisational capabilities are not specific to ammunition management and apply to the management of any type of equipment. This module will nevertheless direct its attention to ammunition management only.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'capability enabling lines' (short: CEL) refers to the cross-sectional functions of an organisation (e.g. Ministry of defense) that must be brought together to integrate goods into the existing organisation and ensure the delivery of a capability. These functions include doctrine and concepts, organisation, training, material, personnel, finances, infrastructure, and safety and security.

The term 'national authority' refers to the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition stockpile management activities.

The term 'procurement' refers to the process of research, development and production or purchase which leads to ammunition or an equipment being accepted as suitable for use, and continues with the provision of spares and post design services throughout the life of the ammunition or equipment.

The term 'safety' refers to the reduction or mitigation of risk to a tolerable level.

The term 'security' refers to the result of measures taken to prevent the theft of explosive ordnance, entry by unauthorised persons into explosive storage areas, and acts of malfeasance, such as sabotage.

The term 'stockpile management' refers to those procedures and activities regarding safe and secure accounting, storage, transportation and handling of ammunition and explosives.

The term 'surveillance' refers to a systematic method of evaluating the properties, characteristics and performance capabilities of ammunition throughout its life cycle in order to assess the reliability, safety and operational effectiveness of stocks and to provide data in support of life reassessment.

The term 'through life management' refers to an integrated approach to the process, planning and costing activities across the whole service life of a specific ammunition type.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement:** It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation:** It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission:** It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability:** It is used for statements of possibility and capability, whether material, physical or casual.

4 Process

The national authority should establish an ammunition management process that ensures that ammunition is managed from planning to decommissioning. A process can be understood as a series of actions or steps taken in order to achieve a particular end state. Through life management (TLM) of ammunition is the integrated approach to the process related to specific types of ammunition. The TLM process can be divided into four phases; (1) planning, (2) procurement, (3) utilisation and (4) decommissioning.

The process runs as a cycle since the decommissioning of some type of equipment has to be assessed in the planning process to evaluate if it creates new gaps that need to be filled. Additionally, costs and measures for the decommissioning shall be integrated in the planning phase.

The TLM process may involve political and legal decisions, especially with regard to the allocation and release of financial resources. As these decisions are highly specific to each country, this module does not address the decision-making and oversight issues.

4.1 Planning

Derived from government guidance, strategic scenarios, some form of top-level doctrine (i.e. the way in which the forces will be trained, equipped and deployed) and the potential gaps between existing and desired operational capabilities, national authorities should consider the following activities in the planning phase:

a) develop a cohesive ammunition stockpile plan and define the needs to meet the long-term goals

b) identification of capability gaps (What equipment – e.g. ammunition – is required to perform the task mandated by government?), including in connection with decommissioning;

c) cost-benefit analysis (What benefit is expected from the acquisition/procurement in terms of filling the capability gap?) and overview over budget;

d) definition of the technical specifications in terms of equipment to address said gap;

e) definition of requirements for procurement, utilisation and decommissioning; and

f) recipient of feedback from the different processes and roles

4.2 Procurement

Procurement can involve the acquisition of a weapon system (i.e. weapons platform and effectors) including ammunition as a sub-system, or just entail the purchase of ammunition, either to replace expired ammunition or increase stock levels. The decision whether a whole system is to be acquired or solely ammunition is to be purchased is made in the planning stage.

National authorities should consider the following activities in the procurement phase:

a) the establishment of the detailed requirements of the equipment to be procured, including markings;

b) the conduct of the tendering procedure;

c) the evaluation of different equipment as to their compliance with the technical requirements (e.g. requirements may amongst others relate to functionality, reliability, safety etc.);

d) the selection of a specific type and quantity of equipment to be procured to address said gap;

e) the procurement of the selected type and quantity of equipment;

f) the physical delivery to and acceptance by the procurement agency of said equipment;

g) the physical acceptance of all related technical data (e.g. all relevant test results related to safety and environmental aspects including hazard classification, proof results, accelerated aging, lot numbers for all components etc.);

h) the physical acceptance of user documentation (e.g. instruction and technical manuals and materials, range safety details, methods of disposal);

i) the elaboration of registration conception for user;

j) the elaboration of (re-)training conception for user; and

k) the physical handover to and integration of the equipment by the entity in charge of the management of the equipment (e.g. user).

During the acquisition/procurement process, the national authority should define and implement all measures related to the continuous utilisation of the equipment (training, operating cost, infrastructure needs, modification requirements to systems employing the ammunition such as new ballistic data etc.).

4.3 Utilisation

The utilisation phase encompasses activities that ensure the continuous performance and use of the equipment as well as the reporting of the stock level. Technical activities related to the management of ammunition are described throughout the IATG[3] and are not repeated here.

National authorities should consider the following activities in the utilisation phase:

a) equipping the final user with the new equipment;

b) allocating personnel to use the new equipment;

c) (re-)training the final user on the new equipment;

d) ensuring the implementation of all specifications related to the physical security and safe stockpile management of the equipment;

e) stockpiling of the equipment;

f) supply management;

g) ensuring that stock levels, equipment performance testing or failures are reported;

h) ensuring that in the case of ammunition incidents component details are recorded;

i) continuous assessment of the quality of the equipment (including the surveillance of ammunition, i.e. testing and estimation of the remaining safe shelf life); and

j) maintenance of the equipment.

4.4 Decommissioning

There are many reasons that can lead to decommissioning; amongst others, equipment may become obsolete (not relevant to fulfil the forces' tasks), expire (become too old for further safe use), become surplus (beyond the actual security needs) etc. The decommissioning of equipment that is not further used or that even poses an additional risk, can lead to cost saving measures. Decommissioning can be partial (e.g. only certain lot numbers, that are considered unsafe) or encompass the total stock of a specific type of equipment (e.g. decommissioning because the equipment became redundant).

National authorities should consider the following activities in the decommissioning phase:

a) assessment of possible decommissioning needs including the related consequences (operationally, financially, in terms of personnel etc.);

b) decision to decommission a specific type of equipment;

c) segregation of the decommissioned equipment (especially, if equipment is to be decommissioned due to safety issues, it is necessary to avoid it being issued);

d) decision on the method of disposal (e.g. demilitarisation, sales, donation, etc.);

[3] Further details see IATG 01.10 and table *Functional areas of ammunition management*.

e) tendering of the demilitarisation process (if external partners are to be entrusted with the decommissioning);

f) preparation of the equipment for decommissioning (e.g. dismantling of certain sensitive components);

g) transport equipment to end-user or disposal location;

h) physical hand-over or disposal; and

i) update of inventories and records.

Decommissioning equipment may lead to the identification of new requirements hence reverting the process back to the planning phase.

5 Functional roles

In theory, structure follows process. In the case of existing organisations, structures are usually historically grown and sometimes inflated due to various management, technology and other legacies. These organisations tend to resist change, reflecting local requirements and specificities of a nation's strategic situation that might have changed over time. There is no ideal model regarding how an organisation should be structured, since structures are a national prerogative and generally culminate from respective countries' background[4].

Some key roles, however, are essential when it comes to ammunition management. National authorities should reflect these key roles in the organisation's structure. Possible tasks related to these roles are described in this chapter. National authorities should ensure that these functional roles are performed and that responsibilities are allocated accordingly.

Since coordination among different roles is essential, national authorities should ensure that there are clear assignments and delimitations of responsibilities. A responsibility assignment matrix, also known as RACI matrix[5] or linear responsibility chart, describes the level of participation by the various roles in completing tasks or deliverables for a project or business process. A RACI matrix maps out who is <u>R</u>esponsible (Who is completing the task?), <u>A</u>ccountable (Who is making decisions and taking actions on the task(s)?), must be <u>C</u>onsulted with (Who will be communicated with regarding decisions and tasks?), and shall stay <u>I</u>nformed (Who will be updated on decisions and actions during the project?). Accordingly, the RACI matrix is a valuable tool to allocate responsibilities and define relations.

5.1 Planning role

The planer ensures the inclusion of ammunition aspects into acquisition and procurement projects, defines and monitors stock levels and lot expiration dates, guides ammunition surveillance, plans consumption and replenishment, accounting and control, and maintains the ammunition process.

National authorities should allocate the following tasks to the entity performing the planning role:

[4] Notably geopolitics, history, politics, economy, society, safety, security, distribution, storage conditions, climatic and environmental conditions, terrain, physical limitations, technology, manoeuvrability, workload and frequency, required skill levels and occupational specific competencies are factors that may influence the nature of organisational structures.

[5] For more information on RACI matrix, see Project Management Body of Knowledge (PMBOK® Guide) from the Project Management Institute, Chapter on Project Human Resource Management.

a) coordinate development of doctrine and concepts;

b) maintain overall responsibility for through life management;

c) define processes and assign responsibilities for through life management;

d) define required stock-levels;

e) define ammunition allowances and contingencies for training purposes;

f) define types and quantities of ammunition to be acquired/procured;

g) define specific requirements of equipment to be acquired/procured;

h) continuously assess available equipment with regard to preparedness, effectiveness and benefit for the organisation;

i) secure the necessary budgets and personnel for acquisition/procurement and disposal;

j) ensure timely maintenance of ammunition;

k) ensure and task ammunition surveillance;

l) anticipate replacements of obsolete or expired ammunition;

m) decommission ammunition; and

n) plan, task and oversee the disposal of ammunition.

5.2 Acquisition or procurement role

While acquisition relates to the purchase of ammunition as part of the total weapon system, procurement is limited to the purchase of ammunition only (e.g. to replenish stock-levels). During both activities, the entity responsible for acquisition/procurement obtains relevant information (e.g. technical parameters for surveillance), assures quality during delivery and also acts as an interface with industry for acquisition/procurement, servicing and disposal.

National authorities should allocate the following tasks to the entity performing the acquisition/procurement role:

a) analyse the market situation, including opportunities for and limitations of procurement cooperation;

b) define production specifications (e.g. markings);

c) define the planned evaluations (develop business plans);

d) define long lists of possible equipment for acquisition/procurement;

e) define basic verification procedures and criteria for pre-evaluation and conducting pre-evaluation;

f) define short lists of possible equipment for acquisition/procurement;

g) define protocol for evaluation and technical tests and conduct them;

h) together with planning role, define user tests;

i) analyse the efficiency of the tested equipment;

j) select the type of equipment to be acquired/procured;

k) negotiate the acquisition/procurement (including training and maintenance) contracts;

l) conduct lot acceptance tests with supplier;

m) together with surveillance role, define surveillance concept;

n) hand over equipment to the entity in charge of the management of the equipment (e.g. user);

o) report to planning role; and

p) conduct disposal of equipment after official decommissioning.

5.3 Logistics role

The logistics role entails the safe and secure management and distribution of ammunition, information management and accounting, storage operations and determination of storability of new ammunition (e.g. space, specific needs). The logistics role also acts as an interface with the user.

National authorities should allocate the following tasks to the entity performing the logistics role:

a) evaluate specific logistics and infrastructure requirements;

b) inspect equipment, including management of testing equipment;

c) maintain equipment, including through outsourcing;

d) manage spare parts for equipment;

e) establish stockpiling principles and stockpiling equipment;

f) supply equipment to user and to entity in charge of surveillance role as required;

g) manage infrastructure relevant to stockpiling equipment;

h) ensure training, capability and availability of logistics personnel to deal with equipment;

i) develop logistics and technical documentations of equipment;

j) (re-)pack and (re-)label equipment;

k) handle and transport equipment; and

l) certify personnel and equipment for transportation.

5.4 Safety and security role

The safety and security role provides guidance on safety and security, inspects implementation of safety and security provisions, enforces compliance with regulations, assesses hazards and threats to ammunition storage and manages risks.

National authorities should allocate the following tasks to the entities performing the safety and security roles:

a) Develop risk-based approaches to ensure safety and security:

   - define safety and security objectives;
   - select performance measures;
   - determine safety and security criteria;
   - develop risk calculation procedure;
   - define decision protocol; and
   - certify infrastructure and equipment for utilisation.

b) Apply the developed approach to ensure safety and security:

   - define situations to be analysed;
   - collect data on threat and hazard potential, protection measures and exposed objects;
   - apply risk analysis model;
   - evaluate calculated risk;
   - reduce calculated risk if necessary with additional safety measures; and
   - accept and monitor residual risk.

5.5 Surveillance role

The purpose of surveillance and in-service proof is to provide the information required to ensure that ammunition remains safe and reliable, and performs correctly throughout the period of its intended life. This topic is covered in detail in IATG 07.10 *Surveillance and proof.*

Surveillance, including in-service proof provides the means by which initial service life estimations can be confirmed, or even extended, to ensure safe and reliable use throughout the required service life. Surveillance and in-service proof can also be used to assess the continued safety of unserviceable ammunition during storage and transportation, pending its disposal.

Surveillance and in-service proof provides evidence

a) that the risk from ammunition in service, regardless of age, remains tolerable and As Low as Reasonably Practicable (ALARP) throughout the life of the ammunition;

b) that ammunition functions correctly and reliably throughout its period of use; and

c) to enhance maintenance and component replacement plans.

National authorities should allocate the following tasks to the entity performing the surveillance role:

a) In the planning and acquisition/procurement phases:

- develop a programme and test plan (including selection of samples);
- evaluate shelf life;
- develop an implementation plan (including specific test equipment, budgeting, statement of work, firing plans etc.); and
- develop cost structure for through life surveillance and in-service proof cost.

b) In the utilisation phase:

- implement periodic test plan;
- sample, monitor, test and analyse; and
- provide reports and recommendations to planning role (i.e. Does the ammunition still meet the requirements?).

5.6 User role

As the consumer of ammunition, the user provides feedback with regard to training, handling, performance and deviation from the standards of the ammunition.

National authorities should allocate the following tasks to the entity performing the user role:

a) training of personnel in use and handling of ammunition;

b) physical security of ammunition in field storage, depots and during ammunition transports;

c) inform about performance failures or changes (e.g. malfunctions, effectiveness); and

d) inform about deviations from standards (e.g. denomination of quantity, packaging, labelling and compatibility).

6 Capability enabling lines

In order to use a specific type of equipment over its shelf life, it needs to be integrated into the broader functioning of an organisation. This can be broken down in eight capability enabling lines (CEL) which are of predominantly non-material nature and not solely related to ammunition management but to the management of any type of equipment. They are constantly evolving as a factor of threats and hazards, changes in policy, laws and the environment, technological developments, new capability requirements, modified resources etc. CEL focus on comprehensive development and management rather than on single cases. Annex C provides examples of the possible considerations made by the different CEL when procuring new equipment or changing ammunition operations.

National authorities should ensure that appropriate CEL are established and that they are fit to support the ammunition management process.

6.1 Doctrine and concepts

Among the CEL, doctrine (and doctrine development) holds an outstanding and overarching position. It depicts the development of operational capabilities and the assignment of resources to execute operational tasks. It is an expression of the principles by which organisations (e.g. military or police), independently of a concrete situation, successfully guide their actions towards their objective and hence contribute to achieve the overarching (e.g. security policy or military-strategic) goals. It is authoritative, but requires judgement in application. Ammunition has a very specific role and function within the operational environment as captured in doctrine.

A concept is an expression of the capabilities that are likely to be used to accomplish an activity in the future. It is designed to give an overall picture of the operations using one or more specific assets, or set of related assets, in the organisation's operational environment from the users' and operators' perspective. Ammunition and the management thereof forms a critical part of those relevant assets within the operational concept. This emphasises the necessity to manage ammunition as part of the total system.

6.2 Organisation

Organisation (and organisational development) relates to the structure of the department or ministry, the military or police, including potential contractors, as well as the organisational relationships among the different units and personnel. The TLM approach to the management of equipment within the organisation necessitates close cooperation, coordination, information-exchange and liaison with the relevant stakeholders within the organisation and where relevant, outside the organisation.

6.3 Training

Training (and training development) is the provision of the means to practise, develop and validate, within constraints, the practical application of a common doctrine to deliver a capability. It includes technical, methodological and leadership training. Training is vital pertaining to the ammunition environment due to the safety, risk and strategic importance of this asset.

6.4 Material

Material (and material development) relates to the provision of platforms, systems, weapons, spare parts, etc. (expendable and non-expendable, including updates of legacy systems) needed to outfit/equip an individual or group within an organisation.

6.5 Personnel

Personnel (and personnel planning and development) relates to the timely provision of sufficient, compliant, motivated and vetted personnel to deliver capabilities, now and in the future. General healthy, vigilant and well-trained personnel will reduce risk in the work environment that poses specific demands.

6.6 Finances

Finances (and financial planning) relates to the timely provision of sufficient finances to deliver capabilities, now and in the future.

6.7 Infrastructure (real estate and information technology)

Infrastructure - real estate - (and infrastructural development) relates to the acquisition, development, management and disposal of all fixed, permanent buildings and structures, land, utilities and facility management services in support of the capabilities. It includes estate development and structures that support personnel. The general condition and upkeep of the infrastructure is vital in order to ensure the optimisation of ammunition management, security, safety and to minimise risk.

Information technology (and its development) relates to the provision of a coherent development of data, information and knowledge[6] requirements for capabilities, exercise control, manage, oversight of the system requirements and all processes designed to gather and handle data, information and knowledge (e.g. record-keeping and inventory management).

6.8 Security and safety

Security (and security development) relates to the provision of measures required to protect data, information, knowledge, personnel, equipment and infrastructure from internal and external physical (e.g. internal theft, terrorism, environmental threats) and intangible threats or hazards (e.g. cyber threats).

Safety (and safety development) relates to the provision of measures required to protect personnel, populations and the environment from harm arising from the equipment held and activities performed by an organisation (e.g. military or police).

7 Interaction between three components

During the four process phases (clause 4), the different functional roles (clause 5) need to interact at different degrees with the eight CEL (clause 6). This continuous interaction ensures a system approach, namely that an equipment, which is being acquired/procured or for which adequate management is being developed, is consistently integrated in the existing management process with due regard to all relevant required resources.

Interaction points between the functional roles and the CEL mainly occur in the planning and procurement phases, diminish strongly in the utilisation phase and are more intense again in decommissioning phase. Generally speaking, the responsible functional role (as defined through the RACI matrix[7]) in each phase (or part of a phase) shall ensure that regular coordination takes place with all the CEL.

Annex D provides a simplified example on how coordination can be ensured in each phase throughout the life of the ammunition. For each phase (or partial phase), national authorities should identify responsible roles. These responsible roles should be in charge to interact in a timely manner with the relevant CEL. Which roles and which CEL must be involved at what stage should be

[6] Data is defined as raw facts, without inherent meaning, used by humans and systems. Information is defined as data placed in context. Knowledge is information applied to a particular situation.

[7] See clause 5.

identified beforehand. Interactions are hence initiated by the functional role responsible or accountable for the specific phase.

Annex A
(normative)
References

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

a) IATG 01.10 *Guide to the International Ammunition Technical Guidelines*. UNODA. 2020

b) IATG 01.30 *Policy development and advice*. UNODA. 2020

c) IATG 01.40 *Terms, glossary and definitions*. UNODA.2020

d) IATG 01.90 *Ammunition management personnel competences*. UNODA.2020

e) IATG 07.10 *Surveillance and proof*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[8] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/un-saferguard/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[8] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) Project Management Institute, *Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition, 2017

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[9] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: http://www.un.org/disarmament/convarms/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[9] Where copyright permits.

Annex C
(informative)
Examples of the relation between the different CEL

Example 1 – Considerations made by the different CEL when procuring a new type of artillery fuze (M1156 Precision Guidance Kit (PGK) for an existing type of artillery shells)

Doctrine

The aim is to use the newest model fuze, which creates more efficiency in use and ensures better mobility of own units

The operational procedures for the use of the new fuze remain unchanged.

Organisation

The new artillery fuze does not require adjustments to organisational structure.

Training

The procurement and introduction of a new fuze requires the following training:

- Personnel of the logistics organisation (management of fuzes); and
- Personnel of artillery units (use of fuzes).

It shall be verified, which observers, in addition to forward observers, can direct artillery fires with the new fuze and ensure appropriate training.

Material

The existing artillery ammunition (projectiles, charges and primers) can be fired with the new fuze. In addition to the fuzes, the following training and operational material shall be procured:

- PGK settable trainers;
- PGK cut away models;
- M76 PGK fuze wrenches;
- Extended Length Artillery Projectile Extractors (ELAPEs);
- Fuze Setters (with integration to the existing artillery system); and
- PGK fuzes for the simulation system.

Personnel

The new fuze requires no additional personnel.

Finances

Costs are incurred in the following areas:

- Procurement of the fuzes and related training material;

- Modification of field manuals, forms and training requirements;
- Modification of the software of the command and control system;
- Modification of the existing training material; and
- Modification of the simulation systems.

Additional costs will be incurred for the surveillance of the fuzes. No further costs for fuze management (handling, storage, etc.) are expected. No special requirements for handling and storage are known.

Infrastructure (real estate & information technology)

The new fuzes will be stored in the existing explosive storehouses. The TNT equivalent of the fuzes has to be checked. It may be necessary to adapt the storage regulations in this respect.

The new fuzes have to be entered into ammunition accounting system for management and handling purposes. Software adaptations must be made in the following areas:

- Command and control system; and
- Modification of the simulation systems.

Security and safety

No additional measures need to be taken when handling the fuzes. Additional safety requirements are not yet known.

Example 2 – Considerations made by the different CEL when restacking ammunition in the framework of an assistance project

Doctrine

The aim is to ensure that the stacking of ammunition is performed in accordance with the IATG in order to contribute to efficiency, improve logistics, prevent diversion (including recognise leaks in a timely manner) and uphold the safety and security guidances.

In order to do so, adequate national standards for ammunition operations (including stockpiling) as well as training should be developed.

Organisation

The newly stacked ammunition does not necessarily require adjustments in the force's organisational structure. The ammunition depots remain subordinated to the pre-existing organisation.

Personnel allocations, however, may need to be revised to ensure that sufficient, adequately trained and vetted personnel is available both during the restacking operation and for sustainable operation thereafter.

A temporary organisation to perform the restacking may be considered. The transition from pre-existing, to temporary, to new organisation is to be managed.

Training

The IATG-compliant stacking of ammunition requires training of the following personnel in order to ensure that stacking procedures are sustainably conducted over time.

- Ammunition operator: training on proper stacking, labelling, issuance and reception of ammunition;
- Ammunition processor: training on inspection, maintenance and repair of ammunition;
- Ammunition accountant: training on accounting measures relevant to stacking procedures;
- Ammunition supervisor: training on supervision tasks, which will ensure that stacking procedures are observed over time;
- Ammunition manager: training on how ammunition stacking procedures must be managed to ensure compliance with standards over time;
- Ammunition Inspector: training on how to develop, implement and audit ammunition stacking instructions; and
- Ammunition Regulator: training on how to develop technical instructions for ammunition stacking.

Material

The restacking does not involve the procurement/acquisition of new ammunition.

For the restacking of the existing stock, the provision of following equipment should be considered:

- Ammunition boxes;
- Labels (e.g. HD/CG);
- Stack tally cards;
- Dunnage (e.g. pallets);
- Banding material;
- Handling equipment (e.g. forklift trucks);
- Personal protective equipment (e.g. gloves); and
- Cleaning material (i.e. to keep ESH clean).

Personnel

Two phases should be considered:

1. The restacking process: During this phase, additional, adequately trained personnel could be required. This increase of personnel requirement is only temporary but should be planned.

2. The sustainable management of the stocks: After the conclusion of the restacking operation, sufficient, adequately trained personnel should be employed to ensure that ammunition operations are sustainably conducted.

During both phases, personnel requirements for guarding and other tasks on the ammunition depot (e.g. cut back vegetation, cleaning, office activities …) should also be considered.

Finances

Two phases should be considered:

1. The restacking process: This phase requires a financial effort in order to ensure the training of personnel, the procurement of equipment, the refurbishment of infrastructure, procurement of data management software, the conduct of the restacking operation etc.

2. The sustainable management of stocks: After the end of the restacking phase, financial means should to be made available to ensure long-term ammunition operations, including continuous training of personnel, maintenance of infrastructure, equipment and software, procurement of replacement material etc.

Financial disbursement related to infrastructure, including security and ammunition management related buildings (maintenance, facilities for personnel etc.), also need to be considered.

The procurement of new or adapted IT systems (e.g. for data management) should also be considered.

Infrastructure (real estate & information technology)

Restacking of ammunition should involve ensuring that the ESH in which the ammunition is stored complies with the IATG. The refurbishment of the ESH should be planned accordingly. This includes security related aspects (e.g. perimeter fencing, CCTV …), ammunition maintenance buildings, facilities for guards and ammunition personnel etc.

At the same time, the ammunition should be recorded appropriately in order to achieve full asset visibility. The procurement, further development or continued use of a data management system should hence be a priority.

Security and safety

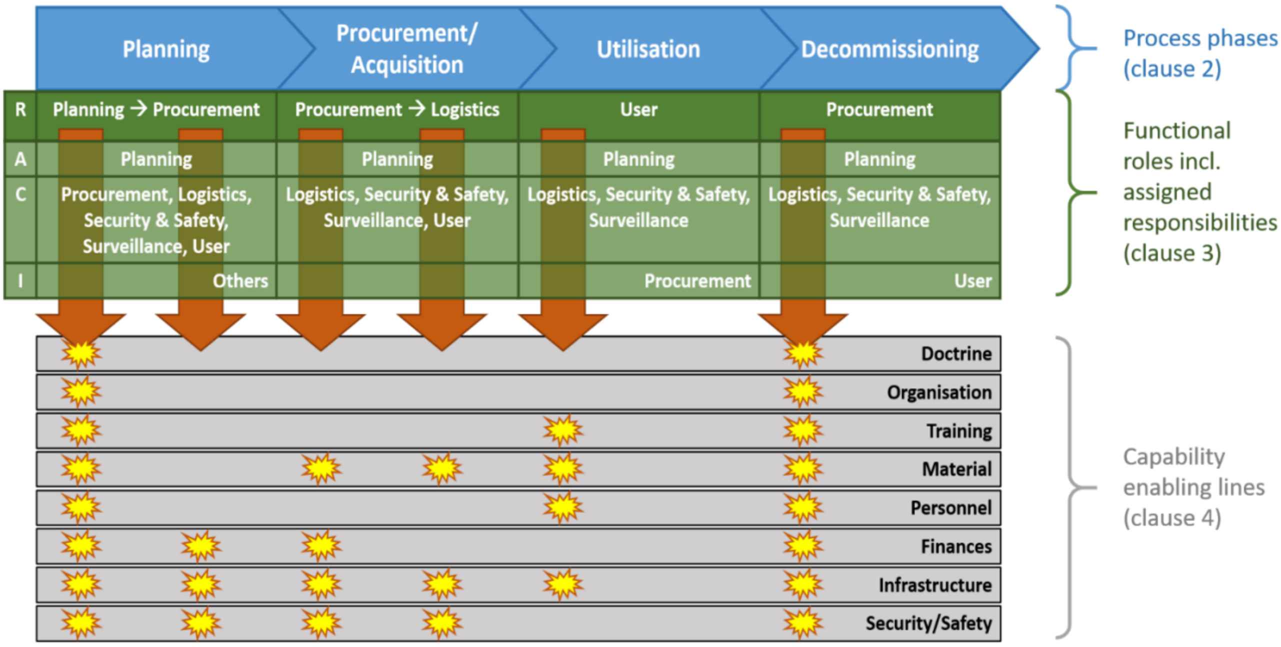
The ESH shall be secured in accordance with the IATG.

Personnel working in the ESH shall be vetted in accordance with the IATG.

Equipment used in the ESH shall be safe to use in accordance with the IATG.

Annex D
(informative)
Examples of the interactions along the process between functional roles and CEL

For each phase (or partial phase, see chapter 4), national authorities should identify responsible roles (see chapter 5). These responsible roles should be in charge to interact in a timely manner with the relevant CEL (see chapter6). Which roles and which CEL must be involved at what stage should be identified beforehand. Interactions are hence initiated by the functional role responsible or accountable for the specific phase.



For each phase (or partial phase, see clause 4), national authorities should identify responsible roles (see clause 5). These responsible roles should be in charge to interact in a timely manner with the relevant CEL (see clause 6). Which roles and which CEL must be involved at what stage should be identified beforehand. Interactions are hence initiated by the functional role responsible or accountable for the specific phase.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINE

IATG 01.40

Third edition
March 2021

Glossary of terms, definitions and abbreviations

IATG 01.40:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Glossary of terms and definitions

Scope

This module of the International Ammunition Technical Guidelines (IATG) compiles the terms and definitions used in all other IATG modules.

Informative references

A list of informative references is given at Annex A in the form of a bibliography which lists additional documents that contain other useful information on terms and definitions related to the stockpile management of conventional ammunition. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Terms and definitions

The terms and definitions used throughout the IATG have been approached from a top down approach as follows:

a) ISO terms and definitions have primacy as they have already been agreed by the 140+ participant Member States in the ISO process;

b) terms and definitions contained within relevant international treaties and agreements;

c) terms and definitions in IMAS,[3] IDDRS[4] and MOSAIC[5];

d) terms and definitions in regional standards and guidelines;

e) appropriate national level terms.

For the purposes of all modules of the IATG the following terms and definitions shall apply.

[3] International Mine Action Standards (IMAS).

[4] International Disarmament, Demobilization and Reintegration Standards (IDDRS).

[5] Modular small-arms-control implementation compendium (MOSAIC).

3.1
abandoned explosive ordnance (AXO)
explosive ordnance that has not been used during an armed conflict, that has been left behind or dumped by a party to an armed conflict, and which is no longer under control of the party that left it behind or dumped it. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.

3.2
above ground storage
storage in **explosive storehouses**, with or without earth cover, or in open stacks, at surface level. An accidental event at such a site may result in blast, fire and projections.

3.3
access control
a system which enables an authority to control access to areas and resources in a given physical facility.

NOTE 1 An access control system, within the field of physical security, is generally seen as the second layer in the security of a physical structure.

3.4
accident
an undesired event, which results in **harm.**

3.5
accounting
information management systems and associated operating procedures that are designed to record, numerically monitor, verify, issue and receive **ammunition** in organisations and stockpiles.

3.6
Airfield
the area prepared for the accommodation (including any buildings, installations, and equipment), of landing and takeoff of aircraft.

3.7
Airport
refers to a civil or municipal airfield.

3.8
all up weight (AUW)
the AUW is the total weight of the **munition**, or munitions, including packaging and palletisation.

3.9
ammunition
a complete device, (e.g. missile, shell, mine, demolition store etc.) charged with explosives, propellants, pyrotechnics, initiating composition or nuclear, biological or chemical material for use in connection with offence, or defence, or training, or non-operational purposes, including those parts of weapons systems containing explosives. (c.f. **munition**).

3.10
ammunition accident
any incident involving ammunition or explosives that results in, or has potential to result in, death or injury to a person(s) and/or damage to equipment and/or property, military or civilian.

3.11
ammunition container
an approved box, cylinder, tin plate liner or receptacle that is designed to contain **explosive articles** or explosives substances. It normally forms part of an ammunition container assembly.

3.12
ammunition depot
an installation devoted primarily to the receipt, storage, issue and maintenance of **ammunition**.

3.13
ammunition process building (APB)
a building or area that contains or is intended to contain one or more of the following activities: maintenance, preparation, inspection, breakdown, renovation, test or repair of **ammunition** and **explosives**.

3.14
ammunition store (unit)
an authorised building containing **ammunition** on unit account.

3.15
anti-static floor
a floor, having a resistance to earth of not less than 5×10^4 ohms and not more than 2×10^6 ohms, which is sufficiently electrically conductive to disperse an accumulated static electrical charge.

3.16
arisings (also Explosive Ordnance Disposal (EOD) arisings) – those explosive items recovered when an EOD task is carried out. Examples would be; an item of ammunition (Unexploded Ordnance (UXO) or Abandoned Explosive Ordnance (AXO)) which is safe to move to a base location (usually a specific explosive storehouse (ESH) in an Ammunition Storage Area (ASA), a dedicated store at an EOD team location, or a dedicated store at a demolition site) for further action; the results of Improvised Explosive Device Disposal (IEDD) action where explosive and other remnants of the device are recovered and either, if safe, given to the authorities for use as forensic evidence, or returned to a base location for future disposal or safe keeping.

3.17
attractive to criminals and terrorist organisations (ACTO)
those ammunition items considered to be of immediate value to a terrorist or criminal.

NOTE 1 For example, SAA, **detonators**, **bulk explosive**, shoulder launched anti-tank weapons or **MANPADS**.

3.18
ban
a moratorium placed on the issue and use of **ammunition**, usually pending technical investigation.

3.19
bastion (gabion)
a cage within which can be placed various fill materials (e.g. gravel, sand, rock), and which is used for building walls, barricades and protective barriers.

3.20
barricade
a natural ground feature, artificial mound, traverse or wall which, for storage purposes, is capable of preventing direct communication of explosion from one quantity of **explosives** to another although it may be destroyed in the process.

3.21
batch
a discrete quantity of ammunition which is assembled from two or more lotted components (one of which will be the Primary Governing Component,) is as homogeneous as possible and, under similar conditions, may be expected to give uniform performance.

NOTE 1 Within the batch a number of sub-batches may be found.

3.22
batch key identity
a term used to identify a particular lot or batch of ammunition.

3.23
batch number
a number allocated to a batch which uniquely identifies that batch.

3.24 black powder
intimate mixture of sodium nitrate or potassium nitrate with charcoal or other carbon, with or without sulphur.

3.25
blast
a destructive wave of gases or air produced in the surrounding atmosphere by an **explosion**. The blast includes a shock front, high pressure behind the shock front and a rarefaction following the high pressure.

the propagation through the air of a high pressure wave, produced by the deflagration or detonation of an explosive material.

3.26
blind
a prepared **explosive** store which, though initiated, has failed to arm as intended or which has failed to explode after being armed (see **misfire**). Alternatively, an **explosive** item that fails to function correctly after initiation.

3.27
bonding
the process of connecting together metal parts so that they provide low electrical resistance contact for direct current (DC) and alternating current (AC) frequencies.

3.28
booster
explosive device used as a **donor charge** to amplify the energy to the **acceptor charge**.

3.29
breech explosion
the uncontrolled initiation of a **round** in the breech of a weapon when fired. The round may not have been chambered or only partially chambered.

3.30
breech loading (BL)
originally 'Breech Loading', now the symbol for a system of rear obturation in which the sealing is achieved by means of a pad in the breech mechanism which presses against the surface in the rear of the chamber of the gun.

3.31
brisance
the shattering effect of an **explosive** or **explosion**.

3.32
bulk explosives
service charges of **explosives** which are generally removed from their containers before use, such as Charges Demolition.

explosive which is not formed into a cartridge and can be loaded by pouring (under gravity), pumping or other pneumatic means.

3.33
burning
the propagation of an exothermic reaction by conduction, convection and radiation.

3.34
burning ground
an area authorised for the destruction of **ammunition** and **explosives** by burning.

3.35
cartridge
a cased quantity of **explosives** (excluding rocket motors) complete with its own means of ignition.

ammunition, ready for firing, wherein the propelling charge(s), its primer, and the projectile with its fuze are assembled in one unit for handling and firing.

3.36
cartridge case
an item which is designed to hold an ammunition primer and propellant and to which a projectile may be affixed; its profile and size conform to the chamber of the weapon in which the round is fired.

3.37
categories of buildings and areas
buildings and areas containing, or likely to contain, military **explosives** are divided into electrical categories according to the likelihood of the explosives giving rise to dust or vapour:

NOTE 1 Category A. Buildings containing, or liable to contain, explosives which produce flammable vapours, but not explosives dust.

NOTE 2 Category A, Zone 0. An area in a Category A building in which a flammable gas or vapour and air mixture is continuously present or is present for long periods.

NOTE 3 Category A, Zone 1. An area in a Category A building in which a flammable gas or vapour and air mixture is likely to occur during normal working.

NOTE 4 Category A, Zone 2. An area in a Category A building in which a flammable gas or vapour and air mixture is not likely to occur in normal operation and, if it occurs, it will exist for only a short time.

NOTE 5 Category B. Buildings containing or likely to contain exposed explosives or explosives which may give rise to an atmosphere of explosives dust, but not flammable vapour.

NOTE 6 Category C. Buildings containing or likely to contain explosives which do not give rise to flammable vapours or explosives dust.

NOTE 7 Category D. These are buildings, usually small Unit Stores, containing or likely to contain packaged explosives that do not give rise to flammable vapours or explosives dust but limited to certain natures and quantities of ammunition.

NOTE 8 For buildings/areas to qualify for use within these categories, electrical equipment and installations and MHE must strictly comply with prescribed specifications.

3.38
CEN (Committee European Normalisation)
CEN is the European Committee for Standardization.

NOTE 1 A CEN standard has the same authority within the EU as an ISO standard.

3.39
charge
a bagged, wrapped or cased quantity of **explosives** without its own integral means of ignition. Secondary means of ignition may or may not be incorporated.

3.40
charge (demolition)
a charge made up from **bulk explosive** for the express purpose of destruction by **blast** or **brisance**.

3.41
charge (expelling)
a charge of generally low or deflagrating **explosive** designed to eject the payload from a parent munitions dispenser by gas pressure without damage to the **sub-munitions**.

3.42
charge (propelling)
articles consisting of a **propellant** charge in any physical form, with or without a casing, for use in artillery, mortars, rockets, or as a component of **rocket motors**.

3.43
chemical stability of propellants
resistance to deterioration by chemical reaction.

3.44
classification of explosives
the allocation of a UN **Hazard Division**, **Compatibility Group** and UN Serial Number to an **explosive**, according to its general properties and characteristics and to those of its packaging, during storage and transport.

3.45
cluster munitions
containers designed to disperse or release multiple **sub-munitions**.

3.46
combat aircraft loading area (CALA)
any area designated for aircraft loading and unloading of munitions.

3.47
combat aircraft parking area (CAPA)
any area specifically designated for parking aircraft loaded with combat configured munitions.

3.48
commercial off the shelf (CoTS)
an **equipment** that is available direct from the manufacturer and requires no further development prior to introduction into service apart from minor modifications.

3.49
compatibility
absence of reactions between explosives and other component within a munition, leading to unacceptable changes in physical properties, sensitiveness or sensitivity of explosives in the munition.

3.50
compatibility group (CG)
grouping identified by a letter which, when referenced to a compatibility table, shows those **explosives** which may be stored or transported together without significantly increasing the probability of an **accident** or, for a given quantity, the magnitude of the effects of such an accident. Codes are used to indicate which **natures** may be safely stored together.

3.51
conducting floor
a floor having a resistance to earth of not more than 5×10^4 ohms.

3.52
confinement
the characteristics of the casing of a charge, which restrict the expansion of the decomposition products when the explosive substance reacts.

3.53
constraint
the imposition of a limitation or restriction in the use, transportation, carriage, issue, storage or inspection of a **munition**.

3.54
contraband / controlled articles / prohibited articles
articles normally prohibited in an **explosives area**, store or vehicle carrying **explosives** unless in an authorised container. Items included are matches, lighters, smoking material and articles, tobacco in any form, alcoholic beverages etc. Additional items as so defined in local orders.

3.55
contractor
a person or persons, company or any other organisation entering into a business agreement for the performance of works services or the supply of goods, with the agreement being legally enforceable.

3.56
conventional ammunition
a complete device, (e.g. missile, shell, mine, demolition store etc.) charged with explosives, propellants, pyrotechnics or initiating composition for use in connection with offence, or defence, or training, or non-operational purposes, including those parts of weapons systems containing explosives. (c.f. **munition**).

3.57
cost benefit analysis (CBA)
a process that involves, whether explicitly or implicitly, weighing the total expected costs against the total expected benefits of one or more actions in order to choose the best, most cost effective or most profitable option.

a technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits.

3.58
cost effectiveness
an assessment of the balance between a system's performance and its whole life costs.

3.59
danger area
(see **explosion danger area**).

3.60
dangerous goods
items classified under the United Nations (UN) system within Classes 1 to 9 in accordance with the UN Transport of Dangerous Goods Regulations (Orange Book).

3.61
debris
any portion of the natural ground or of a structure or material (not part of the functioning **explosive**) that is propelled from the site of an **explosion**. Also known as projections or secondary fragments.

3.62
debris and fragment distance (DFD)
the term 'debris and fragment distance' (DFD) refers to the distance from the point of explosion to the point which the density of the debris and fragments generated by the explosion has decreased

to where people in the open are not expected to be seriously injured. This is equivalent to the hazardous fragment distance (HFD).

NOTE 1 Blast distance (BD) is the protection from the shock front, high pressure wave produced by the deflagration or detonation of an explosive.

NOTE 2 If an Exposed Site (ES) provides sufficient protection (barricade and protected roof) against debris and fragments the BD may be used. Otherwise use the greater of the BD or the DFD (HFD).

3.63
decomposition
chemical reaction of a substance which is not a detonation or deflagration, resulting in significant change in properties.

3.64
deflagration
reaction of combustion through a substance at sub-sonic velocity in the reacting substance.

the conversion of **explosives** into gaseous products by chemical reactions at or near the surface of the explosive.

a rapid chemical reaction in which the output of heat is sufficient to enable the reaction to proceed and be accelerated without input of heat from another source.

NOTE 1 Deflagration is a surface phenomenon with the reaction products flowing away from the unreacted material normal to the surface at subsonic velocity. The effect of a deflagration under confinement is an **explosion**. Confinement of the reaction increases the pressure rate of reaction and temperature and may cause transition into a **detonation**.

3.65
deflagration to detonation transition (DDT)
the transition to detonation from an initial burning reaction.

3.66
demilitarization
the complete range of processes that render weapons, **ammunition** and **explosives** unfit for their originally intended purpose.

NOTE 1 Demilitarization not only involves the final destruction process, but also includes all transport, storage, accounting, and pre-processing operations that are equally critical to achieving the result.

3.67
demolition
the destruction of structures, facilities, or materiel by the use of fire, water, explosives, mechanical or other means.

3.68
destruction
the process of final conversion of weapons, **ammunition** and **explosives** into an inert state so that the item can no longer function as designed

3.69
destruction (in situ)
the destruction of any item of **explosive ordnance** by **explosives** without moving the item from where it was found - normally by placing an **explosive** charge alongside. Also referred to as Blow in place (BIP).

3.70
detonating cord

article consisting of a core of detonating **explosive** (usually **PETN**) surrounded by a flexible outer covering or clad by a soft metal tube.

3.71
detonation
reaction which moves through an **explosive** material at supersonic velocity in the reacting material.

the rapid conversion of **explosives** into gaseous products by means of a shock wave passing through the explosive.

an exothermic reaction wave which follows, and maintains, a supersonic shock front in an **explosive**.

decomposition reaction in which the zone of chemical reaction propagates through the initial medium at a supersonic velocity behind a shock front.

NOTE 1 Typically, the velocity of such a shock wave is more than two orders of magnitude higher than a fast **deflagration**.

3.72
detonation velocity
velocity at which the **detonation** travels through the **explosive** charge or column in m/s.

3.73
detonator
a device containing a sensitive **explosive** intended to produce a **detonation** wave.

article consisting of a small metal or plastic tube containing a **primary explosive** charge, such as lead azide, and a **secondary explosive** charge, such as **PETN**, or other combinations of explosives normally not exceeding a mass of 2g.

3.74
detonator (delay)
detonator assembly in which a time delay between initiation and detonation is included.

NOTE 1 Delay detonators can be electric, electronic or non-electric.

3.75
detonator (electric)
detonator assembly activated by means of an electric current.

NOTE 1 Electric detonators include direct current (DC) and alternating current (AC) (magnetically coupled) systems.

3.76
detonator (electronic)
detonator assembly in which the time delay is achieved by means of an electronic chip activated by an electric or non-electric stimulus.

3.77
detonator (instantaneous)
detonator with no nominal time delay.

3.78
detonator (non-electric)
detonator assembly initiated by means of shock tube, burning fuse or other means not involving electrical stimuli as the primary mode of initiation.

3.79
detonator (plain)

instantaneous non-electric detonator supplied without means of initiation.

NOTE 1 Plain detonators are usually initiated by means of , safety fuze, pyrotechnic igniter or shock tube.

3.80
diurnal cycling
the exposure of **ammunition** and **explosives** to the temperature changes induced by day, night and change of season.

3.81
disposal (logistic)
the removal of **ammunition** and **explosives** from a **stockpile** by the utilisation of a variety of methods, (that may not necessarily involve destruction). Logistic disposal may or may not require the use of **render safe procedures**.

NOTE 1 There are six traditional methods of disposal used by armed forces around the world: 1) sale; 2) gift; 3) use for training; 4) deep sea dumping; 5) land fill; and 6) destruction or demilitarization.[6] Method 6, destruction or demilitarisation, are the only generally accepted methods.

3.82
disposal site
an area authorised for the destruction of **ammunition** and **explosives** by **detonation** and burning.

3.83
diversion
the shifting of weapons, ammunition or explosives from the legal market or owner to an illegal market or owner as a result of losses, theft, leakage or proliferation from a stockpile or other source.

3.84
donor
all sources of funding, including by the host nation government.

3.85
donor charge
charge of explosive supplying a stimulus to another charge.

3.86
donor explosive
serviceable **explosive** used in demolitions to initiate and destroy unserviceable **ammunition** and **explosives** during Explosive Ordnance Disposal (**EOD)** operations.

3.87
drill ammunition
an inert replica of **ammunition** specifically manufactured for drill, display or instructional purposes.

3.88
electrically initiated device (EID)
any single shot component or sub-assembly initiated by electrical means and having an explosive, pyrotechnic or mechanical output resulting from an explosive, pyrotechnic, laser or electrothermal action.

3.89

[6] This is an obvious area where confusion can be caused due to the use of incorrect terminology or translation. One party may assume that when the other mentions disposal they are really talking about destruction. This may not be the case.

electrical category
the standard of electrical installations and equipment required in an **explosive** building. The electrical category is the same as the category allocated to the building or area. (See also **categories of buildings and areas)**.

3.90
electro-explosive device (EED)
a one-shot **explosive** or **pyrotechnic** device used as the initiating element in an **explosive** or mechanical train and which is activated by the application of electrical energy.

3.91
equipment
a physical, mechanical, electrical and/or electronic system which is used to enhance human activities, procedures and practices.

3.92
equivalence (TNT)
when **explosives** having a significantly more or less powerful effect than **TNT** are being considered, a TNT equivalent may be used to determine the appropriate **quantity distance**(s).

3.93
error in drill
an Error in Drill is an incident where the authorised and/or laid down drills are found to be at fault and require to be revised.

3.94
error of drill
an Error of Drill is an incident where the authorised and/or laid down drills have not been followed correctly.

3.95
EUExcert
European Union Explosives Certification project.

3.96
evaluation
the analysis of a result or a series of results to establish the quantitative and qualitative effectiveness and worth of software, a component, **equipment** or system, within the environment in which it will operate.

NOTE 1 Definition when used in context of equipment test and evaluation.

a process that attempts to determine as systematically and objectively as possible the merit or value of an intervention.

NOTE 1 The word "objectively" indicates the need to achieve a balanced analysis, recognising bias and reconciling perspectives of different stakeholders (all those interested in, and affected by programmes, including beneficiaries as primary stakeholders) through use of different sources and methods.

NOTE 2 Evaluation is considered to be a strategic exercise.

3.97
explosion
sudden release of energy producing a **blast** effect with the possible projection of **fragments**.

NOTE 1 The term explosion encompasses fast combustion, deflagration and detonation.

3.98
explosion consequence analysis (ECA)

the structured process, utilising explosives science and explosives engineering, to provide scientific evidence of the potential risk to individuals and property from the effects of an undesirable explosive event.

3.99
explosion danger area
the area surrounding an explosive facility determined by the distances any blast or fragments may be expected to travel due to the **detonation** of **ammunition**.

3.100
explosive
solid, gas or liquid substance or mixture of substances which, by intrinsic chemical reaction is capable of producing an **explosion**.

a substance or mixture of substances, which, under external influences, is capable of rapidly releasing energy in the form of gases and heat.

3.101
explosives safety site plan
a map or drawing of an explosives area which graphically demonstrates compliance with the inside quantity distance (IQD) and outside quantity distance (OQD) requirements. The plan is approved by safety authorities of the MoD prior to construction of new facilities or planned increase of the explosives limit licenses in an extant explosives area.

3.102
explosive materials
components or ancillary items which contain some **explosives** or behave in an **explosive** manner, such as **detonators** and **primers**.

3.103
explosive ordnance (EO)
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; 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.

3.104
explosive ordnance disposal (EOD)
the detection, identification, evaluation, render safe, recovery and final disposal of unexploded **explosive ordnance**.

NOTE 1 EOD may also include the rendering safe and/or disposal of such explosive ordnance which have become hazardous by damage or deterioration, when the disposal of such explosive ordnance is beyond the capabilities of those personnel normally assigned the responsibility for routine disposal. The level of EOD response is dictated by the condition of the ammunition, its level of deterioration and the way that the local community handles it.

3.105
explosive remnants of war (ERW)
unexploded ordnance (UXO) and **abandoned explosive ordnance** (AXO) that remain after the end of an armed conflict.

3.106
explosive safeguarding map
a map produced by the appropriate authority to define areas into which **inhabited buildings** should not be allowed to encroach.

3.107
explosive storehouse (ESH)

a building or structure designed and erected for the sole purpose of storing **explosives** or a building modified, adopted or appropriated for that purpose and approved by a competent authority.

NOTE 1 Explosives storehouses are described according to their method of construction and use:

NOTE 2 **Above Ground**: A building at natural ground level, the roof and at least one side of which are exposed to the open air.

NOTE 3 **Earth Covered Magazine (ECM)**: A storehouse normally built at ground level, earth covered and constructed in corrugated steel or reinforced concrete, provided with a strong headwall and door(s). Earth covers the roof, the sides and the rear. The storehouse and its earth cover are designed to stringent criteria for resistance to external blast loading and attack by high velocity projections. The cross-section of the ECM may be semicircular, elliptical, rectangular etc.

NOTE 4 **Underground**: A natural or excavated space underground with a ceiling not less than 600mm below the natural ground level, specially adapted for the storage of explosives. Access is by tunnel or lift-shaft.

NOTE 5 **Semi-underground**: A building constructed into a hillside with the front face exposed to the open air.

3.108
explosives area
an area used for the handling, processing and storing of **ammunition** and **explosives**. Where there is no fence, it is taken as being the area within a radius of 50m from any building or stack containing explosives.

3.109
explosives classification
the division of explosives according to the risk they present when initiated in storage and transport. See also **Hazard Division, Compatibility Group** and **Classification**.

3.110
explosives limit (licence) (ELL)
the permitted amount of explosives at a **potential explosion site**. Also known as Explosives Licence Limit.

3.111
explosives storage area (ESA)
an area used for the storage of **explosives** and within which authorised **ammunition** or **missile** preparation, inspection and rectification operations may also be carried out.

3.112
exposed site (ES)
a **magazine**, cell, stack, truck or trailer loaded with **ammunition,** explosives workshop, **inhabited building**, assembly place or **public traffic route** which is exposed to the effects of an **explosion** (or fire) at the p**otential explosion site** under consideration.

3.113
failure
an event in which any system, **equipment**, component or sub-component does not perform as previously specified.

NOTE 1 Failures may be classified as to cause, degree, relevance, dependence and responsibility.

3.114
fault
any error in the make-up, and/or marking, and/or deterioration in the physical state of the ammunition, explosives, ammunition packages or ammunition containers.

3.115
foreign object debris (FOD)

the term ‘foreign object debris’ (FOD) refers to any object, live or not, located in an inappropriate location in the airport environment that has the capacity to injure the airport or air carrier personnel and damage aircraft.

3.116
fragment
any solid material in contact with **explosive** or surrounding it closely that is propelled from the site of an explosion. It is mainly applied to the metal casing and packaging.

3.117
fragmentation hazard zone
the area that could be reached by **fragmentation** in the case of **detonation** for a given explosive item, **explosive** storage or **UXO** contaminated area.

NOTE 1 Several factors should be considered when determining this zone: the amount of explosive, body construction, type of material, ground conditions etc.

3.118
fuse
a device for protecting an electrical circuit against damage from an excess current by the melting of a fuse element to break the circuit. Also used for burning fuses, i.e. those fuses which do not use detonation to ignite the explosive train.

3.119
fuze
a device that initiates an **explosive** train.

3.120
gabion (bastion)
a cage within which can be placed various fill materials (e.g. gravel, sand, rock), and which is used for building walls, barricades and protective barriers.

3.121
hammerhead
the term ‘hammerhead’ is the area near the departure end of the runway. An operational surface with dimensions to allow an aircraft to execute 180-degree turns without using reverse operations.

3.122
hardened aircraft shelter (HAS)
a structure designed to minimize aircraft QD separation distances and yet provide a high level of aircraft protection.

3.123
grenade
munitions that are designed to be thrown by hand or to be launched from a rifle. Excludes rocket-propelled grenades. (c.f. **rocket**).

3.124
harm
physical injury or damage to the **health** of people, or damage to property or the environment.

3.125
hazard
potential source of **harm.**

3.126
hazard class
the UN recommended system of nine classes for identifying **dangerous goods**. Class 1 identifies **explosives**.

3.127
hazard classification code (HCC)
an alpha-numeric symbol which denotes the complete hazard classification for a particular nature. The code consists of two digits divided by a full stop indicating the **hazard division** followed by a letter corresponding to the **compatibility group**, e.g. 1.3G.

3.128
hazard divisions (HD)
the UN classification system that identifies hazardous substances.

NOTE 1 For example, Class 1 (Explosives) is subdivided into 6 Hazard Divisions.

3.129
hazards of electromagnetic radiation to ordnance (HERO)
the danger of accidental actuation of electro-explosive devices or otherwise electrically activating ordnance because of radio frequency electromagnetic fields. Situations in which transmitting equipment (e.g., radios, radar, electronic countermeasures, electronic counter-countermeasures, ground penetrating radar, etc.) or other electromagnetic emitting devices can generate radiation of sufficient magnitude to induce or otherwise couple electromagnetic energy sufficient to exceed specified safety and/or reliability margins in EIDs

3.130
hazardous fragment distance (HFD)
the term hazardous fragment distance (HFD) refers to the point of explosion to the point at which the density of hazardous fragments generated by the explosion has decreased has decreased to where people in the open are not expected to be seriously injured. This is equivalent to DFD.

NOTE 1 HFD is an impact density of less than one hazardous fragment per 55.7m^2.

3.131
health
in relation to work, indicated not merely by the absence of disease or infirmity, it also includes the physical and mental elements affecting health which are directly related to safety and hygiene at work.

3.132
heavy walled building
a building of non-combustible construction used for **explosive** storage with walls of at least 450 mm reinforced concrete (RC), or 700 mm brick, or equivalent penetration resistance of other materials, with or without a **protective roof**. The door is normally strengthened if it faces another **potential explosion site**.

3.133
high explosive (HE)
substance or mixture of substances that can undergo a fast internal **decomposition** reaction leading to a **detonation** in its normal use.

A substance or mixture of substances which, in their application as primary, booster or main charge in **ammunition** is required to detonate.

3.134
high velocity projections
debris or fragments at high velocity as the result of a **detonation / explosion** and that may have sufficient remaining energy to propagate an detonation/explosion to another stack.

3.135
humidity indicator
a device used to show, by change of colour spots or markings, that moisture has invaded a store or container.

3.136
hypergolic reaction
the spontaneous ignition of two components – particularly relevant in the case of **liquid bipropellants.**

3.137
ignition
the initial heating of a deflagrating **explosive** or **pyrotechnic** composition, by flame or other source of heat, up to its point of inflammation. Means of ignition may include **propellant**, **primers**, igniters, squibs, fuze lighters, etc.

3.138
illuminating munition
ammunition designed to produce a single source of intense light for lighting-up an area. The term includes illuminating cartridges, grenades and projectiles; and illuminating and target identification bombs.

3.139
improvised explosive device (IED)
a device placed or fabricated in an improvised manner incorporating **explosive** material, destructive, lethal, noxious, incendiary, **pyrotechnic** materials or chemicals designed to destroy, disfigure, distract or harass. They may incorporate military stores but are normally devised from non-military components.

3.140
incendiary munition
ammunition, containing an incendiary substance, and designed to give a primary incendiary effect which may be a solid, liquid or gel including **white phosphorus**.

3.141
incident
a generic term that includes all accidents, performance failures and faults involving ammunition or where ammunition is present.

3.142
incident involving explosives
a generic term that includes all **accidents**, faults and **performance failures** involving explosives, or where **explosives** are present.

3.143
inert munition
an item of **ammunition** that contains no **explosive, pyrotechnic, lachrymatory**, radioactive, chemical, biological or other toxic components or substances.

NOTE 1 An inert munition differs from a drill munition in that it has not necessarily been specifically manufactured for instructional purposes. The inert state of the munition may have resulted from a render safe procedure or other process to remove all dangerous components and substances. It also refers to the state of the munition during manufacture prior to the filling or fitting of explosive or hazardous components and substances. (c.f. **drill**; c.f. **lachrymatory ammunition**; c.f. **pyrotechnic**).

3.144
inhabited building
a building or structure occupied in whole or in part by people (usually civilian). Used synonymously with **occupied building**.

3.145
inhabited building distance (IBD)
the minimum permissible distance between **potential explosive sites** (PES) and non-associated **exposed sites** (ES) that requires a high degree of protection from an explosion.

NOTE 1 The IBD is a form of Outside Quantity Distance (OQD).

3.146
inhabited building distance (IBD)
the term ‘inhabited building’ refers to a building or structure occupied in whole or in part by people (usually civilian). The term is used synonymously with occupied building.

The term inhabited building distance (IBD) refers to ‘the minimum permissible distance between a potential explosion site (PES) and a non-associated exposed site (ES) that requires a high degree of protection from an explosion.

NOTE 2 The IBD is a form of Outside Quantity Distance (OQD).

The term ‘inside quantity distance’ (IQD) refers to the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) inside the explosives area.

3.147
inside quantity distance (IQD)
the minimum permissible distance between a **potential explosion site (PES)** and an **exposed site (ES)** inside the **explosives area**.

3.148
inter-magazine distance (IMD)
the distance between a building or stack containing explosives to other such buildings or stacks which will prevent the direct propagation of explosions or fire from one to the other by missile, flame or blast.

NOTE 1 The IMD is a form of Inside Quantity Distance (IQD).

NOTE 2 Subsequent reactions (fire or detonation) may still occur at adjacent explosive locations that meet IMD, as a result of burning debris, high angle fragment impacts, building collapse, etc.

3.149
International Organization for Standardization (ISO)
NOTE 1 A worldwide federation of national bodies from over 130 countries. Its work results in international agreements which are published as ISO **standards** and **guides**. ISO is a NGO and the standards it develops are voluntary, although some (mainly those concerned with **health**, **safety** and environmental aspects) have been adopted by many countries as part of their regulatory framework. ISO deals with the full spectrum of human activities and many of the tasks and processes which contribute to **conventional ammunition stockpile management** have a relevant standard. A list of ISO standards and guides is given in the ISO Catalogue [www.iso.ch/infoe/catinfo/html].

NOTE 2 The International Ammunition Technical Guidelines have been developed to be compatible with ISO standards and guides. Adopting the ISO format and language provides some significant advantages including consistency of layout, use of internationally recognised terminology, and a greater acceptance by international, national and regional organisations that are accustomed to the ISO series of standards and guides.

3.150
intrusion detection system (IDS)
a security alarm system consisting of various types of alarms to detect the unauthorised intrusion into a room, structure, facility or area.

3.151
inventory management
the systems and processes that identify stockpile requirements, the condition of the stockpile, provide replenishment techniques and report actual and projected inventory status.

3.152
isolated storage

a licensed storage facility for **explosives** which are in an unsafe, or possibly unsafe, condition, away from all other explosives.

3.153
joint use airfield
(i.e., utilized by commercial and military aircraft); Civilian airfields where written agreements exist between the military and the host nation or national authority that allow military use of airfields, or portions of airfields, for which both parties have executed a joint-use agreement granting equal privileges. This area is generally limited to runways and taxiways. All other facilities (parking ramps, hangars, terminals, etc.) are the sole property of the host nation or national authority.

3.154
lachrymatory ammunition
ammunition containing chemical compounds that are designed to incapacitate by causing short-term tears or inflammation of the eyes.

3.155
level 1, 2 or 3
see risk reduction process level (RRPL).

3.156
life-cycle management of ammunition (LCMA)
a comprehensive set of integrated processes and activities that ensure sustainable and cost-effective management of ammunition, delivering a safe and secure stockpile that meets national strategic and operational needs. Referred to as Through Life Management (TLM) in IATG.

3.157
light weapon
any man-portable lethal weapon designed for use by two or three persons serving as a crew (although some may be carried and used by a single person) that expels or launches, is designed to expel or launch, or may be readily converted to expel or launch, a shot, bullet or projectile by the action of an explosive.

NOTE 1 Includes, inter alia, heavy machine guns, hand-held under-barrel and mounted grenade launchers, portable anti-aircraft guns, portable anti-tank guns, recoilless rifles, portable launchers of anti- tank missile and rocket systems, portable launchers of anti-aircraft missile systems, and mortars of a calibre of less than 100 millimetres, as well as their parts, components and ammunition.

3.158
lightning protection system (LPS)
a system designed to protect against the effects of lightning discharges by providing a conductive path between the atmosphere above a structure and the general mass of earth so that the discharge can pass to earth with the minimum risk to the structure, its contents and occupants.

3.159
liquid propellant
any liquid that can be used for the chemical generation of gas at controlled rates and used for propulsion purposes.

3.160
lobbed munition
unexploded **ammunition** projected from an exploding building or stack. It may explode on impact.

3.161
logistic disposal
the removal of **ammunition** and **explosives** from a **stockpile** utilising a variety of methods (that may not necessarily involve **destruction**).

NOTE 1 Logistic disposal may or may not require the use of **render safe procedure**s.

3.162
lot
a lot is a predetermined quantity of ammunition or components which is as homogeneous as possible and, under similar conditions, may be expected to give uniform performance.

NOTE 1 A lot would normally be manufactured from the same raw materials, using the same production technique and in the same production run.

3.163
lot number
a number allocated to a lot which uniquely identifies that lot, together with where and when it was manufactured.

3.164
low order detonation
an incomplete and relatively slow **detonation**, being more nearly a combustion than an **explosion**.

3.165
magazine
any building, structure, or container approved for the storage of **explosive** materials. (c.f. **explosives storehouse (ESH)**).

3.166
making safe
(c.f. **render safe procedure (RSP)**).

3.167
marking
the application of marks - including colours, descriptive text and symbols - to **munitions**, parts and components thereof, and associated packaging, for the purposes of identifying, among other things, their role, operational features, and age; and the potential **hazards** posed by those munitions.

3.168
marshalling yard
groups of railway sidings in which freight trains are formed/reformed, or areas where road convoys are assembled.

3.169
mass explosion
an **explosion** which affects, practically instantaneously, virtually the entire quantity of explosives under consideration. The term usually relates to **detonation** but also applies to **deflagration** when the practical effects are similar (e.g. the mass deflagration of **propellant** under strong confinement to produce a bursting effect and a serious **hazard** from **debris**).

3.170
mass fire
a **deflagration** of the entire quantity of **explosives** under consideration under circumstances that avoid a bursting effect and a serious **hazard** from **debris**. A typical mass fire occurs in a few seconds at most, and produces extensive flame, intense radiant heat and minor projection effects.

3.171
maximum credible event (MCE)
in hazards evaluation, the MCE from a hypothesized accidental explosion, fire, or toxic chemical agent release (with explosives contribution) is the worst single event that is likely to occur from a given quantity and disposition of AE. The event must be realistic with a reasonable probability of occurrence considering the explosion propagation, burning rate characteristics, and physical protection given to the items involved. The MCE evaluated on this basis may then be used as a basis for effects calculations and casualty predictions.

3.172
military airfield
(i.e., utilised only by military aircraft); are an area prepared for the accommodation (including any buildings, installations and equipment) of landing and takeoff of military aircrafts.

3.173
maximum credible event / effective risk
in each situation the greatest quantity of **explosives** which can function virtually at once to provide an explosion effect.

3.174
mine
an **item of ammunition** designed to be placed under, on or near the ground or other surface area and to be actuated by the presence, proximity or contact of a person, land vehicle, aircraft, or boat, including landing craft.[7]

3.175
misfire
ammunition that, when initiated, fails to fire or launch as intended.

3.176
missile
Ammunition which consists of propellant type motors fitted with a payload and equipped with guidance devices.

3.177
munition
a complete device charged with **explosives**, **propellants**, **pyrotechnics**, initiating composition, or nuclear, biological or chemical material for use in military operations, including **demolitions**. (c.f. **ammunition**).

3.178
munitions
ammunition, weapons and materials for use in military operations.

3.179
munition life assessment (MLA)
a systems approach to optimising the useful life of ammunition.

3.180
national authority
the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition stockpile management activities.

3.181
national stockpile
the full range of **ammunition stockpiles** in a country under the control of separate organisations such as the police, military forces (both active and reserve), border guards, ammunition producing companies, etc. (c.f. **stockpile**).

NOTE 1 It includes all ammunition types, irrespective of classification (i.e. operational, training or awaiting disposal).

3.182

[7] NATO (2007).

nature
the specific types of **ammunition**.

a means of categorising **ammunition** or **munitions** by their function (e.g. anti-tank ammunition, or riot control ammunition).

3.183
near miss
an occurrence, or potential occurrence, involving an **explosive**, or an occurrence potentially involving an explosive, which could have caused: 1) damage to the explosives; 2) damage to, or contamination of, military or civilian equipment, property or the environment; 3) injury to, or illness of, military personnel, Ministry of Defence (MoD) civilian personnel or members of the public; or 4) threat to the structural integrity of, or to cause damage to, military or civilian equipment, property or the environment.

3.184
net explosive quantity (NEQ)
the total **explosive** content present in a container, **ammunition**, building etc, unless it has been determined that the effective quantity is significantly different from the actual quantity. It does not include such substances as **white phosphorous**, smoke or incendiary compositions unless these substances contribute significantly to the dominant **hazard** of the **hazard division** concerned.

NOTE 1 Sometimes referred to as Net Explosive Content (NEC), Net Explosive Mass (NEM) or Net Explosive Weight (NEW).

3.185
neutralize
to alter the state of a piece of **ammunition** or **munition** so that it cannot explode, for example by replacing safety devices such as pins or rods into an **explosive** item to prevent the **fuze** or **igniter** from functioning.

NOTE 1 Neutralization does not make an item completely safe as removal of the safety devices will immediately make the item active again.

3.186
non-sparking material
material that will not produce a spark when struck with other tools, rocks, or hard surfaces.

NOTE 1 In ammunition depots, hand tools are usually made of non-ferrous, wood or brass materials.

3.187
open burning (OB) and open detonation (OD) or (OBOD) when described together
ammunition destruction methods using burning, **deflagration** and **detonation** techniques.

3.188
outside quantity distance (OQD)
the minimum permissible distance between a **potential explosion site (PES)** and an **exposed site (ES)** outside the **explosives area**.

3.189
over-pressure
the pressure resulting from the **blast** wave of an **explosion**. It is referred to as ‘positive’ when it exceeds atmospheric pressure and ‘negative’ when during the passage of the wave the resulting pressures are less than the atmospheric pressure.

3.190
oxidant / oxidiser / oxidising agent
a substance that is combined with a fuel to produce an energetic material.

3.191

pallet
a portable item of equipment affording a platform upon which goods may be placed to form a unit load for lifting by means of rigid forks or blades.

3.192
performance failure
a performance failure is the failure of the **ammunition** or any of its constituent parts, including the **explosives**, to function as designed.

3.193
perimeter intrusion detection system (PIDS)
a security alarm system consisting of various types of alarms to detect the unauthorised intrusion into a facility or area.

3.194
personal protective equipment (PPE)
all **equipment** and clothing designed to provide protection, which is intended to be worn or held by an employee at work and which protects him/her against one or more **risks** to his/her **safety** or **health**.

3.195
phosphorous munition
a flare / smoke producing incendiary weapon, or smoke-screening agent, made from a common allotrope of the chemical element phosphorus.

3.196
potential explosion site (PES)
the location of a quantity of **explosives** that will create a **blast**, **fragment**, thermal or **debris** hazard in the event of an **explosion** of its content.

3.197
primary explosive
an **explosive** substance which is sensitive to spark, friction, impact or flame and is capable of promoting initiation in an unconfined state.

an **explosive** that is extremely sensitive to stimuli such as heat, friction and/or shock and requires special care in handling. Generally, primary explosives are synonymous with initiating explosives.

3.198
primary governing component
(c.f. batching component)
the component in a batch which is considered to be of major importance to the correct functioning of the round.

NOTE 1 This component governs the size, homogeneity and identity of a batch. An ammunition batch contains only one lot of the primary governing component.

3.199
primer
a self-contained **munition** which is fitted into a cartridge case or firing mechanism and provides the means of igniting the **propellant** charge.

3.200
process building distance (PBD)
the minimum permissible distance from a building (e.g. an explosives workshop) or stack containing explosives to an Ammunition Process Building (APB), or from an APB to another APB, which will provide a reasonable degree of immunity for the operatives within the APB(s), and a high degree of protection against immediate or subsequent propagation of explosions. Can also be referred to as an explosive workshop distance (EWD).

NOTE 1 The PBD is a form of Inside Quantity Distance (IQD).

3.201
processing
the activities undertaken in an ammunition process building that involve building, repair, refurbishment, breakdown, test and inspection of **explosives articles** and their components.

3.202
procurement
the process of research, development and production or purchase which leads to **ammunition** or an **equipment** being accepted as suitable for use, and continues with the provision of spares and post design services throughout the life of the ammunition or equipment.

3.203
projectile
An object capable of being propelled by a force normally from a gun, which continues in motion by virtue of its kinetic energy.

3.204
proliferation
the increase or spread of weapons and ammunition to users.

3.205
proof
the functional testing or firing of **ammunition** and **explosives** to ensure **safety** and **stability** in storage and intended use.

3.206
propagation of detonation
ability to maintain a **detonation** front throughout the whole mass of an **explosive**.

3.207
propellant
deflagrating **explosive** used for propulsion.

NOTE 1 Propellants can also be used as components of gas generators or other items.

3.208
propellant stabiliser
a substance added to single, double or triple base propellants to retard decomposition.

3.209
propellant surveillance
the periodical testing of propellants, e.g. by determination of stabiliser content, in order to monitor deterioration.

3.210
protective measures
means used to reduce, or mitigate, **risk.**

3.211
protective roof
a roof of a nominal minimum of 150 mm reinforced concrete (RC), or its equivalent, designed to protect the contents of a **storehouse** from projections and **lobbed** items. The roof should not collapse if the walls are damaged.

3.212
public traffic route (PTR)

a road used for public traffic; a railway outside the **explosives area** which is used for public passenger traffic; a waterway, such as a river having tidal water and a canal, used by passenger vessels.

3.213
public traffic route distance (PTRD)
the minimum permissible distance between a potential explosion site (PES) and public traffic routes which is such that the ignition or explosion of explosives at the PES will not cause intolerable danger to the occupants of vehicles at an exposed site (ES).

NOTE 1 The PTRD is a form of Outside Quantity Distance (OQD).

3.214
purple line
a continuous line drawn on a map or plan of an **explosives** storage location which encompasses the **explosives area** and defines the minimum permissible distance between a **potential explosion site** and **inhabited buildings** which are by definition of vulnerable construction. It is usually at twice the yellow line or normal **inhabited building distance** determined by **blast** considerations. Additionally, the construction of new inhabited buildings of curtain-wall construction or high rise buildings is restricted. The area within the Purple Line is known as the Purple Zone.

3.215
pyrophoric
a substance capable of spontaneous ignition when exposed to air, such as **white phosphorous**.

3.216
pyrotechnic
a device or material that can be ignited to produce light, smoke, or noise.

3.217
qualitative risk assessment
qualitative risk assessments are descriptive versus measurable.

NOTE 1 This is by far the most widely used approach to risk analysis. Probability data is not required and only estimated potential loss is used.

3.218
quality
degree to which a set of inherent characteristics fulfils requirements.

3.219
quality assurance (QA)
part of **quality management** focused on providing confidence that **quality** requirements will be met.

3.220
quality control (QC)
part of **quality management** focused on fulfilling **quality** requirements.

3.221
quality management
coordinated activities to direct and control an organisation with regard to **quality**.

3.222
quantitative risk assessment

a method of estimating and compounding the approximate probability of an accidental **explosion** with that of fatalities and other losses. This enables professional judgement to be applied as to whether or not the risk meets the ALARP[8] principal.

3.223
quantity distance
the minimum permissible distance required between a **potential explosion site** (PES) and an **exposed site** (ES).

3.224
render safe procedure (RSP)
the application of special **explosive ordnance disposal** methods and tools to provide for the interruption of functions or separation of essential components to prevent an unacceptable **detonation**.

3.225
restricted area
an area under jurisdiction in which special **security** measures are employed to prevent unauthorised entry or to safeguard property or material.

3.226
residual risk
the remaining potential for **harm** to persons, property or the environment following all possible efforts to reduce predictable **hazard**s.

3.227
risk
combination of the probability of occurrence of **harm** and the severity of that harm.

3.228
risk analysis
systematic use of available information to identify **hazards** and to estimate the **risk**.

3.229
risk assessment
the overall process comprising a **risk analysis** and a **risk evaluation**.

the objective evaluation of **risk** in a manner in which assumptions and uncertainties are clearly considered and presented.

the determination of the quantitative or qualitative value of **risk** related to a concrete situation and a recognised threat.

3.230
risk evaluation
the process based on **risk analysis** to determine whether the **tolerable risk** has been achieved.

3.231
risk management
the complete risk-based decision-making process.

risk mitigation In
relation to ammunition management, is the term used to describe the measures taken to reduce the effects should an explosion or deflagration occur. Examples would be following compatibility mixing

[8] As Low As Reasonably Practicable.

rules to prevent an item in an incompatible group exacerbating the effects of an explosion, and keeping inhabited buildings outside the yellow line (inhabited building distance).

3.232
risk reduction
actions taken to lessen the probability, negative consequences or both, associated with a particular **risk**. In relation to ammunition management, Risk Reduction is the term used to describe those measures to be taken to reduce the risk of ammunition exploding or deflagrating. It also refers to the methods used to make the ammunition more secure. Examples would be continuous surveillance of ammunition to ensure any safety problems are detected at an early stage and storing ammunition in optimum conditions in secure areas and buildings.

3.233
risk reduction process level 1 (RRPL 1)
basic safety precautions are in place to reduce the risk of undesirable explosive events during ammunition storage, but fatalities and injuries to individuals in local civilian communities may still occur.

3.234
risk reduction process level 2 (RRPL 2)
safety precautions, in the form of appropriate Separation and Quantity Distances, have been implemented to reduce the risk of fatalities and injuries to individuals within local communities to a tolerable level.

3.235
risk reduction process level 3 (RRPL 3)
a safe, secure, effective and efficient conventional ammunition stockpile management system is in place that is fully in line with international best practices.

3.236
rocket
ammunition consisting of a **rocket motor** and a payload. , without an on-board guidance system.

NOTE 1 The term often includes both guided and unguided missiles, although it traditionally referred to unguided missiles.

3.237
rocket motor
articles consisting of a solid, liquid or **hypergolic** fuel contained in a cylinder fitted with one or more nozzles. They are designed to propel a **rocket** or a **guided missile**.

3.238
round
a complete assembly of a projectile (with or without **fuze**), the propelling charge in a **cartridge case**, and the means of igniting the propelling charge. The word is also used in the expression 'supply by complete rounds' meaning that all the components necessary for the **ammunition** to be fired are issued together. For instance, with breech loading (BL) ammunition, the complete round consists of a shell, charge, fuze and **primer**.

3.239
runway
a defined rectangular area of an airfield or heliport, with no curves or tangents, prepared for the landing and takeoff run of aircraft along its length.

3.240
sabotage
destructive or obstructive action designed to hinder capability.

3.241

safe
the absence of **risk**. Normally the term **tolerable risk** is more appropriate and accurate.

3.242
'safe to move'
a technical assessment, by an appropriately qualified technician or technical officer, of the physical condition and stability of **ammunition** and **explosives** prior to any proposed move.

NOTE 1 Should the ammunition and explosives fail a 'Safe to Move' inspection, then they must be destroyed in situ, or as close as is practically possible, by a qualified EOD team acting under the advice and control of the qualified technician or technical officer who conducted the initial Safe to Move inspection.

3.243
safeguarding
a consultative procedure with the appropriate local authority whereby safeguarded areas outside boundary fences are established for each explosives establishment.

NOTE 1 Explosives Safeguarding maps for each establishment are produced depicting a Yellow Line based on inhabited building distance (IBD) and a Purple Line, usually but not always, based on 2 x IBD.

NOTE 2 Copies are provided to the appropriate local authority. It is the aim to restrict the construction of any inhabited building, caravan site, or public traffic routes within the yellow line and the construction of curtain-wall and high rise buildings with large glazed areas, between the yellow and purple lines.

NOTE 3 All new applications for development within safeguarded areas should be notified to the MoD by the appropriate local authority in order that any necessary objections may be lodged.

3.244
safety
the reduction of **risk** to a tolerable level.

degree of freedom from unacceptable **risk**.

3.245
security
the result of measures taken to prevent the theft of **explosive ordnance**, entry by unauthorised persons into **explosive storage areas**, and acts of malfeasance, such as sabotage.

3.246
segregated storage
segregated storage is the storage of **explosives** whose **compatibility groups**, whilst not requiring separate storage, do not permit mixed storage.

NOTE 1 The requirement for segregated storage may be met by any means which is effective in the prevention of propagation between the different groups, e.g. a separate compartment, or an internal traverse or barrier, or by physical distance.

3.247
sensitiveness
a measure of the relative probability of an **explosive** being ignited or initiated by a prescribed stimulus. It is used in the context of accidental ignition or initiation.

3.248
sensitiser
substance used to increase susceptibility to ignition (initiation).

3.249
sensitivity
a measure of the stimulus required to cause reliable design mode function of an **explosive**.

3.250
separation distance
a generic term for the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES).

NOTE 1 Separation distances may or may not involve the use of the quantity distance system. They can be developed through the use of explosion consequence analysis.

3.251
shelf life / service life
time period for which an **explosive** or device can be stored or maintained under specific conditions before use or disposal without becoming unsafe or failing to meet specified performance criteria.

the length of time an item of **ammunition** may be stored before the performance of that ammunition may degrade.

Shelf life (service life) expiry date (SLED)
date on which the shelf life (or service life) of an ammunition item expires.

3.252
shell
a type of projectile, often filled with high explosive.

3.253
shock tube
tube usually consisting of a dusting of **explosive** charge on the inner wall capable on activation of transmitting a shock wave from one end of the tube to another at constant velocity and having no external explosive effect.

NOTE 1 A shock tube is commonly used as a component of detonator assemblies.

3.254
single base propellant
propellant composition containing nitrocellulose as the sole **explosive** ingredient.

3.255
small arms ammunition (SAA)
small arms ammunition (less than 20mm calibre) consists of **cartridges** used in rifles, carbines, revolvers, pistols, submachine guns, and machine guns and shells/cartridges used in shotguns.

3.256
small unit
any government organization, at the tactical level, where individuals are involved in the storage, handling and use of ammunition and explosives but are not directly managed by ammunition qualified personnel.

NOTE 1 Examples of small units would include police stations, isolated small military units, border guard posts etc.

small unit ammunition storage
storage that allows 'ready use' ammunition of HD 1.22, HD 1.32 and HD 1.4 to be kept within buildings that are not specifically designed for ammunition storage (e.g. a police station, unit guardroom or training store).

3.257
stability
the physical and chemical characteristics of **ammunition** and **explosives** that impact on their **safety** in storage, transport and use.

3.258
stabiliser
a substance which stops or reduces auto-catalytic decomposition of explosives.

3.259
standard
a standard is a documented agreement containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes and services are fit for their purpose.

3.260
standing operating procedures (SOPs)
instructions that define the preferred or currently established method of conducting an operational task or activity.

NOTE 1 Their purpose is to promote recognisable and measurable degrees of discipline, uniformity, consistency and commonality within an organisation, with the aim of improving operational effectiveness and safety. SOPs should reflect local requirements and circumstances.

3.261
(ammunition) stock
a given quantity of **explosive ordnance**. (c.f. **Stockpile**).

3.262
(ammunition) stockpile
a large, accumulated stock of **explosive ordnance**. Often used interchangeably with **stock** or to denote the **ammunition** retained in a specific ammunition storage facility or depot. (c.f. **stock**; c.f. **national stockpile**).

3.263
stock check
the process of counting the physical balance of stock at a particular time as part of a system of inventory control.

3.264
stockpile destruction
the physical activities and destructive procedures leading to a reduction of the national stockpile. (c.f. d**estruction**; c.f. d**emilitarization**; c.f. **disposal (logistic)**; c.f. **stockpile**).

3.265
stockpile management
procedures and activities regarding safe and secure accounting, storage, transportation and handling of **ammunition** and **explosives**.

3.266
stockpile safety
the result of measures taken to ensure minimal risk of **accidents** and **hazards** deriving from **explosive ordnance** to personnel working with arms and munitions as well as adjacent populations.

3.267
stockpile security
the result of measures taken to prevent the theft of **explosive ordnance**, entry by unauthorized persons into **explosive storage areas**, and acts of malfeasance, such as sabotage.

3.268
storage
the deposit of **munitions** in a covered or uncovered enclosure, awaiting transportation to or from operational theatres or direct use.

NOTE 1 Normally, the munition is stacked, in its logistic package, and ideally in a controlled environment.

3.269
storage environment
the total set of all external natural and induced conditions to which a materiel is exposed during its storage life.

3.270
storage life
the time for which an **explosive** item in specified storage may be expected to remain safe and serviceable within the envelope of its **service life**.

3.271
storage sub-divisions (SsD)
a numeric code distinguishing the degree of hazard within a hazard division.

NOTE 2 The SsD comprises three digits separated by periods and is used only in storage situations.

3.272
storage temperature limits
the temperature limits to which the **munition** is restricted if it is not to suffer permanent damage or shorten the service life of the **munition** affecting its performance and serviceability.

3.273
sub-munitions
any **munition** that, to perform its tasks, separates from a parent munition. (c.f. **cluster munitions**).

3.274
surplus
the quantity of **explosive ordnance** exceeding the requirements of the **national stockpile**.

3.275
surveillance
a systematic method of evaluating the properties, characteristics and performance capabilities of **ammunition** throughout its life cycle in order to assess the reliability, **safety** and operational effectiveness of stocks and to provide data in support of life reassessment.

the constant review of accumulating test results to ensure that the overall quality remains acceptable. The term is also applied to the continuing examination of the stores themselves.

3.276
tampering
an incident caused by altering the makeup of or attempted dismantling of an item of ammunition.

NOTE 1 Tampering may be malicious, as a prank or through curiosity and be carried out by either military or civilian personnel.

3.277
taxiway
a specially prepared or designated path, on an airfield or heliport other than apron areas, on which aircraft move under their own power to and from landing, service and parking areas.

3.278
through life management (TLM)
an integrated approach to the processing, planning and costing activities across the whole service life of a specific ammunition type until it is used or disposed of.

3.279
tolerable risk
risk, which is accepted in a given context based on the current values of society.

3.280
tracer ammunition
ammunition containing **pyrotechnic** substances designed to reveal the trajectory of a projectile.

3.281
tracing
the systematic tracking of illicit **ammunition** from the point of its manufacture or import, through the lines of supply, to the point at which it became illicit.

3.282
transit area
areas where consignments of explosives undergoing movements are assembled/dismantled for transhipment between modes of transport which operate within an explosives facility, and those which operate outside the area.

3.283
underground storage
storage in chambers that are below surface level. In the case of an accidental **explosion** at such a site, the hazard of low angle, high velocity projections is reduced significantly. The other **hazardous** effects are similar to those in above ground storage, but are gradually reduced as the cover is increased.

3.284
unexploded ordnance (UXO)
explosive ordnance which has been primed, fused, armed or otherwise prepared for action, and which has been dropped, fired, launched, projected, or placed in such a manner as to constitute a **hazard** to operations, installations, personnel or material and remains unexploded either by malfunction or design or for any other cause.

3.285
unit load
the unit formed when packages or unpacked articles are assembled on or in a device that enables them to be mechanically handled as one unit, but which is not a freight container. (Usually **pallets**).

3.286
unit of space (UOS)
for planning purposes, storage space for palletized stores is calculated in units of space (UoS).

NOTE 1 In NATO, each UoS equates to a standard Unit Load of a maximum size of 1080 x 1300 x 1372 mm (i.e. 1.93m^3), subject to a maximum floor loading of 16,000 lbs. (7257 kg) for a single stack pallet base area.

NOTE 2 For non-NATO countries it is recommended that a UOS equates to 1m^3, with an All Up Weight (AUW) of 1 tonne.

3.287
user
the individual or organisation that will operate the equipment or facility.

3.288
vulnerable building
exposed site deemed to be vulnerable by nature of its construction or function and therefore sited at greater than other **OQDs**.

3.289
vulnerable building

the term ‘vulnerable building’ refers to an exposed site (ES) deemed to be vulnerable by nature of its construction or function and therefore sited at greater than IBD.

NOTE 1 Examples are multi-story buildings with lots of exposed glass facing the PES, hospitals, places of high concentrations of people such as schools and churches, and warehouse type structures that use curtain-wall construction techniques.

3.290
vulnerable building distance (VBD)
the minimum permissible distance between a **potential explosion site** (PES) and a **vulnerable building**.

NOTE 1 The VBD is a form of Outside Quantity Distance (OQD).

3.291
warhead
munitions containing detonating **explosives**. They are designed to be fitted to a rocket, missile or torpedo.

the portion of a weapon system which contains the payload which the projectile, rocket, missile or torpedo is to deliver.

NOTE 1 Generally, the payload is explosive, or it may contain telemetric or other components.

3.292
weapon
anything used, designed or intended for use in causing death or injury, or for the purposes of threatening or intimidating any person.

3.293
workplace
all places where employees need to be or to go by reason of their work and which are under the direct or indirect control of the employer.

3.294
works services
the construction, repair or maintenance work done by organisations or staff, usually civilian, who are not integral parts of the ammunition storage unit.

3.295
yellow line
a continuous line drawn on the map or plan of an **explosives area** which encompasses the explosives area and defines the minimum permissible distance between a **potential explosion site** and **inhabited buildings**, caravan sites or assembly places.

a line at **IBD** within which the construction of new inhabited buildings, caravan sights and public traffic routes are restricted. The area within the Yellow Line is known as the Yellow Zone.

Abbreviations

For the purposes of all IATG modules the following abbreviations shall apply.

$\sqrt{2E}$	Gurney Constant for a given explosive (m/s) *(In Formula)*
θ	Launch Angle (Radians) *(In Formula)*
AAP	Allied Administration Publication (NATO)
AASTP	Allied Ammunition Storage and Transport Publications (NATO)
AC	Alternating Current or Ammunition Container
ACA	Ammunition Container Assembly
ACTO	Attractive to Criminals and Terrorist Organisations
ADAC	Ammunition Descriptive Asset Code
ADF	Ammunition Demilitarization Facility
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
ALARP	As Low As Reasonably Practicable
ALM	Air Launched Munitions
AMPS	Ammunition Management Policy Statements
AOP	Allied Ordnance Publication
AP	Armour Piercing
APB	Ammunition Process Building
APE	Ammunition Peculiar Equipment
ASA	Ammunition Storage Area
ASO	Ammunition Storage Officer
AT	Ammunition technician
ATA	Ammunition Technical Assessment
ATN	Air Termination Network
ATO	Ammunition Technical Officer
AUW	All Up Weight (kg)
BI	Batch Identity
BL	Breech Loading
BKI	Batch Key Identity
BS	British Standards
c	Speed of Sound (m/s) (*In Formula)*
C_{exp}	Charge Mass of Explosive (kg) (*In Formula)*
C_r	Reflection Coefficient, Pressure (*In Formula)*
CBA	Cost Benefit Analysis
CCM	Convention on Cluster Munitions
CCTV	Close-Circuit Television
CEN	Comité Européen de Normalisation
CFFE	Certified Free Form Explosives
CG	Compatibility Group
CG/HCCS	Coordinating Group for the Harmonization of Chemical Classification Systems (IOMC)
CID	Chamber Interval Distance (Underground Storage)
CMD	Conventional Munition Disposal
COSHH	Control of Substances Hazardous to Health
COTIF	Convention concerning International Carriage by Rail

CoTS	Commercial off The Shelf
CTA	Chief Technical Advisor
CW	Continuous Wave
CWA	CEN Workshop Agreement
D	Density (g/cm^3) (*In Formula)*
D_{air}	Density of Air (kg/m^3) (*In Formula)*
D_{cd}	Chamber Interval Distance (underground storage)
D_{sf}	Density of Air behind Shock Front (kg/m^3) (*In Formula)*
DAC	Dangerous Air Cargo
DAER	Daily Ammunition Expenditure Rate
DC	Direct Current
DDESB	Department of Defense Explosives Safety Board
DDR	Disarmament, Demobilization and Reintegration
DG	Dangerous Goods
DGR	Dangerous Goods Regulations
DU	Depleted Uranium
E^d_{exp}	Detonation Energy, Specific of Explosive (J/kg) (*In Formula)*
E^d_{TNT}	Detonation Energy, Specific of TNT (J/kg) (*In Formula)*
EBP	Equipotential Bonding
EBW	Exploding Bridge Wire
EC	European Commission
ECM	Earth Covered Magazine
ECA	Explosion Consequence Analysis
ECM	Earth-Covered Magazine
ECVET	European Credit system for Vocational Education and Training
EED	Electro-Explosive Device
EFI	Exploding Foil Initiator
EID	Electrically Initiated Device
EIDS	Extremely Insensitive Detonating Substance
ELL	Explosive Limit License
EM	Electro-Magnetic
EMC	Electro-Magnetic Compatibility
EMR	Electro-Magnetic Radiation
EMV	Expected Monetary Value
EN	European Normalization (CEN Standard)
ENEQ	Effective Net Explosive Quantity
EO	Explosive Ordnance
EOD	Explosive Ordnance Disposal
EPA	Electrostatic Discharge Protected Area
EPB	Equipotential Bonding
ERP	Effective Radiated Power
ES	Exposed Site
ESA	Explosive Storage Area
ESC	Explosive Safety Case
ESD	Electrostatic Discharge

ESH	Explosive Storehouse
ESM	Explosives Safeguarding Map
ESMRM	Explosives Safety and Munitions Risk Management
ESO	Explosives Safety Officer
EU	European Union
EUExcert	European Union Explosive Certification
EUExImp	European Union Explosives sector Implementation of occupational standards
EWD	Explosives Workshop Distance
EWI	Explosive Waste Incinerator
EWS	Emergency Water Supply
f_d	Decoupling Factor
FB	Film Bridge (detonator)
FESO	Force Explosives Safety Officer
FFE	Free From Explosives
FSA	Field Storage Area
FSM	Field Stack Module
FSP	Fire Safety Plan
FSSM	Field Storage Site Module
g	Gravity (m/s^2) (*In Formula)*
GAAP	Generally Accepted Accounting Principles
GHS	Globally Harmonized System
GM	Guided Missile
GRP	Glass Reinforced Plastic
GW	Guided Weapon
HATPM	Hazardous Area Personal Test Meter
HCC	Hazard Classification Code (UN)
H_D	Hydraulic Diameter
HD	Hazard Division (UN)
HE	High Explosive
HEI	High Explosive Incendiary
HERO	Hazards of Electromagnetic Radiation to Ordnance
HESH	High Explosive Squash Head
HPLC	High Performance Liquid Chromatography
HRHY	Hot-Rolled High-Yield
HV	High Velocity *(Ballistics)* or High Voltage *(Electrical)*
I_s	Impulse, Side On (kg.m/s) (*In Formula)*
I_{si}	Impulse, Scaled (kg.m/s) (*In Formula)*
I&RI	Inspection and Repair Instruction (Ammunition Processing)
IACG (CA)	Inter Agency Coordination Group (Conventional Ammunition)
IATA	International Air Transport Association
IATG	International Ammunition Technical Guidelines
IBD	Inhabited Building Distance
IBIN	INTERPOL Ballistic Identification Network
ICAO	International Civil Aviation Organisation
IDDRS	International Disarmament, Demobilization and Reintegration Standards

IDP	Internally Displaced Persons
IDS	Intrusion Detection System
IED	Improvised Explosive Device
IEDD	Improvised Explosive Device Disposal
IFFA	Immediate Fire-Fighting Appliances
IFRT	INTERPOL Firearms Reference Table
IFTR	INTERPOL Firearms Tracing Request
ILO	International Labour Organization
IM	Insensitive Munition(s)
IMAS	International Mine Action Standards
IMD	Inter Magazine Distance
IMDG	International Maritime Dangerous Goods (Code)
IMO	International Maritime Organization
IOMC	Inter-organization Programme for the Sound Management of Chemicals
IQD	Inside Quantity Distance
IR	Individual Risk of Fatality (Annual)
ISO	International Standards Organisation
IT	Information Technology
KE	Kinetic Energy
kPa	Kilo- Pascal
KR	Key Role
LPG	Liquid Petroleum Gas
LPS	Lightning Protection System
LSF	Low Smoke and Fume (Cable)
LV	Low Voltage
m	Mass (kg) (*In Formula)*
M_{exp}	Mass, Explosive TNT (kg) (*In Formula)*
M_{TNTe}	Mass, Equivalent TNT (kg) (*In Formula)*
MΩ	Mega Ohm
MANPADS	Man Portable Air Defence Systems
MCE	Maximum Credible Explosive Event
MFA	Ministry of Foreign Affairs
MHE	Mechanical Handling Equipment
MHz	Mega-Hertz
MIA	Ministry of Internal Affairs
MIMC	Mineral Insulated Metal Covered
MJ	Mega Joule
MLA	Munition Life Assessment
MLAD	Munition Life Assessment Database
MN	Multi-National
MOD	Ministry of Defence
MOI	Ministry of Interior
MOU	Memorandum of Understanding
MPa	Mega-Pascal
MSER	Manufacture and Storage of Explosive Regulations 2005 (UK)

NAMSA	NATO Maintenance and Supply Agency (has been renamed NSPA)
NATO	North Atlantic Treaty Organisation
NC	Nitrocellulose
NEC	Net Explosive Content
NEQ	Net Explosive Quantity (alternatively NEC (Net Explosive Content))
NFT	No-Fire Threshold
NG	Nitroglycerine
NGO	Non-Governmental Organisation
NOS	National Occupational Standards
NSO	NATO Standardization Organization
NSPA	NATO Support and Procurement Agency
OB	Open Burning
OBOD	Open Burning and Open Detonation
OD	Open Detonation
OECD	Organization for Economic Cooperation and Development
OEL	Occupational Exposure Limit
OIC	Officer in Charge
OQD	Outside Quantity Distance
OSCE	Organisation for Security and Cooperation in Europe
P_0	Pressure, Ambient (kPa) (*In Formula)*
P_d	Pressure, Peak Dynamic (kPa) (*In Formula)*
P_{det}	Pressure, Detonation (GPa) (*In Formula)*
P_r	Pressure, Peak Reflected (kPa) (*In Formula)*
P_s	Pressure, Peak Side On (kPa) (*In Formula)*
PAT	Portable Appliance Test
PB	Process Building
PBD	Process Building Distance
PCP	Polychloroprence
PCS	Pollution Control System
PE	Plastic Explosive
PED	Personal Electronic Devices
PES	Potential Explosion Site
PETN	Pentaerythrite-Tetranitrate
PIDS	Perimeter Intrusion Detection Sysytem
PME	Protected Multiple Earths
POL	Petroleum, Oils and Lubricants
PPE	Personal Protective Equipment
PPEC	Personal Protective Equipment and Clothing
PPR	Post Project Review
PTR	Public Traffic Route
PTRD	Public Traffic Route Distance
PTW	Permit to Work
PVC	Poly Vinyl Chloride
QA	Quality Assurance
QD	Quantity Distance

QRA	Quantitative Risk Assessment
R	Range (m) (*In Formula)*
RADHAZ	Radiation Hazard
RAG	Returned Ammunition Group
RC	Reinforced Concrete
RCD	Residual Current Device
RDX	Research Department Explosive (Cyclonite)
RES	Remaining Effective Stabiliser
RF	Radio Frequency
RFID	Radio Frequency Identification Device
RH	Relative Humidity
RID	International Ordinance on the Transport of Dangerous Goods by Rail
RMS	Root Mean Square
RP	Red Phosphorus
RRPL	Risk Reduction Process Level
RSP	Render Safe Procedure
SAA	Small Arms Ammunition
SAADS	Small Arms Ammunition Disposal System (Commercial)
SAQA	South Africa Qualifications Agency
SAU	Safety and Arming Unit
SCBA	Self Contained Breathing Apparatus
SELV	Separated Extra Low Voltage
SFO	Senior Fire Officer
SHA	Small Holding Area
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea
SON	Statement of Operational Need
SOP	Standing (Standard) Operating Procedure
SPS	Splinter Proof Shelter
SsD	Storage sub-Division
SSOW	Safe Systems of Work
STANAG	Standardisation Agreement (NATO)
STO	Statement of Tasks and Output
SWL	Safe Working Load
τ	Thermal Time Constant
t	Time (s) (*In Formula)*
t	Tonnes
T/PCC	Troop/Police Contributing Countries
TD	Temporary Distance
TEH	Test Equipment House
TLM	Through Life Management
TNT	Trinitrotoluene (Trotyl)
TOIC	Technical Officer in Charge
TOR	Terms of Reference
TRADS	Transportable Ammunition Demilitarization System

TRB	Technical Review Board
UAV	Un-crewed Aerial Vehicle
ULC	Unit Load Container (Pallets)
ULS	Unit Load Specification
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCETDG/GHS	Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals
UNDP	United Nations Development Programme
UNGA	United Nations General Assembly
UNODA	UN Office for Disarmament Affairs
UNSC	UN Security Council
UNSCETDG	United Nations Economic and Social Council's Sub-Committee of Experts on the Transport of Dangerous Goods
UOS	Unit of Space
UPS	Uninterruptible Power Supply
UXO	Unexploded Ordnance
V_0	Velocity, Initial Fragment (m/s) (*In Formula)*
V_d	Velocity of Detonation (m/s) (*In Formula)*
V_p	Velocity of Particle (m/s) (*In Formula)*
V_{sf}	Velocity of Shock Front (m/s) (*In Formula)*
VBD	Vulnerable Building Distance
W	Weight of Explosive (kg) (*In Formula)*
WACR	Weapon Assembly and Check Rooms
WLL	Working Load Limit
WP	White Phosphorus
XLPE	Cross Linked Polyethylene

Annex A
(informative)
References

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

a) AAP-6 (Edition 2016), *NATO Glossary of Terms and Definitions*. NATO Standardization Office (NSO). http://nso.nato.int/nso/nsdd/listpromulg.html.

b) AOP-38 *Glossary of Terms and Definitions concerning the Safety and Suitability for Service of Munitions, Explosives and Related Products*. (5th Edition). NATO Standardization Office (NSO). June 2009.

c) CEN 13857-1:2003(E) *Explosives for civil uses – Part 1: Terminology*. CEN. 2003;

d) ISO Guide 51:2014 *Safety aspects – Guidelines for their inclusion in standards*. ISO. 2014;

e) ISO 9001:2015(E) *Quality management systems – Requirements.* ISO. 2015; and

f) ISO 14001:2015(E) *Environmental management systems – Guidelines*. ISO. 2015.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[9] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[9] Where copyright permits.

Amendment record

Management of IATG amendments

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

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

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

The most recently amended, and thus extant, IATG will be the versions that are posted on the UN *Safer*Guard IATG website at www.un.org/disarmament/convarms/ammunition/ .

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	Xx xx 17	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.50

Third edition
March 2021

UN explosive hazard classification system and codes

UN SaferGuard
Securing ammunition, protecting lives

IATG 01.50:2021[E]

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United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

In order to primarily promote the safe transport of dangerous goods, an internationally agreed system for classification was devised by the United Nations, which is now globally used. Whilst initially produced for the transport of dangerous goods the principles have been applied by many nations as the basis for a simplified consequential hazard and risk assessment for the storage of ammunition.

The system comprises Hazard Divisions that indicate the type of hazard to be expected primarily in the event of an accident involving a quantity of ammunition, and Compatibility Groups. The Compatibility Groups are designed to minimise the risk of storing items together that will either increase the risk of an accident or, for a given quantity, the magnitude of the effects of such an accident. This process does not take into account the probability of an incident. It assumes that if it can happen it will, and when it does, it identifies the extent of the hazards.

The combination of the Hazard Division and the Compatibility Group results in a range of Hazard Classification Codes for all types of ammunition and explosives. These codes, or a similar national system, are critical to the safe storage and movement of ammunition and explosives.

Ideally, a higher degree of safety may be achieved by storing and transporting every ammunition type separately, but this is usually not practicable for reasons of storage and transportation efficiency and capacity. In practice, ammunition of different Compatibility Groups may be stored and transported together in order to maximize the efficient use of available storage space or transport capacity, provided certain conditions are met.

UN explosive hazard classification system and codes

1 Scope

This IATG module introduces and explains the UN explosive classification system and codes, which is based on the UN Globally Harmonized System of Classification and Labelling of Chemicals (GHS).[3]

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

The term 'compatibility group' refers to *a grouping identified by a letter which, when referenced to a compatibility table, shows those explosives which may be stored or transported together without significantly increasing the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident. Codes are used to indicate which natures may be safely stored together*.

The term 'hazard class' refers to *the UN recommended system of nine classes for identifying dangerous goods. Class 1 identifies explosives*.

The term 'hazard classification code' (HCC) refers to *an alpha-numeric symbol that denotes the complete HCC for a particular nature. The code consists of two or three digits indicating the hazard division followed by a letter corresponding to the compatibility group, e.g. 1.3G*.

The term 'hazard division' (HD) refers to *the UN classification system that identifies hazardous substances*.

The term 'storage sub-divisions' (SsD) refers to a *numeric code distinguishing the degree of hazard within a hazard division*.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

[3] *United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. ST/SG/AC.10/30/Rev.6 Geneva. United Nations. 2015.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS)[4] is the culmination of more than a decade of work. The work began with the premise that existing systems should be harmonized in order to develop a single, globally harmonized system to address classification of chemicals, labels, and safety data sheets; this included military and civil explosives. The existing *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*[5] are used as a complementary document containing details of the symbols and hazard classes themselves. The relevant ones have been extracted into this IATG.

The international mandate that provided the impetus for completing this work was adopted in the 1992 United Nations Conference on Environment and Development (UNCED), as reflected in Agenda 21, paragraph 19.27:

> *'A globally harmonized hazard classification and compatible labelling system, including material safety data sheets and easily understandable symbols, should be available, if feasible, by the year 2000'.*

The work was coordinated and managed under the auspices of the Inter-organization Programme for the Sound Management of Chemicals (IOMC) Coordinating Group for the Harmonization of Chemical Classification Systems (CG/HCCS). The technical focal points for completing the work were the International Labour Organization (ILO); the Organization for Economic Cooperation and Development (OECD); and the United Nations Economic and Social Council's Sub-Committee of Experts on the Transport of Dangerous Goods (UNSCETDG).

Once completed in 2001, the work was transmitted by the IOMC to the new United Nations Economic and Social Council's Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals (UNSCEGHS). This Sub-committee was established by the Council's resolution 1999/65 of 26 October 1999 as a subsidiary body of the former UNCETDG, which was reconfigured and renamed at the same occasion 'Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals' (UNCETDG/GHS). The Committee and its sub-committees work on a biennium basis.

The UNCEGHS is responsible for maintaining the GHS and promoting its implementation. It provides additional guidance as needs arise while maintaining stability in the system to encourage its adoption. Under its auspices, the document is regularly revised and updated to reflect national, regional and international experiences in implementing requirements into national, regional and international laws, as well as experiences of those doing the classification and labelling. This IATG shall be updated to reflect any applicable changes in the GHS.

[4] *United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. ST/SG/AC.10/30/Rev.6. Geneva. United Nations. 2015

[5] *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Nineteenth revised edition), ST/SG/AC.10/1/Rev.19, , 2015. *(Referred to as the UN Model Regulations).*

5 Purpose of explosive hazard classification system and codes

The purpose of explosive hazard classification codes is to:

a) enhance the protection of human health and the environment by providing an internationally comprehensible system for hazard communication;

b) provide a recognised framework for those countries without an existing explosive hazard classification system;

c) reduce the need for testing and evaluation of ammunition, explosives, propellants and pyrotechnics; and

d) facilitate internal and external movement of ammunition and explosives whose hazards have been properly assessed and identified on an international basis.

6 Hazard classification codes

In order to primarily promote the safe transport of dangerous goods, an internationally agreed system for classification has been devised as explained in Clause 4. Whilst initially produced for the transport of dangerous goods the principles have been applied by many nations as the basis for a simplified consequential hazard and risk assessment for the storage of ammunition. The system consists of 9 dangerous goods classes of which Class 1 comprises ammunition and explosives.

Class 1 is then divided into Hazard Divisions, which indicate the type of hazard to be expected primarily in the event of an accident involving a quantity of ammunition. Class 1 ammunition is further divided into Compatibility Groups designed to minimise the risk of storing items together that will either increase the risk of an accident or, for a given quantity, the magnitude of the effects of such an accident. This process does not take into account the probability of an incident. It assumes that if it can happen it will, and when it does, it identifies the extent of the hazards.

The UN hazard classification code (HCC) for an explosive or type of ammunition shall therefore consist of a combination of:

a) the Hazard Division; and

b) the Compatibility Group.

6.1 Hazard divisions (LEVEL 1)

The Hazard Division for a particular explosive or type of ammunition, within Hazard Class 1 of the GHS, shall be determined by its performance and test results according to Part I of the *Manual of Tests and Criteria*[6] of the UN Recommendations on the Transport of Dangerous Goods.[7]

Stockpile management organisations should ensure that the ammunition and explosives in their possession is classified in accordance with the GHS. Table 1 summarises the Hazard Divisions that should be adopted during the stockpile management of conventional ammunition, although alternative local systems may be utilised.

HD 1.2 and HD 1.3 have been sub-divided into storage sub-divisions (SsD), which are applicable only to storage situations. These are explained in IATG 05.20 Types of Buildings for Explosives Storage (articles 5.2 and 5.3).

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[6] *United Nations Manual of Tests and Criteria,* (6th revised edition), ST/SG/AC.10/11/Rev.6, , 2015. (*Referred to as UN Manual of Tests and Criteria).*

[7] The UN Recommendations effectively consist of two parts: 1) *The Manual of Tests and Criteria*; and 2) *The Model Regulations* (both normative references in Annex A).

Hazard Division/ Storage Sub-division	**Description**	**Pictogram**[8]	**Signal Word**	**Hazard Statement**
1.1	Ammunition that has a mass explosion hazard.		▪ **Danger**	▪ Mass explosion hazard.
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.		▪ **Danger**	▪ Severe projection hazard.
1.2.1 (SsD)	Ammunition that has a projection hazard but not a mass explosion hazard. (More hazardous items of HD 1.2, which give large fragments over an extended range). SsD 1.2.1 contains articles which have above 0.136kg NEQ of HE content.		▪ **Danger**	▪
1.2.2 (SsD)	Ammunition that has a projection hazard but not a mass explosion hazard. (The less hazardous items of HD 1.2, which give smaller fragments of limited range). SsD 1.2.2 contains articles which have 0.136kg NEQ of HE content and below		▪ **Danger**	▪
1.2.3 (SsD)	Ammunition that exhibit at most an explosion reaction during sympathetic reaction testing and a burning reaction in bullet impact and heating tests.[9]		▪ **Danger**	▪
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.		▪ **Danger**	▪ Fire, blast or projection hazard.
1.3.1 (SsD)	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. (The more hazardous items with mass fire hazard and considerable thermal radiation).		▪ **Danger**	▪

[8] The examples shown also include the Compatibility Group.

[9] This is a 'new' HD and is derived from NATO AASTP-3, Edition 1, Change 3. *Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives.* August 2009

Hazard Division/ Storage Sub-division	**Description**	**Pictogram[8]**	**Signal Word**	**Hazard Statement**
1.3.2 (SsD)	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. (The less hazardous items that burn sporadically).		▪ **Danger**	▪
1.4	Ammunition that presents no significant hazard.		▪ **Warning**	▪ Fire or projection hazard.
1.5	Very insensitive substances, which have a mass explosion hazard.		▪ **Danger**	▪ May mass explode in fire.
1.6	Extremely insensitive articles which do not have a mass explosion hazard.		▪ *No Signal Word*	▪ *No hazard statement.*
Unstable Explosive	Any explosive in an unstable condition.	*No pictogram assigned as the transport of unstable explosive is not permitted.*	▪ **Danger**	▪ Unstable explosive.

Table 1: Hazard Divisions[10]

6.1.1. Fire Divisions (LEVEL 1)

The six fire divisions, which equate to the hazard divisions, should be indicated during storage and transportation by one of four distinctive symbols in order to be recognised by the fire-fighting personnel approaching the fire scene. Hazard Division symbols may also be used for this purpose. A fire division number is shown on each symbol. Due to similar fire-fighting hazards, the Fire Division 1 fire symbol and number are also used for Fire Division 5 and the Fire Division 2 fire symbol and number are also used for Fire Division 6. The symbols in Table 2 shall be used when fire divisions are indicated during storage and transport:

[10] GHS Annex 1.

Fire Division	Symbol	Remarks
1.1		▪
1.2		▪
1.3		▪
1.4		▪
1.5		▪ Fire Division 1 symbol used due to similar fire-fighting hazards.
1.6		▪ Fire Division 2 symbol used due to similar fire-fighting hazards.

Table 2: Fire Divisions

6.2 Compatibility Groups (LEVEL 1)

There may be hundreds of thousands of individual ammunition items, of many different types, stored in a single stockpile. The different types of ammunition will vary in purpose, calibre, explosive type and manufacturer, all with varying degrees of volatility. In order to improve overall safety by reducing the magnitude of an accident that may occur, each specific type of conventional ammunition should be allocated to a Compatibility Group. Strict application of the Mixing Rules (Clause 7.1) will then ensure a significant reduction and/or mitigation of the risk.

Compatibility Group	Full Description[11]	Examples
A	▪ Primary explosive substance.	▪ Examples are lead azide, lead styphnate, mercury fulminate, tetracene, dry RDX, and dry PETN.
B	▪ Articles containing a primary explosive substance and not containing two or more effective protective features. Some articles, such as detonators for blasting, detonator assemblies for blasting and primers, cap-type, are included, even though they do not contain primary explosives.	▪ Examples are detonators, blasting caps, small arms primers, and fuses without two or more safety features. ▪

[11] Full descriptions are from the *UN Model Regulations*.

Compatibility Group	Full Description[11]	Examples
C	▪ Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance.	▪ Examples are single-, double-, triple-based, and composite propellants, rocket motors (solid propellant), and ammunition with inert projectile.
D	▪ Secondary detonating explosive substance or black powder or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features.	▪ Examples are bulk TNT, Composition B, wet RDX, bombs, projectiles, warheads, or fuzes with two or more safety features.
E	▪ Article containing a secondary detonating explosive substance without means of initiation, with propelling charge (other than one containing a flammable liquid or gel or hypergolic liquids).	▪ Examples are artillery ammunition, rockets, or guided missiles.
F	▪ Article containing a secondary detonating explosive substance with its own means of initiation, with a propelling charge (other than one containing a flammable liquid or gel or hypergolic liquids) or without a propelling charge.	▪ An example is a rocket propelled grenade.
G	▪ Pyrotechnic substance, or article containing a pyrotechnic substance, or article containing both an explosive substance and an illuminating, incendiary, tear- or smoke-producing substance (other than a water activated article or one containing white phosphorus, phosphides, a pyrophoric substance, a flammable liquid or gel, or hypergolic liquids).	▪ Examples are flares, signals, incendiary or illuminating ammunition, and other smoke and tear producing devices.
H	▪ Article containing both an explosive substance and white phosphorus.	▪ Examples are WP, plasticized white phosphorus (PWP), or other ammunition containing pyrophoric material.
J	▪ Ammunition containing both an explosive substance and a flammable liquid or gel.	▪ Examples include liquid- or gel-filled incendiary ammunition.
K	▪ Articles containing both an explosive substance and a toxic chemical agent.	▪ Examples are artillery or mortar ammunition (fuzed or unfuzed), grenades, and rockets or bombs filled with a lethal or incapacitating chemical agent.
L	▪ Explosive substance or article containing an explosive substance and presenting a special risk (e.g. due to water activation or presence of hypergolic liquids, phosphides or a pyrophoric substance) and needing isolation of each type.	▪ Examples are pre-packaged hypergolic liquid-fuelled rocket engines, TPA (thickened TEA).

Compatibility Group	Full Description[11]	Examples
N	▪ Articles containing only extremely insensitive detonating substance (EIDS).	▪ Examples are bombs and warheads. ▪ If dissimilar Group N munitions, such as Mk 82 and Mk 84 Bombs, are mixed together and have not been tested to assure non- propagation; the mixed munitions are considered to be Hazard Division 1.2, Compatibility Group D for purposes of transportation and storage.
S	▪ Substance or article so packed or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit fire-fighting or other emergency response efforts in the immediate vicinity of the package.	▪ Examples are small arms cartridges (ball), explosive switches or valves.

Table 3: Compatibility Groups

A list of extant Hazard Classification Codes for explosives and explosive articles, together with the appropriate UN Serial Number for transport has been extracted from the *UN Model Regulations* and is at Annex C for information.

NOTES

(1) Attention is drawn to the descriptions of CGs B, F, D and E. The essential differences between them are subtle and depend on such things as:

(a) Whether a means of initiation is or is not fitted.
(b) Whether the means of initiation has at least two effective protective measures that prevent the initiation of the ammunition in the event of accidental functioning of the means of initiation during handling, storage and transportation.
(c) Whether the means of initiation is packed in the same package as the ammunition (but separately). The method of packaging is such as to prevent the initiation of the ammunition in the event of an accidental functioning of the initiating device.

(2) These differences are best illustrated by examples, as follows:

(a) A detonating fuze will be CG B if it does not have at least two effective protective features but will be CG D if it does.
(b) A plugged HE shell, or bomb will be CG D.
(c) An HE shell, or bomb fitted with a CG D fuze will be classified as CG D.
(d) An HE shell, or bomb fitted with a CG B fuze will be classified as CG F.
(e) HE grenades packed with their fuzes will be classified as CG D only if it has been demonstrated that even if the fuzes function accidentally, the grenades will not be initiated; otherwise they will be classified CG F.
(f) An HE round fitted with a CG D fuze will be CG E but will be CG F if it has a CG B fuze.

(3) CG D applies only when secondary detonating explosive (High Explosives) substances, or Black Powder, are properly packaged in an approved dust- tight container. Otherwise CG L applies.

7 Storage of Compatibility Groups (LEVEL 1)

7.1 Mixing rules

Ideally, a higher degree of safety may be achieved by storing every ammunition type separately, but this is usually not practicable for reasons of storage capacity. Ammunition of different Compatibility Groups may be stored together in order to maximise the efficient use of available storage space.

Conventional ammunition should be stored by Compatibility Group in accordance with the mixing rules illustrated in Table 4.

Compatibility Group	A	B	C	D	E	F	G	H	J	K	L	N	S
A	X												
B		X	X (1)	X (1)	X (1)	X (1)	X (1)						X
C		X (1)	X	X	X	X (2)	X (3)					X (4)	X
D		X (1)	X	X	X	X (2)	X (3)					X (4)	X
E		X (1)	X	X	X	X (2)	X (3)					X (4)	X
F		X (1)	X (2)	X (2)	X (2)	X	X (2,3)						X
G		X (1)	X (3)	X (3)	X (3)	X (2,3)	X						X
H								X					X
J									X				X
K										X			
L											(5)		
N			X (4)	X (4)	X (4)							X (6)	X (7)
S		X	X	X	X	X	X	X	X			X (7)	X

Table 4: Compatibility Group Mixing Rules

NOTE 1 Compatibility Group B fuzes may be stored with the articles to which they will be assembled, but the Net Explosive Quantity (NEQ) shall be aggregated and treated as Compatibility Group F.

NOTE 2 Storage in the same building may be permitted if effectively segregated to prevent propagation.

NOTE 3 Mixing of articles of Compatibility Group G with articles of other compatibility groups is at the discretion of the National Competent Authority.

NOTE 4 Articles of Compatibility Group N should not in general be stored with articles in other compatibility groups except S. However, if such articles are stored with articles of Compatibility Group C, D and E, the articles of Compatibility Group N should be considered as having the characteristics of Compatibility Group D and the compatibility groups mixing rules apply accordingly.

NOTE 5 Compatibility Group L articles shall always be stored separately from all articles of other compatibility groups as well as from all other articles of different types of Compatibility Group L.

NOTE 6 It is allowed to mix 1.6N munitions. The Compatibility Group of the mixed set remains N if the munitions belong to the same family or if it has been demonstrated that, in case of a detonation of one munition, there is no instant transmission to the munitions of another family (the families are then called 'compatible'). If it is not the case the whole set of munitions should be considered as having the characteristics of Compatibility Group D.

NOTE 7 A mixed set of munitions 1.6N and 1.4S may be considered as having the characteristics of Compatibility Group N.

7.2 Ammunition requiring separate storage (LEVEL 1)

In addition to the mixing rules (Clause 7.1) certain types of conventional ammunition should always be stored separately (or under specific conditions) from other types of ammunition:

a) detonators and blasting caps (separated from Compatibility Groups C, D, E, and F by a dividing wall capable of preventing sympathetic detonation of other items);

b) damaged ammunition. (If considered unsafe for storage, damaged munitions should be destroyed at the earliest convenience);

c) ammunition in an unknown condition. (This shall be stored at such a distance that detonation of this ammunition will not jeopardize other stocks);

d) ammunition that has deteriorated and become hazardous. (This shall be stored in isolation and destroyed at the earliest convenience).

8 Types of tests for UN hazard classification (LEVEL 3)

8.1 General

There is a range of tests stipulated in Part 1 of the *UN Manual of Tests and Criteria* that should be used to determine the Hazard Division applicable to a certain type of ammunition. This testing should usually be done by the ammunition and explosives manufacturer prior to initial sale.

If the Hazard Division of conventional ammunition is not known, records have been lost or the system has never been used before in the country, then stockpile management organisations may be able to allocate the appropriate Hazard Division by comparison of the ammunition characteristics to similar ammunition for which a Hazard Division has been allocated. This would negate the requirement for a range of expensive and time-consuming tests. Alternatively, the ammunition may be allocated HCC 1.1.F if it is not G, H, J, K or L. This Clause of the IATG only seeks to introduce the test classification system; full details are available in the *UN Manual of Tests and Criteria.*

The full range of test series covers:

Test Series	Test Aim
1	▪ To determine if a substance has explosive properties.
2	▪ To determine if a substance is too insensitive for inclusion in Class 1 (Explosives).
3	▪ To determine if a substance is thermally stable and not too dangerous to transport in the form in which it was tested.
4	▪ To determine if an article, packaged article or packaged substance is too dangerous for transport.
5	▪ To determine if a substance may be allocated to Hazard Division 1.5.
6	▪ To determine if a substance may be allocated to Hazard Divisions 1.1, 1.2, 1.3 or 1.4 or to exclude it from Hazard Class 1.
7	▪ To determine if an article may be assigned to Hazard Division 1.6.
8	▪ To determine if an ammonium nitrate emulsion, suspension or gel, intermediate for blasting explosives (ANE), is insensitive enough for inclusion in Hazard Division 5.1 and to evaluate the suitability for transport in tanks.

Table 5: Summary of Part 1 Test Series

8.2 Test Identification Codes

Each test has a specific identification code that indicates:

a) the part of the *UN Manual of Tests and Criteria* that the test relates to. (i.e. I for Part I, which covers Hazard Class 1 - explosives);

b) the test series, (see Clause 8.1);

c) test type; and

d) test number.

This is summarised in Table 6:

Part of Manual	Test Series	Test Type	Test Number	Example Test Identification Code
I	1 – 8	(a), (b), (c) etc	**(i), (ii), (iii) etc**	1 (b) (iii)

Table 6: Test Identification Codes

8.3 Recommended tests for explosives and explosive articles

Table 7 lists the recommended tests from the *UN Manual of Tests and Criteria* for explosives and explosive articles (ammunition):

Test Series	Test Type	Test Identification Code	Test Name	Remarks
1	(a)	1 (a)	UN Gap Test	▪
1	(b)	1 (b)	Koenen Test	▪
1	(c)	1 (c) (i)	Time / Pressure Test	▪
2	(a)	2 (a)	UN Gap Test	▪
2	(b)	2 (b)	Koenen Test	▪
2	(c)	2 (c) (i)	Time / Pressure Test	▪
3	(a)	3 (a) (ii)	BAM Fallhammer	▪
3	(b)	3 (b) (i)	BAM Friction Apparatus	▪
3	(c)	3 (c)	Thermal Stability Test at 75^0C	▪
3	(d)	3 (d)	Small-scale Burning Test	▪
4	(a)	4 (a)	Thermal Stability Test	▪ For unpacked articles and packaged articles.
4	(b)	4 (b) (i)	Steel Tube Drop Test for liquids	▪
4	(c)	4 (b) (ii)	12m Drop Test	▪ For unpacked articles, packaged articles and packaged substances.
5	(a)	5 (a)	Cap Sensitivity Test	▪
5	(b)	5 (b) (ii)	USA DDT[12] Test	▪
5	(c)	5 (c)	External Fire Test for Division 1.5	▪
6	(a)	6 (a)	Single Package Test	▪
6	(b)	6 (b)	Stack Test	▪
6	(c)	6 (c)	External Fire (Bonfire) Test	▪
6	(d)	6 (d)	Unconfined Package Test	▪
7	(a)	7 (a)	EIS[13] Cap Test	▪
7	(b)	7 (b)	EIS Gap Test	▪

[12] Deflagration to Detonation Transfer.

[13] Extremely Insensitive Substance (EIS).

Test Series	Test Type	Test Identification Code	Test Name	Remarks
7	(c)	7 (c) (ii)	Friability Test	▪
7	(d)	7 (d) (i)	EIS Bullet Impact Test	▪
7	(e)	7 (e)	EIS External Fire Test	▪
7	(f)	7 (f)	EIS Slow Cook-off Test	▪
7	(g)	7 (g)	1.6 Article External Fire Test	▪
7	(h)	7 (h)	1.6 Article Slow Cook-off Test	▪
7	(j)	7 (j)	1.6 Article Bullet Impact Test	▪
7	(k)	7 (k)	1.6 Article Stack Test	▪
7	(l)	7 (l)	1.6 Article Fragment Impact Test	▪
8	(a)	8 (a)	Thermal Stability Test	▪ For ANE[14]
8	(b)	8 (b)	ANE Gap Test	▪
8	(c)	8 (c)	Koenen Test	▪
8	(d)	8 (d)	Vented Pipe Test	▪ This evaluates suitability for transport in storage tanks.
Test Series	**Test Type**	**Test Identification Code**	**Test Name**	**Remarks**
1	(a)	1 (a)	UN Gap Test	▪
1	(b)	1 (b)	Koenen Test	▪
1	(c)	1 (c) (i)	Time / Pressure Test	▪
2	(a)	2 (a)	UN Gap Test	▪
2	(b)	2 (b)	Koenen Test	▪
2	(c)	2 (c) (i)	Time / Pressure Test	▪
3	(a)	3 (a) (ii)	BAM Fallhammer	▪
3	(b)	3 (b) (i)	BAM Friction Apparatus	▪
3	(c)	3 (c)	Thermal Stability Test at 75^{0}C	▪
3	(d)	3 (d)	Small-scale Burning Test	▪
4	(a)	4 (a)	Thermal Stability Test	▪ For unpacked articles and packaged articles.
4	(b)	4 (b) (i)	Steel Tube Drop Test for liquids	▪
4	(c)	4 (b) (ii)	12m Drop Test	▪ For unpacked articles, packaged articles and packaged substances.
5	(a)	5 (a)	Cap Sensitivity Test	▪
5	(b)	5 (b) (ii)	USA DDT[15] Test	▪
5	(c)	5 (c)	External Fire Test for Division 1.5	▪

[14] Ammonium Nitrate Explosives. Unlikely to be required for military ammunition and explosives.

[15] Deflagration to Detonation Transfer.

Test Series	Test Type	Test Identification Code	Test Name	Remarks
6	(a)	6 (a)	Single Package Test	▪
6	(b)	6 (b)	Stack Test	▪
6	(c)	6 (c)	External Fire (Bonfire) Test	▪
6	(d)	6 (d)	Unconfined Package Test	▪
7	(a)	7 (a)	EIS[16] Cap Test	▪
7	(b)	7 (b)	EIS Gap Test	▪
7	(c)	7 (c) (ii)	Friability Test	▪
7	(d)	7 (d) (i)	EIS Bullet Impact Test	▪
7	(e)	7 (e)	EIS External Fire Test	▪
7	(f)	7 (f)	EIS Slow Cook-off Test	▪
7	(g)	7 (g)	1.6 Article External Fire Test	▪
7	(h)	7 (h)	1.6 Article Slow Cook-off Test	▪
7	(j)	7 (j)	1.6 Article Bullet Impact Test	▪
7	(k)	7 (k)	1.6 Article Stack Test	▪
7	(l)	7 (l)	1.6 Article Fragment Impact Test	▪
8	(a)	8 (a)	Thermal Stability Test	▪ For ANE[17]
8	(b)	8 (b)	ANE Gap Test	▪
8	(c)	8 (c)	Koenen Test	▪
8	(d)	8 (d)	Vented Pipe Test	▪ This evaluates suitability for transport in storage tanks.

Table 7: Recommended tests

[16] Extremely Insensitive Substance (EIS).

[17] Ammonium Nitrate Explosives. Unlikely to be required for military ammunition and explosives.

Annex A
(normative)
References

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

a) IATG 01.40 *Terms, glossary and definitions*. UNODA. 2015;

b) *United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. ST/SG/AC.10/30/Rev.6. Geneva. United Nations. 2015; http://www.unece.org/trans/danger/publi/ghs/ghs_rev06/06files_e.html#c38156

c) *United Nations Manual of Tests and Criteria,* (6th revised edition), ST/SG/AC.10/11/Rev.6New York and Geneva, United Nations, 2015; https://shop.un.org/

d) *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Nineteenth revised edition), ST/SG/AC.10/1/Rev.19, New York and Geneva, United Nations,2015. https://shop.un.org/

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[18] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[18] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

e) *Handbook of Best Practices on Conventional Ammunition*, Chapters 1 and 2. Decision 6/08. OSCE. 2008.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[19] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[19] Where copyright permits.

Annex C
(informative)
List of extant Hazard Classification Codes[20]

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Amatols	1.1D	0082
Ammonium Nitrate Explosive (ANE)	1.1D 1.5D	0082 0331
Ammonium Nitrate *(with more than 0.2% combustible substances, including any organic substance, calculated as carbon, to the exclusion of any other added substance).*	1.1D	0222
Ammonium Perchlorate	1.1D	0402
Ammunition (Blank)	1.1C 1.2C 1.3C 1.4C 1.4S	0326 0413 0327 0338 0014
Ammunition, Fixed **Ammunition, Semi-Fixed** **Ammunition, Separate Loading**	1.1E 1.1F 1.2E 1.2F 1.4E 1.4F	0006 0005 0321 0007 0412 0348
Ammunition, Illuminating *(with or without burster, expelling charge or propelling charge)*	1.2G 1.3G 1.4G	0171 0254 0297
Ammunition, Incendiary *(liquid or gel, with burster, expelling charge or propelling charge)*	1.3J	0247
Ammunition, Incendiary *(liquid or gel, with or without burster, expelling charge or propelling charge)*	1.2G 1.3G 1.4G	0009 0010 0300
Ammunition, Incendiary *(water activated contrivances, with burster, expelling charge or propelling charge)*	1.2L 1.3L	0248 0249
Ammunition, Incendiary, White Phosphorus *(with burster, expelling charge or propelling charge)*	1.2H 1.3H	0243 0244
Ammunition, Industrial	1.2C 1.3C 1.3C 1.4C 1.4C 1.4S	0381 0275 0277 0276 0278 0323
Ammunition, Lachrymatory	1.2G 1.3G 1.4G	0018 0019 0301
Ammunition, Practice	1.3G 1.4G	0488 0362
Ammunition, Proof	1.4G	0363
Ammunition, Smoke *(with or without burster, expelling charge or propelling charge)*	1.2G 1.3G 1.4G	0015 0016 0303
Ammunition, Smoke, White Phosphorus *(water activated contrivances, with burster, expelling charge or propelling charge)*	1.2L	0248
Ammunition, Smoke, White Phosphorus *(with burster, expelling charge or propelling charge)*	1.2H 1.3H	0245 0246
Ammunition, Sporting	1.2C 1.3C 1.4C 1.4S	0328 0417 0339 0012
Ammunition, Tear-producing *(with burster, expelling charge or propelling charge)*	1.2G 1.3G 1.4G	0018 0019 0301
Ammunition, Toxic *(with burster, expelling charge or propelling charge)*	1.2K 1.3K	0020 0021
Ammunition, Toxic *(water activated contrivances, with burster, expelling charge or propelling charge)*	1.2L 1.3L	0248 0249
Articles, EEI	1.6N	0486

[20] Extracted from the *Alphabetical Index of Articles and Substances* contained within the *UN Model Regulations*.

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Articles, Explosive, NOS	1.1C	0462
	1.1D	0463
	1.1E	0464
	1.1F	0465
	1.1L	0354
	1.2C	0466
	1.2D	0467
	1.2E	0468
	1.2F	0469
	1.2L	0355
	1.3C	0470
	1.3L	0356
	1.4B	0350
	1.4C	0351
	1.4D	0352
	1.4E	0471
	1.4F	0472
	1.4G	0353
	1.4S	0349
Articles, Pyrophoric	1.2L	0380
Articles, Pyrotechnic	1.1G	0428
	1.2G	0429
	1.3G	0430
	1.4G	0431
	1.4S	0432
Bag Charges	1.1C	0279
	1.2C	0414
	1.3C	0242
Ballistite	1.1C	0160
	1.3C	0161
Bangalore Torpedos	1.1D	0137
	1.1F	0136
	1.2D	0138
	1.2F	0294
Barium Azide *(dry or wetted with less than 50% water by mass)*	1.1A	0224
Black Powder, Compressed	1.1D	0028
Black Powder, Granular or as a Meal	1.1D	0027
Black Powder, In Pellets	1.1D	0028
Blasting Caps, Assemblies	1.1B	0360
	1.4B	0361
Blasting Caps, Electric	1.1B	0030
	1.1B	0255
	1.1S	0456
Blasting Caps, Non-Electric	1.1B	0029
	1.4B	0267
	1.4S	0455
Bombs *(with bursting charge)*	1.1D	0034
	1.1F	0033
	1.2D	0035
	1.2F	0291
Bombs, Illuminating	1.3G	0254
Bombs, Photo-Flash	1.1D	0038
	1.1F	0037
	1.2G	0039
	1.3G	0299
Bombs, Smoke, Target Identification	1.2G	0171
	1.3G	0254
	1.4G	0297
Bombs with Flammable Liquid *(with bursting charge)*	1.1J	0399
	1.2J	0400
Bombs *(without detonator)*	1.1D	0042
	1.2D	0283
Bombs *(with detonator)*	1.1B	0225
	1.2B	0268
Bursters, Explosive	1.1.D	0043
Cartridge Case, Empty, Primed	1.4C	0379
	1.4S	0055
Cartridges, Explosive	1.1D	0048
Cartridges, Flash	1.1G	0049
	1.3G	0050

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Cartridges for Weapons *(with bursting charge)*	1.1E 1.1F 1.2E 1.2F 1.4E 1.4F	0006 0005 0321 0007 0412 0348
Cartridges for Weapons, Blank	1.1C 1.2C 1.3C 1.4C 1.4S	0326 0413 0327 0338 0014
Cartridges for Weapons, Inert projectile	1.2C 1.3C 1.4C 1.4S	0328 0417 0339 0012
Cartridges, Illuminating	1.2G 1.3G 1.4G	0171 0254 0297
Cartridges, Signal	1.3G 1.4G 1.4S	0054 0312 0405
Cartridges, Small Arms	1.3C 1.4C 1.4S	0417 0339 0012
Cartridges, Small Arms, Blank	1.3C 1.4C 1.4S	0327 0338 0014
Charges, Bursting, Plastic Bonded	1.1D 1.2D 1.4D 1.4S	0457 0458 0459 0460
Charges, Demolition	1.1D	0048
Charges, Depth	1.1D	0056
Charges, Propelling	1.1C 1.2C 1.3C 1.4C	0271 0415 0272 0491
Charges, Propelling for Cannon	1.1C 1.2C 1.3C	0279 0414 0242
Charges, Shaped, Flexible, Linear	1.1D 1.4D	0288 0237
Charges, Shaped *(without detonator)*	1.1D 1.2D 1.3D 1.4S	0059 0439 0440 0441
Charges, Supplementary, Explosive	1.1D	0060
Collodion Cottons	1.1D 1.1D 1.3C	0340 0341 0342
Components, Explosive Train, NOS	1.1B 1.2B 1.3B 1.DS	0461 0382 0383 0384
Contrivances, Water Activated *(with burster, expelling charge or propelling charge)*	1.2L 1.3L	0249 0249
Cord, Detonating, Flexible	1.1D 1.4D	0065 0289
Cord Detonating, Metal Clad	1.1D 1.2D	0102 0290
Cord Detonating, Mild Effect, Metal Clad	1.4D	0104
Cord, Igniter	1.4G	0066
Cordite	1.1C 1.3C	0160 0161
Cutters, Cable, Explosive	1.4S	0070
Cyclonite	1.1D	0072 0391 0483
Cyclotetramethylene-Tetranitramine, Desensitised	1.1D	0484

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Cyclotetramethylene-Tetranitramine, Wetted *(with not less than 15% water by mass)*	1.1D	0226
Cyclotrimethylenetrinitramine and Cyclotetramethylene-Tetranitramine, Desenstised *(with not less than 10% phlegmatizer by mass)*	1.1D	0391
Cyclotrimethylenetrinitramine and Cyclotetramethylene-Tetranitramine, Wetted *(with not less than 15% water by mass)*	1.1D	0391
Cyclotrimethylenetrinitramine, Desensitised	1.1D	0483
Cyclotrimethylenetrinitramine, Wetted *(with not less than 15% water by mass)*	1.1D	0072
Deflagrating Salts of Aromatic Nitroderivatives	1.3C	0132
Detonating Relays	1.1B 1.1B 1.4B 1.4B 1.4S 1.4S	0029 0360 0267 0361 0455 0500
Detonator Assemblies, Non-Electric *(for blasting)*	1.1B 1.4B 1.4S	0360 0361 0500
Detonators for Ammunition	1.1B 1.2B 1.4B 1.4S	0073 0364 0365 0366
Detonators, Electric *(for blasting)*	1.1B 1.4B 1.4S	0030 0255 0456
Detonators, Non-Electric *(for blasting)*	1.1B 1.4B 1.4S	0029 0267 0455
Diazonitrophenol, Wetted *(with not less than 40% water, or mixture of water and alcohol by mass)*	1.1A	0074
Diethyleneglycol Dinitrate, Desensitised *(with not less than 25% non-volatile, water-insoluble phlegmatizer, by mass)*	1.1D	0075
Dingu	1.1.D	0489
Dinitroglycoluril	1.1D	0489
Dinitrophenol, Wetted *(with not less than 15% water by mass)*	1.1D	0076
Dinitroresorcinol *(dry or wetted with not less than 15% water by mass)*	1.1D	0078
Dinitrosobenzene	1.3C	0406
Dinitrotoluene mixed with Sodium Chlorate	1.1D	0083
Dipricrylamine	1.1D	0079
Dipricryl Sulphide *(dry or wetted with not less than 10% water by mass)*	1.1D	0401
Dynamite	1.1D	0081
Engines, Rocket	1.2L 1.3L	0322 0250
Explosive, Blasting, Type A	1.1D	0081
Explosive, Blasting, Type B	1.1D 1.5D	0081 0331
Explosive, Blasting, Type C	1.1D	0083
Explosive, Blasting, Type D	1.1D	0084
Explosive, Blasting, Type E	1.1D 1.5D	0241 0332
Explosives, Emulsion	1.1D 1.5D	0241 0332
Explosive, Seismic	1.1D 1.1D 1.1D 1.5D	0081 0082 0083 0331
Explosive, Slurry	1.1D 1.5D	0241 0332
Explosive, Water Gel	1.1D 1.5D	0241 0332
Fireworks	1.1G 1.2G 1.3G 1.4G 1.4S	0333 0334 0335 0336 0337
Flares, Aerial or Aeroplane	1.1G 1.2G 1.3G 1.4G 1.4S	0420 0421 0093 0403 0404

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Flares, Highway, Distress or Railway	**1.4G** **1.4S**	**0191** **0373**
Flares, Water-Activated	**1.2L** **1.3L**	**0248** **0249**
Flash Powder	**1.1G** **1.3G**	**0094** **0305**
Fracturing Devices, Explosive *(without detonator, for oil wells)*	**1.1D**	**0099**
Fuse, Safety	**1.4S**	**0105**
Fuse, Combination, Percussion or Time	**1.1B** **1.2B** **1.3G** **1.4B** **1.4G** **1.4S** **1.4S**	**0106** **0107** **0257** **0316** **0317** **0367** **0368**
Fuze, Detonating	**1.1B** **1.2B** **1.3B** **1.4S**	**0106** **0107** **0257** **0367**
Fuzes, Detonating *(with protective features)*	**1.1D** **1.2D** **1.4D**	**0408** **0409** **0410**
Fuses, Igniting	**1.3G** **1.4G** **1.4S**	**0316** **0317** **0368**
Gelatin, Blasting	**1.1D**	**0081**
Gelatin, Dynamites	**1.1D**	**0081**
Glyceryl Trinitrate	**1.1D**	**0143** **0144**
Grenades, Hand or Rifle, *(with bursting charge)*	**1.1D** **1.1F** **1.2D** **1.2F**	**0284** **0292** **0285** **0293**
Grenades, Illuminating	**1.2G** **1.3G** **1.4G**	**0171** **0254** **0297**
Grenades, Practice, Hand or Rifle	**1.2G** **1.3G** **1.4G** **1.4S**	**0372** **0318** **0452** **0110**
Grenades, Smoke	**1.2G** **1.2H** **1.3G** **1.3H** **1.4G**	**0015** **0245** **0016** **0246** **0303**
Guanylnitrosamino-Guanylidene Hydrazine, Wetted *(with not less than 30% water by mass)*	**1.1A**	**0113**
Guanylnitrosamino-Guanylidene Hydrazine, Wetted *(with not less than 30% water, or mixture of water and alcohol, by mass)*	**1.1A**	**0114**
Gunpowder, Compressed	**1.1D**	**0028**
Gunpowder, Granular or as a Meal	**1.1D**	**0027**
Gunpowder, In Pellets	**1.1D**	**0028**
Hexanitrodiphenylamine	**1.1D**	**0179**
Hexanitrostilbene	**1.1D**	**0392**
Hexagon	**1.1D**	**0072** **0391** **0483**
Hexolite *(dry or wetted, with less than 15% water by mass)*	**1.1D**	**0118**
Hexotol	**1.1D**	**0118**
Hexoctonal	**1.1D**	**0393**
Hexoctonal, Cast	**1.1D**	**0393**
Hexyl	**1.1D**	**0079**
HMX	**1.1D**	**0226** **0391** **0484**
1-Hydroxybenzotriazole, Anhydrous, Wetted *(dry or wetted, with less than 20% water by mass)*	**1.3C**	**0508**

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Igniters	**1.1G** **1.2G** **1.3G** **1.4G** **1.4S**	**0121** **0314** **0315** **0325** **0454**
Lead Azide, Wetted *(with not less than 20% water, or mixture of water and alcohol by mass)*	**1.1A**	**0129**
Lead Styphnate, Wetted *(with not less than 20% water, or mixture of water and alcohol by mass)*	**1.1A**	**0130**
Lead Trinitroresorcinate, Wetted	**1.1A**	**0130**
Lighters, Fuse	**1.4S**	**0131**
Mannitol Hexanitrate, Wetted *(with not less than 40% water, or mixture of water and alcohol by mass)*	**1.1D**	**0133**
5-Mercaptotetrazol-1-Acetic Acid	**1.4C**	**0448**
Mercury Fulminate, Wetted *(with not less than 20% water, or mixture of water and alcohol by mass)*	**1.1A**	**0135**
Mines *(with bursting charge)*	**1.1D** **1.1F** **1.2D** **1.2F**	**0137** **0136** **0138** **0298**
Missiles	**1,1E** **1.1F** **1.1J** **1.2C** **1.2E** **1.2F** **1.2J** **1.3C** **1.3C** **1.4C**	**0181** **0180** **0397** **0436** **0182** **0295** **0398** **0183** **0437** **0438**
5-Nitrobenzotriazol	**1.1D**	**0385**
Nitrocellulose *(dry or wetted with less than 25% water or alcohol, by mass)*	**1.1D**	**0340**
Nitrocellulose, Unmodified or Plasticised *(with less than 18% plasticising substance by mass)*	**1.1D**	**0341**
Nitrocellulose, Plasticised *(with not less than 18% plasticising substance by mass)*	**1.3C**	**0343**
Nitrocellulose, Wetted *(with not less than 25% alcohol by mass)*	**1.3C**	**0342**
Nitroglycerin, Desensitised *(with not less than 40% non-volatile water-insoluble phlegmatizer by mass)*	**1.1D**	**0143**
Nitroglycerin Solution in Alcohol *(with more than 1% but not more than 10% nitroglycerin)*	**1.1D**	**0144**
Nitroguanidine *(dry or wetted with less than 20% water, by mass)*	**1.1D**	**0282**
Nitromannite, Wetted	**1.1D**	**0133**
Nitrostarch *(dry or wetted with less than 20% water, by mass)*	**1.1D**	**0146**
Nitrotriazolene	**1.1D**	**0490**
Nitro Urea	**1.1D**	**0147**
NTO	**1.1D**	**0490**
Octogen	**1.1D**	**0226** **0391** **0484**
Octol *(dry or wetted with less than 15% water, by mass)*	**1.1D**	**0266**
Octolite *(dry or wetted with less than 15% water, by mass)*	**1.1D**	**0266**
Octonal	**1.1D**	**0496**
PETN Pentaerythritetetranitrate *(with not less than 7% wax by mass)*	**1.1D**	**0411**
PETN Pentaerythritetetranitrate *(desensitised with not less than 15% phlegmatizer by mass)*	**1.1D**	**0150**
PETN Pentaerythritetetranitrate *(with not less than 25% water by mass)*	**1.1D**	**0150**
PETN Pentaerythritetetranitrate	**1.1D**	**0151** **0411**
Pentolite *(dry or wetted with less than 15% water, by mass)*	**1.1D**	**0151**
Picramide	**1.1D**	**0153**
Picric Acid	**1.1D**	**0154**
Picrite	**1.1D**	**0282**
Picryl Chloride	**1.1D**	**0155**
Plastic Explosives	**1.1D**	**0084**
Potassium Chlorate mixed with Mineral Oil	**1.1D**	**0083**
Powder, Cake, Wetted *(with not less than 17% alcohol by mass)*	**1.1C**	**0433**
Powder, Cake, Wetted *(with not less than 25% water by mass)*	**1.3C**	**0159**
Powder, Paste	**1.1C** **1.3C**	**0433** **0159**

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Powder, Smokeless	1.1C 1.3C	0160 0161
Power Devices, Explosive	1.2C 1.3C 1.4C 1.4S	0381 0275 0276 0323
Primers, Cap Type	1.1B 1.4B 1.4S	0377 0378 0044
Primers, Small Arms	1.4S	0044
Primers, Tubular	1.2G 1.4G 1.4S	0319 0320 0376
Projectiles, Illuminating	1.2G 1.3G 1.4G	0171 0254 0297
Projectiles *(inert with tracer)*	1.3G 1.4G 1.4S	0424 0425 0345
Projectiles *(with burster or expelling charge)*	1.2D 1.2F 1.2G 1.4D 1.4F 1.4G	0346 0426 0434 0347 0427 0435
Projectiles *(with bursting charge)*	1.1D 1.1F 1.2D 1.2F 1.4D	0168 0167 0169 0324 0344
Propellant, Liquid	1.1C 1.3C	0497 0495
Propellant, Solid	1.1C 1.3C 1.4C	0498 0499 0501
Propellant, Single Based **Propellant, Double Based** **Propellant, Triple Based**	1.1C 1.3C	0160 0161
RDX	1.1D	0072 0391 0483
Release Devices, Explosive	1.4S	0173
Rivets, Explosive	1.4S	0174
Rocket Motors	1.1C 1.2C 1.3C	0280 0281 0186
Rocket Motors, Liquid Fuelled	1.2J 1.3J	0395 0396
Rocket Motors with Hypergolic Liquids *(with or without expelling charge)*	1.2L 1.3L	0322 0250
Rockets *(with bursting charge)*	1.1E 1.1F 1.2E 1.2F	0181 0180 0182 0295
Rockets *(with expelling charge)*	1.2C 1.3C 1.4C	0436 0437 0438
Rockets *(with inert head)*	1.2C 1.3C	0502 0183
Rockets, Line-Throwing	1.2G 1.3G 1.4G	0238 0240 0453
Rockets, Liquid Fuelled *(with bursting charge)*	1.1J 1.2J	0397 0398
Shaped Charges	1.1D 1.2D 1.4D 1.4S	0059 0439 0440 0441

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Signal Devices, Hand	1.4G 1.4S	0191 0373
Signals, Distress, Ship	1.1G 1.3G 1.4G 1.4S	0194 0195 0440 0441
Signals, Distress Ship, Water-activated	1.3L	0249
Signals, Railway Track, Explosive	1.1G 1.3G 1.4G 1.4S	0194 0195 0505 0506
Signals, Smoke	1.1G 1.2G 1.3G 1.4G 1.4S	0196 0313 0487 0197 0507
Sodium Chlorate mixed with Dinitrotoluene	1.1D	0083
Sodium Dinitro-o-Cresolate *(dry or wetted with less than 15% water, by mass)*	1.3C	0234
Sodium Picramate *(dry or wetted with less than 20% water, by mass)*	1.3C	0235
Sounding Devices, Explosive	1.1D 1.1F 1.2D 1.2F	0374 0296 0375 0204
Squibs	1.4G 1.4S	0325 0454
Styphnic Acid	1.1D 1.1D	0219 0394
Substances, Explosive, NOS	1.1A 1.1C 1.1D 1.1G 1.1L 1.2L 1.3C 1.3G 1.3L 1.4C 1.4D 1.4G 1.4S	0473 0474 0475 0476 0357 0358 0477 0478 0359 0479 0480 0485 0481
Substances, Explosive, Very Insensitive, NOS	1.5D	0482
Tetranitroaniline	1.1D	0207
Tetrazene, Wetted	1.1A	0114
Tetrazole-1-Acetic Acid	1.4C	0407
1H-Tetrazole	1.1D	0504
Tetryl	1.1D	0208
Torpedos *(with bursting charge)*	1.1D 1.1E 1.1F	0451 0329 0330
Torpedos, Liquid Fuelled *(with inert head)*	1.3J	0450
Torpedos, Liquid Fuelled *(with or without bursting charge)*	1.1J	0449
Tracers for Ammunition	1.3G 1.4G	0212 0306
Trinitroaniline	1.1D	0153
Trinitroanisole	1.1D	0213
Trinitrobenzene *(dry or wetted with less than 30% water, by mass)*	1.1D	0214
Trinitrobenzenesulphonic Acid	1.1D	0386
Trinitobenzoic Acid *(with not less than 30% water by mass)*	1.1D	0215
Trinitrochlorobenzene	1.1D	0155
Trinitro-m-cresol	1.1D	0216
Trinitrofluorenone	1.1D	0387
Trinitronapthalene	1.1D	0217
Trinitrophenetole	1.1D	0218
Trinitrophenol *(dry or wetted with less than 30% water, by mass)*	1.1D	0154
Trinitrophenylmethylnitramine	1.1D	0208
Trinitroresorcinol *(dry or wetted with less than 20% water, or mixture of water and alcohol, by mass)*	1.1D	0219
Trinitroresorcinol, Wetted *(with not less than 20% water, or mixture of water and alcohol, by mass)*	1.1D	0394

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
TNT Trinitrotoluene *(dry or wetted with less than 30% water, by mass)*	1.1D	0209
TNT Trinitrotoluene and Hexanitrostilbene Mixture	1.1D	0388
TNT Trinitrotoluene and Trinitrobenzene Mixture	1.1D	0388
TNT Trinitrotoluene Mixture containing Trinitrobenzene and Hexanitrostilbene	1.1D	0389
TNT Trinitrotoluene mixed with Aluminium	1.1D	0390
Tritonal	1.1D	0390
Urea Nitrate *(dry or wetted with less than 20% water, by mass)*	1.1D	0220
Warheads, for Guided Missiles	1.1D 1.1F 1.2D 1.4D 1.4F	0286 0369 0287 0370 0371
Warheads, Rocket *(with burster or expelling charge)*	1.4D 1.4F	0370 0371
Warheads, Rocket *(with bursting charge)*	1.1D 1.1F 1.2D	0286 0369 0287
Warheads, Torpedo *(with bursting charge)*	1.1D	0221
Zirconium Picramate *(dry or wetted with less than 20% water, by mass)*	1.3C	0236

Table C.1: List of Hazard Classification Codes

Amendment record

Management of IATG amendments

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Number	Date	Amendment Details
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INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.60

Third edition
March 2021

Ammunition faults and performance failures

UN SaferGuard
Securing ammunition, protecting lives

IATG 01.60:2021E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The reporting and investigation of conventional ammunition faults or performance failures is a key component in ensuring the safety of the conventional ammunition stockpile during storage, handling and use. As there is no such thing as perfect safety, it is inevitable that personnel using conventional ammunition during training, or on operations, will themselves be at risk of fatality or injury. Accidents[3] or incidents involving conventional ammunition are a regular occurrence, even in the best-trained military and security forces, yet most of them are preventable.

As a fundamental preventative measure any faults or performance failures should be immediately reported and investigated in order that the appropriate action can be taken to prevent reoccurrence. Such actions may include the revision of operating systems and procedures, rectification of ammunition faults, and/or the imposition of bans or constraints[4] on the use, storage, handling, transport or disposal of the ammunition type involved. The use of an ammunition fault and performance failure reporting system assists the development of such actions.

[3] Details on the appropriate response to ammunition accidents is contained within IATG 11.10 *Ammunition accidents, reporting and investigation.*

[4] See IATG 01.70 *Bans and constraints*.

Ammunition faults and performance failures

1 Scope

This IATG module introduces and explains the concept of ammunition faults and performance failures and the responses necessary to ensure a safe, effective and efficient conventional ammunition management system.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'ammunition accident' refers to *any incident involving ammunition or explosives that results in, or has potential to result in, death or injury to a person(s) and/or damage to equipment and/or property, military or civilian.*

The term 'blind' refers to *ammunition, which, though initiated, has failed to arm as intended or which has failed to explode after being armed. Alternatively, an explosives item that fails to function correctly after initiation.*

The term 'fault' refers to *any error in the make-up and/or marking and/or deterioration in the physical state of the ammunition, explosives, ammunition packages or ammunition containers*.

The term 'incident' is *a generic term that includes all accidents, performance failures and faults involving ammunition or where ammunition is present.*

The term 'misfire' refers to *ammunition which, when initiated, fails to fire or launch as intended*.

The term 'performance failure' refers to *the failure of the ammunition or any of its constituent parts, including the explosives, to function as designed*. *Blinds and misfires are included within performance failures.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 General (LEVEL 2)

As a fundamental preventative measure to support safe conventional ammunition stockpile management, any faults or performance failures should be immediately reported by users and appropriately investigated in order that the appropriate action can be taken to prevent reoccurrences. Such actions may include:

a) the revision of operating systems and procedures;

b) the imposition of a ban on the use, storage, handling, transport or disposal of the ammunition type involved;

c) after investigation, the imposition of constraints on the use, storage, handling, transport or disposal of the ammunition type involved;

d) rectification of the fault by repair; or

e) withdrawal of the ammunition from service use.

This will require that an appropriate investigating authority is nominated, staffed and resourced. Therefore, ammunition stockpile management organisations should nominate an appropriate investigating authority and ensure that it is provided with the technically qualified staff and resources that are necessary to provide an effective and efficient capability in this area.

It should be a mandatory requirement for users or stock-holding units to report any ammunition faults or performance failures to the investigating authority. All incidents of this type should be reported, and users or stock-holding units shall not make the decision that incidents are minor or not worth reporting.

If any damage or injury has occurred, no matter how minor, the event shall be reported as an ammunition accident in line with the requirements of IATG 11.10 *Ammunition accidents, reporting and investigation.*

4.1 Ammunition faults

An ammunition fault is deemed to have occurred when a fault is found with the explosives or their containers, and they were sealed by the manufacturer or authorised technical personnel when received by the user unit.

Ammunition faults should normally be detected by ammunition technical personnel at storage depots and corrected before issue to user units. However, on occasions some faults may go unnoticed. User units will probably detect a fault while receipting or issuing ammunition from unit ammunition stores or while distributing ammunition on a range or training area. User units should ensure that all personnel involved in the distribution of ammunition during training are fully conversant with the procedures recommended at Clause 7 of this guideline. Ammunition faults would include, for example:

a) the safety pin is found to be missing from a mortar bomb when it is removed from its packaging;

b) the quantity of rounds of ammunition in a sealed package is found to be different from that marked on the package; or

c) the percussion cap is found to be missing from a round of small arms ammunition.

4.2 Ammunition performance failures

Ammunition performance failures most frequently occur when user units are on a range or training area and away from their barracks. In these instances, safety staff are unlikely to be carrying a full set of publications. Hence, user units should ensure that safety and supervisory staff are fully conversant with the procedures at Clause 8 to this guideline. Ammunition performance failures would include, for example:

a) after throwing a smoke grenade it bursts into flames;

b) after firing a mortar bomb it does not reach the required range and drops short; or

c) any blinds or misfires.

5 Rationale for reporting faults and performance failures

There are a number of reasons why an effective system for the reporting and investigation of ammunition faults and performance failures should be developed and utilised by States:

a) safety can be improved as immediate action[5] to prevent a reoccurrence may be taken;

b) ammunition may degrade in storage at a faster rate than predicted. When combined with the results of in-service proof[6] quality trends can be identified. These trends are of significant value in calculating the efficiency and reliability of operational and war stocks. In addition, the life of the explosives can be estimated and future buys influenced. The reporting of faults and performance failures is therefore essential feedback to identify whether unexpected degradation is occurring;

c) hazardous practices, which are not necessarily the fault of the user, may have developed in the use of the ammunition that has not previously been identified.[7] Improved safety practices can be developed to prevent a reoccurrence; and

d) information may be obtained than can lead to improvements in weapon and ammunition design.

The implications of failure to report an ammunition fault or performance failure can have lethal consequences. For example, the failure to report an ammunition fault or performance failure by a user could result in a recurrence that may result in fatalities and/or injuries. In such circumstances, the organisation investigating the first occurrence would have banned the use by forces under its control of that particular type, lot or batch ammunition world-wide. Therefore, the second accident with fatalities and injuries to personnel would have been prevented. In this instance the failure to report the initial fault or performance failure could be considered as criminally negligent.

6 Reporting of ammunition faults and performance failures (LEVEL 2)

The organisation responsible for the stockpile management of conventional ammunition should ensure that a system of reporting and investigating ammunition fault and performance failures is developed, promulgated to all users and is then effectively used. Users should be instructed to immediately report the following information on an ammunition fault or performance failure to the appropriate investigating authority:[8]

[5] Including the use of bans and constraints. See IATG 01.70 *Bans and constraints*.

[6] See IATG 07.20 *Surveillance and proof.*

[7] For example, fast loading drills for mortars.

[8] An example form is at Annex C, which is replicated in IATG 11.10 *Ammunition Accidents and Reporting.*

a) name of individual reporting fault or performance failure;

b) user unit;

c) user unit contact person;

d) date and time of fault or performance failure;

e) location where the ammunition fault or performance failure has occurred, including map grid reference;

f) type of ammunition involved (full technical name);

g) weapon type involved (full technical name, condition of weapons, year of manufacture, serial number etc);

h) batch, lot and/or serial number of the ammunition involved;

i) brief description of fault or performance failure; and

j) action taken by user unit.

7 Actions by user unit (faults) (LEVEL 2)

The unit using the ammunition should take the following actions in the event of an ammunition fault:

a) secure all ammunition of that particular lot, batch and/or serial number for the technical investigator;

b) use another batch, lot or serial number of the same type of ammunition for further training; and

c) immediately report the ammunition fault in accordance with the instructions developed as a result of Clause 6 and wait for further guidance from the technical investigator.

8 Actions by user unit (performance failures) (LEVEL 2)

The unit using the ammunition should take the following actions in the event of an ammunition performance failure:

a) cease firing. If there are no injuries or fatalities firing may recommence providing a different lot or batch of ammunition is used, or if the number of performance failure(s) does not exceed between 1% and 4% of the total quantity of ammunition[9] of the lot or batch involved;

b) cordon off the area to preserve evidence for the investigating authority;

c) record the names of potential witnesses;

d) make safe the individual weapon involved and secure it for the investigating authority; and

e) immediately report the ammunition performance failure in accordance with the instructions developed as a result of Clause 6 and wait for further guidance from the nominated technical investigator.

[9] The exact % level to be selected shall be at the discretion of the appropriate national authority.

9 Investigating authority (LEVEL 2)

The investigating authority nominated by the conventional ammunition stockpile management organisation should have the following responsibilities:

a) appoint a technical investigator to each ammunition fault or performance failure incident;

b) examine the reports submitted by technical investigators on ammunition faults and performance failures;

c) consult with other appropriate organisations (manufacturers, designers, procurement agencies etc.) to obtain further information as necessary;

d) make a technical judgement as to the cause[10] of the fault or performance failure;

e) initiate remedial action (in accordance with Clause 4) to prevent a reoccurrence;

f) inform the user unit of the results of the investigation;

g) maintain records of all ammunition faults and performance failures; and

h) provide technical advice to the conventional ammunition stockpile management organisation as appropriate.

10 Actions of the technical investigator (LEVEL 2)

The technical investigator appointed by the investigating authority should:

a) examine the scene of the performance failure;

b) examine any weapon involved;[11]

c) visually inspect any pieces of the ammunition involved;

d) recover any pieces of the ammunition that was involved for further technical investigation, or destroy if unsafe to move;

e) examine other ammunition of the same type, and the same lot, batch or serial number being used;

f) question appropriate witnesses;

g) make an initial technical appraisal of the cause of the performance failure and recommend any appropriate bans or constraints to the investigating authority;

h) if appropriate, impose an immediate local ban on the use of the ammunition (by lot, batch or serial number) involved in the performance failure; and

i) submit a written ammunition performance failure report to the investigating authority in the appropriate format.

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[10] Investigating authorities may wish to consider the use of 'Cause Codes' as a simplified means of notifying organisations of the results of their investigation. An example of such a system is at Annex D.

[11] The support of a specialist armourer may be needed to determine that performance failure is not the fault of the weapon.

Annex A
(normative)
References

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

a) IATG 01.40 Glossary of *terms, definitions and abbreviations*. UNODA. 2020; and

b) IATG 11.10 *Ammunition accidents, reporting and investigation*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[12] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[12] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) IATG 01.70 *Bans and constraints.* UNODA. 2020;

b) IATG 07.10*Surveillance and proof*. UNODA. 2020; and

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[13] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencig conventional ammunition stockpile management programmes.

[13] Where copyright permits.

Annex C
(informative)
Example Ammunition Incident Reporting Form

Ammunition Incident / Accident Reporting Form			
Serial		**IATG Form 01.60 / 11.10**	
1	**Person reporting the accident**		
1.1		Name:	
1.2		Rank / Appointment:	
1.3		Unit:	
1.4		Unit Address:	
1.5		Unit Telephone Number:	
2	**Accident details:**		
2.1		Date:	
2.2		Time:	
2.3		Location:	
2.4		Point of Contact *(if different from Serial 1)*	
2.5		Ammunition Type *(including Batch Key Identity, lot or serial number)*	
2.6		Fatalities	
2.7		Injuries	
2.8		Weapon Type and serial number	
2.9		Weapon Damage	
3	**Action taken by unit**		
3.1		Firing stopped	
3.2		Ammunition of same type isolated	
3.3		Forensic evidence secured	
3.4		Any other information	
4	**Other agencies informed**		
4.1		Service Police	
4.2		Civilian Police	
4.3		Others	

Annex D
(informative)
Example Cause and Closure Codes[14]

Table D.1 contains an example system of Cause and Closure Codes that Investigating Authorities may use to promulgate the results of technical investigations and as a simple reference system for the conventional ammunition stockpile management system.

More than one cause or closure code may be awarded to an incident, and the code may be changed as more evidence becomes available during the technical investigation.

Cause or Closure Code	Description	Remarks
0	Open – Under Investigation	
0A	Not Known – Ammunition item not available for examination	
0B	Not Known – Cause can not be identified with available evidence	
0C	Not Known – Cause can not be identified with available evidence, but ammunition item is suspected	
0D	Not Known – Not investigated as Fault or Performance Failure within Acceptable Limits	
0E	Not Known – Cancelled – Re-categorized	
0F	Not Known – Cancelled	
0G	Not Known – Fault or Performance Failure not related to ammunition item, weapon or drill	
1A	Storage – Army Depot	
1B	Storage – Army Unit	
1C	Storage – Field or Emergency	
1D	Storage – On Range	
1E	Storage – On Navy Vessel	
1F	Storage – Navy Depot	
1G	Storage – Transit by Road / Rail/ Air / Sea Stationary Parked	
1H	Storage – Temporary Authorised Location	
1J	Storage – Air Force Depot	
1K	Storage – Air Force Unit	
1L	Storage – Other	Specify on report.
2A	Handling – Mechanical Handling Equipment - Accident	
2B	Handling – Mechanical Handling Equipment - Negligent	
2C	Handling – Manual Handling – Accident	
2D	Handling – Manual Handling – Negligent	
2E	Transportation – Road	
2F	Transportation – Rail	
2G	Transportation – Sea	
2H	Transportation – Air	
2J	Handling – Air Dropped	
2K	Transportation – Cross Country	
2L	Handling – Cause Not Known	
2M	Handling – User Negligent	
2N	Handling – Crane or Overhead Gantry	
2O	Handling – Vertical (VERTRAS) or At Sea (RAS) Replenishment	
2P	Handling – Other	Specify on report.
2Q	Handling – Loading on/off Operating Aircraft	
3A	Design – Ammunition Item Design Fault	
3B	Design – Ammunition Packaging Fault	
3C	Design – Equipment (Ammunition not at fault)	
3D	Design – Range Construction or Maintenance	
3E	Design – Range Construction or Maintenance Suspected	
3F	Design – Inert Component	
3G	Design – Other	Specify on report.

[14] These example Clause and Closure Codes are also contained as an Annex to IATG 11.10 *Ammunition accidents, reporting and investigation* to allow for consistency in use.

Cause or Closure Code	Description	Remarks
4A	Tampering – Malicious (Military)	
4B	Tampering – Malicious (Civilian)	
4C	Tampering – Prank (Military)	
4D	Tampering – Prank (Civilian)	
4E	Tampering – Experimental / Curiosity (Military)	
4F	Tampering - Experimental / Curiosity (Civilian)	
4G	Tampering – No evidence to assign other closure code	
4H	Tampering – Other	Specify on report.
5A	Error of Drill – Ammunition Loading / Unloading / Firing	
5B	Error of Drill – Ammunition Handling	
5C	Error of Drill – Equipment	
5D	Error of Drill – Negligent Discharge	
5E	Error of Drill – Incorrect Instruction(s)	
5F	Error of Drill – Malicious	
5G	Error of Drill – Prank	
5H	Error IN Drill	
5J	Error of Drill – Miscellaneous	
5K	Error of Drill – Negligent Supervision	
6A	Equipment / Platform Only Failure – Broken / Damaged / Unserviceable	
6B	Equipment / Platform Only Failure – Poor Maintenance	
6C	Equipment / Platform Only Failure – Ingress of Water / Moisture	
6D	Equipment / Platform Only Failure – Ingress of Dirt / Grit	
6E	Equipment / Platform Only Failure – Design	
6F	Equipment / Platform Only Failure – Production by Manufacturer	
6G	Equipment / Platform Only Failure – Cause Not Known	
6H	Equipment / Platform Failure – Small Calibre Trapped Link	Chain Guns.
6J	Equipment / Platform Failure – Firing Circuit	
6K	Equipment / Platform Failure – Maintenance Error	
7A	Production – Ammunition Item Fault (Not Design)	
7B	Production – Ammunition Packaging Fault (Not Design)	
7C	Production – Incorrect or Temporary Ammunition Packaging	
7D	Production – Inert Component Fault	
7E	Certified Free From Explosive (FFE) Violation	
8A	Defect Points	
8B	Packaging	
8C	Track Spread	
8D	Split Points	
8E	Spread Points	
8F	Missile / Torpedo / Guided Weapon – Guidance Failure	
8G	Missile / Torpedo / Guided Weapon – Hardware / Software Failure	
8H	Missile / Torpedo / Guided Weapon – In Flight / Run Failure	
8J	Missile / Torpedo / Guided Weapon – Explosive Component Failure	
8K	Missile / Torpedo / Guided Weapon – Test Failure	
9A	In Service Deterioration – Beyond Design Shelf / Service Life	
9B	In Service Deterioration – Approaching Design Shelf / Service Life	
9C	In Service Deterioration – Packaging Open and Ammunition Returned	By user unit.
9D	In Service Deterioration – Prolonged Use / Handling by Unit	
9E	In Service Deterioration – No Cause Known	
9F	In Service Deterioration – Prolonged Exposure to Unprescribed Climatic Conditions	
10A	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Planning Activities	
10B	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Supervision	
10C	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Firing	
10D	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Other	Specify on report.
Z1	Provisionally Closed – Awaiting Legal Judgement	
Z2	Provisionally Closed – Awaiting Full Written Report	Verbal report only received.

Table D.1: Example Cause or Closure Codes

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Bans and constraints

UN SaferGuard
Securing ammunition, protecting lives

IATG 01.70:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

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Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

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The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Bans and constraints on the use, storage, handling, transportation or disposal of conventional ammunition are a fundamental component of a safe, effective and efficient ammunition management system. They are primarily issued by the conventional ammunition stockpile management organisation to control the issue and use of explosives and ammunition to make sure that the users receive ammunition that is: 1) safe to use; and 2) will perform within the agreed ballistic and performance envelopes. Constraints on the use of ammunition may also be used to protect ammunition stock levels during shortages of certain types of ammunition.

It is essential for the safety and morale of users that they receive ammunition that they have confidence in; a system of ammunition bans and constraints, instigated by the conventional ammunition stockpile management organisation, ensures this.

Bans and constraints

1 Scope

This IATG module introduces and explains the concept and use of bans and constraints on the use, storage, handling, transportation or disposal of ammunition as part of a safe, effective and efficient conventional ammunition management system.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘ban’ refers to *a moratorium placed on the issue and use of ammunition, usually pending technical investigation*.

The term ‘constraint’ refers to *the imposition of a limitation or restriction in the use, transportation, carriage, issue, storage or inspection of a munition*.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Aim of a bans and constraints system

The aim of a formal system of bans and constraints, instigated by a conventional ammunition stockpile management organisation, should be to ensure:

a) the safety of personnel during the use, storage, handling, transportation or disposal of conventional ammunition;

b) the optimum use of the conventional ammunition stockpile, which is an expensive national asset; and

c) the controlled issue and use of specific or generic conventional ammunition during times of shortages.

5 Content of a ban or constraint

Any ban or constraint on the use of specific or generic type of ammunition should contain the following information, which shall be disseminated to users as soon as possible:

a) the type and calibre of ammunition;

b) the specific lot, batch and/or serial number of the ammunition to which the ban or constraint applies; and

c) full details of the ban or constraint, which may require:

   i) a total cessation of use;

   ii) a limitation which is necessary during use, storage, handling, transportation or disposal; or

   iii) a limitation in use during training.

6 Bans (LEVEL 2)

6.1 Rationale for bans

A ban on the use of specific type of conventional ammunition (which may be at generic type, lot, batch and/or serial number level) should be imposed to prevent the issue or use of conventional ammunition under the following circumstances:

a) when it is suspected of being the cause of an ammunition accident, irrespective of whether death or injury has been caused;

b) when there have been excessive performance failures;

c) when a defect, which could compromise safety, has been discovered; or

d) when the ammunition is to be withdrawn at the end of its serviceable life.

6.2 Dissemination of bans

The organisation responsible for the overall conventional ammunition management system should ensure that an appropriate system is in place that can rapidly alert users to the imposition of an ammunition ban.

6.3 Action on notification of a ban

Users should take the following action when they receive notice of an ammunition ban from the conventional ammunition stockpile management organisation:

a) mark the ammunition packaging or container with the following information:

   i) 'NOT FOR ISSUE OR USE';

   ii) the ban serial number; and

   iii) any special instructions received with the ban.

b) enter the details of the ban in the user's ammunition account; and

c) if instructed to do so, arrange for the ammunition to be transported to the designated ammunition demilitarisation or destruction organisation.[3]

7 Constraints (LEVEL 2)

7.1 Rationale for constraints

Constraints (which may be at generic type, lot, batch and/or serial number level) are the imposition of a limitation or restriction in the use, transportation, carriage, issue, storage or inspection of munitions. Constraints should be used as a tool for the ammunition management system. They normally remain in force for the life of ammunition, while a ban can be a short-term measure.

Details of the constraints shall be printed on the ammunition issue vouchers, and a note shall be made on the ammunition account sheet of any constraints.

Constraints on the use, storage, handling, transportation or disposal of ammunition may include:

a) storage temperatures to be adhered to;

b) special handling requirements;

c) a decision that ammunition is for training use only; and

d) a change of shelf life parameters.

7.2 Dissemination of constraints

The organisation responsible for the overall conventional ammunition management system should ensure that an appropriate system is in place that can rapidly alert users to the imposition of an ammunition constraint.

7.3 Action on notification of a constraint

Users should take the following action when they receive notice of a constraint on ammunition use, storage, handling, transportation or disposal from the conventional ammunition stockpile management organisation:

a) mark the ammunition packaging or container with the following information:

   i) the constraint serial number; and

   ii) details of the constraint.

b) enter the details of the constraint in the user's ammunition account.

[3] This responsibility may lie with the conventional ammunition stockpile management organisation.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations* . UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[4] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website:www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[4] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[5] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

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Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.80

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Introduction

The nature of ammunition and explosives with their potential for unplanned, violent reaction makes it necessary to develop recommendations and guidelines for safe conventional ammunition management stockpile management. This requires, by necessity, a risk-based approach[3], which should be based on sound explosive engineering and science.

Risk management decisions based on more complete knowledge can be made if the likelihood of an explosives accident can be taken into account as well as the consequences. This requires knowledge of the range of scientifically accepted formulae that can be used to support decision-making and risk management during conventional ammunition stockpile management.

In this document a survey of the best practice models for estimation of the consequences of explosions is given.

Formulae are taken basically from two documents, which represent the state-of-the art of explosion modeling, since these documents have been developed by leading experts, who have access to the most elaborate experimental data on this topic as well as to the adequate modeling background.

These documents, which are listed in annex A are

- AASTP-1 by NATO CNAD AC326, Ammunition Safety
- DDESB Technical Paper TP-14 by US DoD Explosives Safety Board

Risk analysis is a three-step process

1) <u>Determination of the effects of the explosion</u>

IATG 1.80 is addressing
- ✓ Airblast
- ✓ Debris
- ✓ Ground shock
- ✓ Thermal effects

2) <u>Determination of the consequences</u>

IATG 1.80 is addressing
- ✓ Damage to buildings by air blast (structural damage and window breakage)
- ✓ Human vulnerability by air blast
- ✓ Human vulnerability by debris (debris from PES, debris from windows of ES, structural damage of ES)
- ✓ Damage to buildings and equipment by ground shock
- ✓ Human vulnerability by thermal effects

3) <u>Determination of the likelihood of the consequences</u>

IATG 1.80 is addressing
- ✓ Probability of breakage of windows and collapse of structures
- ✓ Probability of fatality, major and minor injury by air blast
- ✓ Probability of consequences for people in an ES
- ✓ Probability of consequences by debris hit, differentiating between fatality, major and minor injury

[3] IATG 02.10 *Introduction to Risk Management Principles and Processes* contains further information on risk-based approaches to conventional ammunition stockpile management.

The risk analysis is to be supported by software-tools implementing the suite of formulae.

A **level-1 toolkit** provides the blast-data of a free field air blast. Consequences are modelled on simple empirical correlations using free field blast wave peak-parameters. A level-1 tool is not capable to provide debris densities caused by a PES.

A **level-2 toolkit** is capable to provide simple modifications of the blast wave by structures (PES, barricades, ES). It is also capable to provide information on PES-related debris based on empirical correlations.
The blast wave is not only characterized by peak-values but also the decay of the blast wave is taken into consideration on calculations.
Empirical correlations are used for calculation where detailed physical modelling cannot be realized properly with reasonable efforts due to complexity.

A **level-3 toolkit** is using full mathematical and physical modelling of all parameters regarded as relevant to describe an effect or consequence.

The **SAFERGUARD toolkit** provides a complete level-1 toolkit for level-1 risk assessment.

IATG 1.80 provides all information necessary for implementation of a level-2 toolkit, which could be based on EXCEL-spreadsheets. Only AASTP-1 and DDESB TP-14 have to be consulted for some details regarding algorithms and tabulated data for empirical calculations.

Examples of such calculations are provided in ***Annex C*** on solving the ***reference scenarios.***

Formulae for ammunition management

1 Scope

This IATG module introduces and summarises scientifically proven and sound formulae that may be used to support the decision-making and risk management processes essential for the safe, efficient and effective stockpile management of conventional ammunition. Guidance on their appropriate use is either contained within this IATG module or the complementary IATG software normative references.

The following referenced documents are indispensable for the application of this module. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2 Normative references

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A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

Annex C contains reference scenarios which are solved by means presented in this IATG 1.80

3 Terms and definitions

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4 Introduction - Physical effects of an explosion

When dealing with the description of the physical effects of an explosion, they are usually described as a set of several primary effects in the following way:

Air blast

This effect is made up of two events in extremely quick succession. A detonation is creating the physical phenomenon of a shock wave, which is subject to complex shock reverberations on reflection of surrounding surfaces. The generated and expanding hot gases of an explosion are producing a blast wind, which is creating a dynamic pressure on the surroundings.

Projection

This effect summarizes various sources of fragments created during an explosion. Fragmentation is generally considered to be of two types:

Primary fragments result from the shattering of material in direct contact with the explosive (eg. casing). These fragments are usually small and are launched with velocities up to 2000m/s.

Secondary debris stems from structures and other items in close proximity to the explosion, which get destroyed or just accelerated by the blast wind or from crater ejecta. This debris is usually larger in size than the primary fragments and is launched at velocities up to hundreds of m/s.

Ground shock

Ground shock is the result of coupling of the energy of explosion into the ground. Ground shock leads to localized movement of the ground or structures.

Thermal effects

Thermal effects are associated with the fireball of an explosive event and might lead to secondary fires. Thermal effects are usually less severe than damage caused by air blast and fragmentation, and therefore play only a minor role in the explosion consequence analysis.

5 Modelling of effects

5.1 Air blast

The air blast of a free field explosion of a certain TNT- equivalent on the ground is commonly the base for any further evaluation of many of the prediction models.

5.1.1. Hopkinson-Cranz scaling law

Free field TNT-air blast has thoroughly been studied by extensive trials in the past. Free field air blast follows a QD-rule, which is also well known as the Hopkinson-Cranz cube-root scaling law (table 1).

It is the basis of much of the work on the estimation of appropriate quantity and separation distances. Many States use rules based upon the explosives, their quantity, and the distance from the explosive to where people are at risk. For HD 1.1. ammunition the QD-concept is based on a pressure-related correlation.

Certain effects are associated with a certain scaled distance, which is directly related to a certain level of overpressure, determined by the Hopkinson-Cranz Scaling law (table 2). This approach is used in the QD-siting concept described in AASTP-1.

However, limitation of this approach is evident by the fact that the impulse of the blast wave is not a direct function of the scaled distance, as it is the pressure (table 3).

$(R_1/R_2) = (W_1/W_2)^{1/3}$ $R = Z.W^{1/3}$	R = Range (m) Z = Constant of Proportionality (dependent on acceptable blast overpressure) W = Explosive Weight (kg)

Table 1: Hopkinson-Cranz Scaling Law

Examples of the constant ‘Z’ used in explosive storage safety[4] are shown in table 2:

Z	Purpose	Remarks
8.0	Used to predict separation distances between ammunition process buildings (APB) within an explosive storage area (ESA).	▪ Additionally minimum safe distances further apply if R is below a certain level, which differs for each ‘Z’ function.
14.8	Used to predict separation distances between an explosive storehouse (ESH) and a public traffic route with civilian access.	
22.2	Used to predict separation distances between an explosive storehouse (ESH) and a building inhabited by civilians.	
44.4	Used to predict separation distances between an explosive storehouse (ESH) and a vulnerable building inhabited by civilians (e.g. a school).	

Table 2: Examples of Constant ‘Z’

[4] These are the default ‘Z’ settings in the IATG Software, although the software does allow the user to input alternative ‘Z’ values.

Further details on the practical use of this formula are contained within IATG 02.20 *Quantity and separation distances*. A complementary IATG software can be found on the UN SaferGuard Website[5].

Amount of explosive [kg]	Distance [m]	Scaled distance	Incident pressure [bar]	Incident impulse [bar ms]	Positive phase duration [ms]
1000	222	22,2	0,054	1,43	61,1
8000	444	22,2	0,054	2,87	122
64000	888	22,2	0,054	5,74	244

Table 3 – Example of application of the scaling rules

The overpressure is calculated with empirical formulae for the description of a blast-wave. The most recognized approaches used in engineering tools are either the formulae developed by Kingery and Bulmash[6] or the formulae by Kinney and Graham. The Kinney-Graham[7] formulae are validated for larger scaled distances, up to Z=500; whereas the Kingery-Bulmash data set is limited to Z=40.

The formulae developed by Kingery and Bulmash for hemispherical surface burst are well established in engineering tools, and are implemented in popular engineering tools as well as the AASTP-1 QD-concept. The Kinney-Graham approach is also scientifically recognized, but the data are derived from spherical air bursts.

Therefore, the Kingery-Bulmash description of a hemispherical surface burst is chosen for the description of relevant blast wave parameters in IATG 1.80.

5.1.2. Blast wave description by Kingery and Bulmash

The characteristic parameters of a blast wave which are needed for further calculation of blast effects are:

Incident pressure: this is the peak pressure of the freely expanding blast wave

Reflected pressure: this is the pressure an object is experiencing, which is situated in front of a large obstacle perpendicular to the direction of expansion of the blast wave

Dynamic pressure: this is the additional pressure an object positioned in the flow of the blast wave is experiencing, due to the forces exerted by the blast wind caused by the expanding gases.

Incident impulse and **reflected impulse** are the corresponding acting impulses of the blast wave.

Further characterizing parameters provided by the Kingery-Bulmash empirical equations are the **time of arrival of the shock front** at a certain distance, the **duration of the positive phase of the blast wave** and the **velocity of the shock wave.**

These essential physical parameters of the blast wave have been made readily available by empirical formulae developed by Kingery and Bulmash. These equations are widely accepted as engineering

[5] https://www.un.org/disarmament/un-saferguard/

[6] Kingery, C. N. and Bulmash, G., Airblast Parameters From TNT Spherical Air Bursts and Hemispherical Surface Bursts, ARBRL-TR-02555, April 1984.

[7] G. Kinney, G. Graham. Explosive Shocks in Air, 1985, Springer.

predictions for determining free-field pressures and loads on structures and form the basis of the US Conventional Weapons Effects Programme (CONWEP) software. Their report[8] contains a compilation of data from explosive tests using charge weights from less than 1kg to over 400,000kg. There are datasets for a spherical burst in free air and for a hemispherical surface burst. The airblast of a ground detonation, as an incident at a storage facility would be, is described by the hemispherical surface burst data which are given below.

The authors used curve-fitting techniques to represent the data with high-order polynomial equations (see Table 4), which are included in the accompanying software to the IATG[9] for ease of application.

T = common logarithm of the distance in m **$U=K_0+K_1*T$** **$Y = C_0 + C_1U + C_2U^2 + C_3U^3 \ldots\ldots\ldots C_nU^n$**	Y = Common Logarithm of the Air Blast Parameter (metric) *(Pressure or Impulse)* $C_{0,1,2\ etc}$ = Constant $U = K_0 + K_1T$ $K_{0,1\ etc}$ = Constant T = Common Logarithm of the Distance (m)

Table 4: Kingery and Bulmash general polynomial form

The coefficients for calculation of the blastwave-parameters are provided in AASTP-1, table 5-5. Examples of results of the calculation are provided in table 5 below.

Amount [kg]	**1000**	**10000**	**100000**
Distance [m]	50	50	50
Scaled distance	5	2,32	1,078
Incident pressure [bar]	0,43	2,02	11,5
Incident impulse [bar ms]	5,9	25,2	106
Dynamic overpressure [bar]*)	0,062	1,12	17,9
Reflected pressure [bar]	1,01	6,8	66,5
Reflected impulse [bar]	12,6	65,5	372
Duration of positive phase [ms]	37,9	46,8	93
Arrival time of shock wave [ms]	82,4	48,1	24,8
Velocity of the shock wave [m/s]	398	559	1114

*) the dynamic overpressure is derived from the relation in table 6

Table 5: Examples of calculated blast wave parameters by Kingery-Bulmash formulae

[8] *Charles N Kingery and Gerald Bulmash*. Airblast Parameters from TNT Spherical Air Burst and Hemispherical Surface Burst, US Technical Report ARBRL-TR-02555. Ballistics Research Laboratory, Aberdeen Proving Ground, Maryland, USA. April 1984.

[9] https://www.un.org/disarmament/un-saferguard/kingery-bulmash/

$P_{dyn}=5/2*P_i^2/(7*P_a+P_i)$	P_{dyn}=dynamic pressure P_i = incident pressure P_a=ambient pressure

Table 6: Calculation of dynamic pressure

5.1.3. Scaling law for atmospheric conditions

In the case of blast waves from explosions produced at altitude, where ambient conditions can be very different from those at sea level, the most commonly used scaling law is that due to Sachs.[10] The application of the Sachs scaling law leads to the formulation of altitude scaling factors.

Scaled Distance at Altitude 'z' $S_{dz} = (P_0/P_z)^{1/3}$ *Scaled Pressure at Altitude 'z'* $S_{pz} = (P_z/P_0)$ *Scaled Impulse at Altitude 'z'* $S_{iz} = (P_z/P_0)^{2/3} \cdot (T_0/T_z)^{1/2}$ *Scaled Impulse at Altitude 'z'* $S_t = (P_0/P_z)^{1/3} \cdot (T_0/T_z)^{1/2}$	S_{dz} = Scaled Distance at Altitude 'z' (m) P_0 = Ambient Pressure (kPa) (101.33kPa) P_z = Pressure at Altitude 'z' (kPa) S_{pz} = Scaled Pressure at Altitude 'z' (kPa) S_{iz} = Scaled Impulse at Altitude 'z' (kg.m/s) T_0 = Ambient Temperature (K) (288.16^{0}K) T_z = Temperature at Altitude 'z' (K) S_t = Scaled Times at Altitude 'z' (s)

Table 7: Sachs scaling factors

Example: 100000kg at 50m distance in altitude 2000 (Table 8):

Amount of explosive [kg]	**100000**	**100000**
Distance [m]	50	50
Altitude above sea [m]	0	3000
Scaled distance	1,08	1,08
Incident overpressure [bar]	11,5	7,99
Incident impulse [bar ms]	106	86,1
Dynamic overpressure [bar]*)	17,9	12,4
Reflected overpressure [bar]	66,5	46,0
Reflected impulse [bar]	372	301
Duration of positive phase [ms]	93	109

Table 8: Altitude correction of blast parameters by Sachs scaling law

[10] *Sachs R G*. The dependence of Blast on Ambient Pressure and Temperature. Technical Report 466. Ballistics Research Laboratory, Aberdeen Proving Ground, Maryland, USA. May 1944.

5.1.4. Pressure reflexion coefficient dependency on angle of incidence

The calculated reflected pressure is valid for a surface perpendicular to the direction of the wave, which is the most severe case in terms of loading.

The reflected pressure decreases with increasing angle of incidence but not monotonically. It is a function of the height of the pressure and the incident angle. Reflection coefficient dependency on angle of incidence is provided in UFC-3-340-02[11], table 2-193.

For small overpressures (incident pressure below 1bar) there is a maximum at higher incident angles, which can exceed the perpendicular reflected pressure by 50%.
For higher overpressures there is a maximum of the reflection factor in the region between 40-50° For these cases the use of the perpendicular reflected overpressure is a save conservative assumption.

Amount of explosive [kg]	1000	1000	1000	1000
Distance [m]	5	10	20	50
Scaled distance	4,93	15,65	46,05	234
Incident overpressure [bar]	50	5,0	0,50	0,05
Incident angle	Refl. Overpressure [bar]			
0° (perpendicular)	**408**	22,5	**1,18**	**0,10**
10°	390	22,0	1,18	0,10
20°	363	21,1	1,17	0,10
30°	330	20,1	1,17	0,10
40°	296	20,2	1,17	0,10
45°	**358**	17,1	1,32	0,10
50°	312	13,6	**1,41**	0,10
55°	227	11,2	1,37	0,10
60°	150	9,6	1,17	0,11
70°	65	7,3	0,87	**0,14**
80°	50	6,0	0,66	0,098
85°	50	5,4	0,58	0,069

Table 9: Dependency of the reflected pressure on angle of incidence and pressure level – example for a 1000kg explosion

5.1.5. TNT equivalence

The formulae for blast wave characterization have been developed for TNT. In the explosives community it is a common strategy to determine a TNT-equivalent for the type of explosive of concern to use the Kingery-Bulmash TNT-blast formulae.

TNT-equivalency is not a precisely defined property, however. There exist coefficients derived by experiment as well as theoretically justified approximations. To provide a standardized approach, TNT-equivalents for several types of explosives are tabulated below (table 10), taken from AASTP-1, Table 5-2.

[11] UFC-3-340-02, *Structures to Resist the Effects of Accidental Explosions*. US Department of Defense. 05 December 2008; Change 2, 01 September 2014

Explosive	TNT Equivalent Mass		Pressure Range (MPa)
	Peak Pressure	Impulse	
ANFO	0,82	0,82	0.007 – 0.700
Composition B	1.11	0.98	0.035 - 0.350
Composition C4	1.37	1.19	0.070 - 0.700
H-6	1.38	1.15	0.035 -0.700
Octol 75/25	1.06	1.06	Estimate
Pentolite	1.42	1.00	0.035 - 0.700
PETN	1.27	1.11	0.035 - 0.700
RDX	1.14	1.09	--
RDX / TNT 60/40 (Cyclotol)	1.14	1.09	0.035 - 0.350
Tetryl	1.07	--	0.021 - 0.140
TNT	1.00	1.00	Standard
Torpex II	1.23	1.28	--
Tritonal 80/20	1.07	0.96	0.035 - 0.700

Table 10: TNT Equivalence (data taken from AASTP-1, Table 5-2)

A TNT-equivalent based on tabulated heats of detonation is provided in UFC-3-340-02, Table 2-1. To give an impression on variability of TNT-equivalence depending on the approach, table 11 is provided below.

Explosive	TNT Equivalent Mass	
	Heat of detonation	TNT equiv.
Baratole	1.04	0,53
Composition B	2.15	1,09
Composition C4	2.22	1,13
HMX	2.27	1,15
Pentolit 50/50	2.14	1,09
PBX 9407	2.24	1,14
PETN	2.31	1,17
RDX	2,27	1,15
Tetryl	2,11	1,07
TNT	1,97	1,00
NQ	1.49	0,76
NG	2.22	1,13

Table 11: TNT Equivalence (data taken from UFC-3-340-02, Table 2-1)

5.2 Modification of blast by Potential Explosion Site (PES)

If a detonation occurs within a building, the propagation of the blast wave will be obviously reduced, as part of the energy is consumed by damaging the surrounding structure.

Based on analysis of large data sets, empirical correlations for attenuation of a blast wave by surrounding structures have been derived for certain types of buildings, which are provided in DDESB TP-14, chapter 4.2.2. The amount of explosive is adjusted by a weight coefficient derived from table A-5 and the pressure and impulse is recalculated with the adjusted weight. For hollow clay tile buildings ad pre-engineered buildings are assumed to provide no blast reduction.

DDESB TP-14 assesses the following types of PES buildings:

Open	
ECM small concrete arch	ECM=earth covered magazine
ECM medium concrete arch	
ECM large concrete arch	
ECM small steel arch	
ECM medium steel arch	
ECM large steel arch	
AGBS small	AGBS=above ground brick structure
AGBS medium	
AGBS large	
PEMB	PEMB=Pre-engineered metal building
Hollow clay tile	
OB small concrete building	OB=office building
OB medium concrete building	
HAS	HAS=Hardened aircraft shelter
Small ship	
Medium ship	
OB medium concrete weak front	
ISO Container	

Table 12: PES building types defined in DDESB TP-14

5.3 Modification of blast by an exposed site (ES)

5.3.1. Blast load on a cuboid structure without significant venting openings

For determination of the blast effect on a nearby building, also several modifying effects have to be considered.

The forces imparted to an above ground structure can be divided into four general components:

- Forces resulting from the incident pressure
- Forces associated with the dynamic pressure
- Forces resulting from the reflection of the incident pressure impinging upon an interfering surface
- Pressures associated with the negative phase of the shock wave.

A simplified approach for the positive pressure phase is provided in AASTP-1, which is outlined below. A more detailed approximation for the total pressure history is given in UFC-3-340-01, chapter 2.15-3.

Assumptions for the following calculations are (see also figure 1):

- ✓ The structure has a rectangular shape
- ✓ The structure is in the region of the Mach stem and the Mach stem is extending the height of the building, which means that the blast wave can be assumed as a uniform perpendicular wave approaching the structure

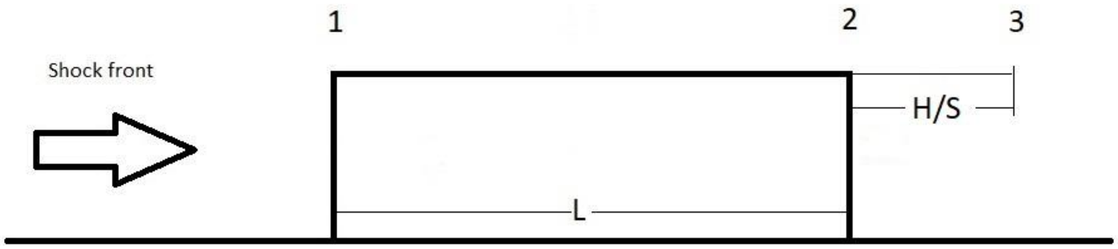

Figure 1 – Blast load on a cuboid structure

The characteristic air blast parameters needed (Kingery-Bulmash equations) at Position 1, 2, 3 (Figure 1) are (x…Position 1 ,2 or 3)

- ✓ Incident peak pressure ($P_{i,x}$)
- ✓ Incident impulse ($I_{i,x}$)
- ✓ Reflected peak pressure ($P_{r,x}$) (position 1 only)
- ✓ Reflected impulse ($I_{r,x}$) (position 1 only)
- ✓ Time of arrival ($t_{a,x}$)
- ✓ Duration of positive phase ($t_{o,x}$)
- ✓ Shock front velocity (U_x)
- ✓ Blast wave length of positive phase ($L_{w,x}$) (approximated as U_x*$t_{o,x}$)

Parameters of the building:

L…length of building
D…position of maximum loading of structural element (usually midpoint of span of element)
H…height of building
W…building width
S…clearing distance (height or 0,5*W, whichever is the smaller value)

Front face load:

$t_{of,1}$=2*$I_{i,1}$/$P_{i,1}$	$t_{of,1}$=fictitious duration of positive phase
$L_{w,1}$=U_1*$t_{o,1}$	
t_r=2*$I_{r,1}$/$P_{r,1}$	tr=duration of reflected pressure
$q_{o,1}$ = 5/2*$P_{i,1}^2$/(7*P_a+$P_{i,1}$)	$q_{o,1}$=dynamic pressure at point 1 P_a=ambient pressure (1,023bar)
$I_{q,1}$=0,5*$q_{o,1}$*$t_{of,1}$	$I_{q,1}$=dynamic impulse at point 1
I_d=C_{D1}*I_q	C_{D1}=drag coefficient (=1,0)
t_s=MIN (t_{s*},t_c) t_{s*}=($P_{r,1}$*$t_{r,1}$-($P_{i,1}$+C_{D1}*$q_{o,1}$)*$t_{o,1}$/($P_{r,1}$-($P_{i,1}$+C_{D1}*$q_{o,1}$) t_c=3*S/U_1	t_s= time at point of intersection between reflected pressure and combined side-on/drag pressure t_c=clearing time (of reflected pressure)
Ir*=0,5*($P_{r,1}$-$P_{i,1}$-C_{D1}*$q_{o,1}$)*t_s I=$I_{s,1}$+I_d+$I_{r,1}$	
Pressure waveform: **0≤t<t_s: $P_{(t)}$=P_{r*}*(1-1/t_s)+($P_{i,1}$+C_{D1}*$q_{o,1}$)*(1-1/$t_{of,1}$)** P_{r*}=$P_{r,1}$-$P_{i,1}$-C_{D1}*$q_{o,1}$ **t_s≤t≤$t_{of,1}$: $P_{(t)}$=($P_{i,1}$+C_{D1}*$q_{0,1}$)*(1-t/$t_{of,1}$)**	

Table 13: Calculation of front wall load

Side wall (at midpoint):

$t_{of,2}=2*I_{i,2}/P_{i,2}$	
$t_{2,eff}=t_{a,2}-t_{a,1}+t_{of,2}$	$t_{2,eff}$=effective duration of positive phase
$L_{w,2}=U_2*t_{o,2}$	
$C=L_{w,2}/L$ $\mathbf{C_2}=0{,}0048*C^5-0{,}0584*C^4+0{,}2817*C^3-0{,}6963*C^2+0{,}9551*C+0{,}2433$ $D/L=0{,}0098*C^5-0{,}1203*C^4+0{,}5682*C^3-1{,}3207*C^2+1{,}6217*C-0{,}0774$ $\mathbf{D}=L*D/L$ $t_{d2}=D/U_2$	
$q_{o,2} = 5/2*P_{i,2}{}^2/(7*P_a+P_{i,2})$	
$P_o=C_2*P_{i,2}+C_{D2}*q_{o,2}$ $I_s=0{,}5*P_o*t_{2,eff}$	C_{D2}=-0,4 (Drag coefficient)
Pressure waveform: **$0\leq t<t_{d2}$: $P_{(t)}=P_o*t/t_{d2}$** **$t_{d2}\leq t\leq t_{2,eff}$: $P_{(t)}=P_o*(1-t*t_{d2}/(t_{2,eff}-t_{d2}))$**	

Table 14: Calculation of side wall load

Rear wall:

$t_{of,3}=2*I_{i,3}/P_{i,3}$	
$t_{3,eff}=2*H/(U_2+U_3)+t_{of,3}$	$T_{3,eff}$=effective duration of positive phase
$L_{w,3}=U_3*t_{of,3}$	
C=Lw,3/H $\mathbf{C_3}=0{,}0048*C^5-0{,}0584*C^4+0{,}2817*C^3-0{,}6963*C^2+0{,}9551*C+0{,}2433$ $D/L=0{,}0098*C^5-0{,}1203*C^4+0{,}5682*C^3-1{,}3207*C^2+1{,}6217*C-0{,}0774$ $\mathbf{D}=H*D/L$	
$t_{d3}=D/U_2$	
$q_{o,3} = 5/2*P_{i,3}{}^2/(7*P_a+P_{i,3})$	
$P_o=C_3*P_{i,3}+C_{D3}*q_{o,3}$ $I_s=0{,}5*P_o*t_{3,eff}$	C_{D3}=-0,4 (Drag coefficient)
$0\leq t<t_{d3}$: $P_{(t)}=P_o*t/t_{d3}$ **$t_{d3}\leq t\leq t_{3,eff}$: $P_{(t)}=P_o*(1-t*t_{d3}/(t_{3,eff}-t_{d3}))$**	

Table 15: Calculation of rear wall load

5.3.2. Blast inside of an exposed building

DDESB TP-14 provides also a method for estimation of the pressure inside a building, described in chapter 4.2.3. A reduction level for pressure is calculated from the percentage of glass of the building walls and the percentage of damage to the windows. This model does not discriminate between different type or quality of windows.

The maximum reduction level is assumed with 50% if all windows remain undamaged, and is gradually reduced to 0% at 25% percentage of glass.

As a building parameter, the vent area to building volume ratio is introduced. The slope of the reduction is determined from a function of pressure and explosive weight.

The following information on ES building is required:

- ✓ Building type
- ✓ Percentage of glass
- ✓ Floor area

DDESB TP-14 assesses the following types of ES:

Small reinforced concrete	
Medium reinforced concrete	
Large reinforced concrete tilt-up	
Small reinforced masonry	
Medium reinforced masonry	
Small unreinforced brick	
Medium unreinforced masonry	
Large unreinforced masonry	
Small PEMB	PEMB=Pre-engineered metal building
Medium PEMB	
Large PEMB	
Small wood frame	
Medium wood frame	
Medium steel stud	
Wood frame trailer/building	
Moving vehicle	
Stationary vehicle	

Table 16: ES building types defined in DDESB TP-14

5.4 Blast reduction by barriers

AASTP-1 gives a short notice on blast reduction by barriers: significant shielding effects are only occurring up to scaled distances of about 1 $m/kg^{1/3}$ and the effects are difficult to quantify.

On the other hand, there is documentation of shielding effects of buildings in certain configurations leading to blast reduction up to 50% at the front side of the shielded building and vice-versa enhancement by reflection effects on the rear wall of the shielding building[12].

Zhou and Hao[13] have developed an empirical model based on analysis of an experimental database and validation with CFD-methods. Parameters are:

- W=amount of explosive, ranging from 10 to 10000kg,
- R= distance between PES and ES, ranging from 5 to 50m,
- H_{ES} = height of ES, from 3 to 40m
- H_B = height of the blast wall from 1 to 4 m; thickness in the dimension of 0,25m
- L = distance between PES and barrier, ranging from 1 to 40m.

The L/R ratio of the database ranged from 0,2 to 0,8.

The model provides information of distribution and peak values of reflected pressure and impulse on the front side of a building, effected by a barricade.

Input parameters are incident pressure and impulse, reflected pressure and impulse for the free-field configuration (derived for W and D from Kingery-Bulmash equations) distance between PES and ES (D), height (H_B) of barricade, height of building (H_{ES}), and distance L between PES and barricade.

AP_{max}=-0,1359+(0,3272+0,1995*lg(H_B/R))*lg Z – 0,5626 *lg(H_B/R)+ +0,4666*L/R	AP_{max}=maximum pressure reduction coefficient Z=R/$W^{1/3}$ lg=common logarithm
AI_{max}=0,0274+(0,4146+0,2393*lg(H_B/R))*lg Z – 0,5044*lg (H_B/R)+ +0,2538*L/R	AI_{max}=maximum impulse reduction coefficient
(HP_{min}-H_B)/R = -0,4275+0,0366*lg Z-0,4043*lg(H_B/R)-0,1709*lg(L/R)	HP_{min}=height of minimum of pressure
AP_{min}/AP_{max}=-0,0284+0,244*lgZ-0,4302*lg(H_B/R)-0,3475*lg(L/R)	AP_{min}=reduction coefficient for pressure minimum
(HI_{min}-H_B)/R=-0,2474+0,1084*lgZ-0,2450*lg(H_B/R)-0,2377*lg(L/R)	HI_{min}=height of minimum of impulse
AI_{min}/AI_{max}=0,3196+0,2154*lgZ-0,3171*lg(H_B/R)-0,2013*lg(L/R)	AI_{min}=reduction coefficient for impulse minimum
HP_{max}/R=1,0995-0,0105*lgZ+0,7806*lg(H_B/R)-0,4109*lg(L/R)	HP_{max}=maximum height of pressure reduction
HI_{max}/R=1,1994-0,0843*lgZ+0,8329*lg(H/R)-0,1841*lg(L/R)	HI_{max}=maximum height of impulse reduction

Table 17: Calculation of pressure and impulse reduction by barricades

[12] *A. Remennikov*, The state of the art of explosive loads characterization,2007, 1-25. https://ro.uow.edu.au/engpapers/4245.

[13] *X.-Q. Zhou, H. Hao*, Prediction of air blast loads on structures behind a protective barrier, International Journal of Impact Engineering, 35(5), 363-375, 2008.

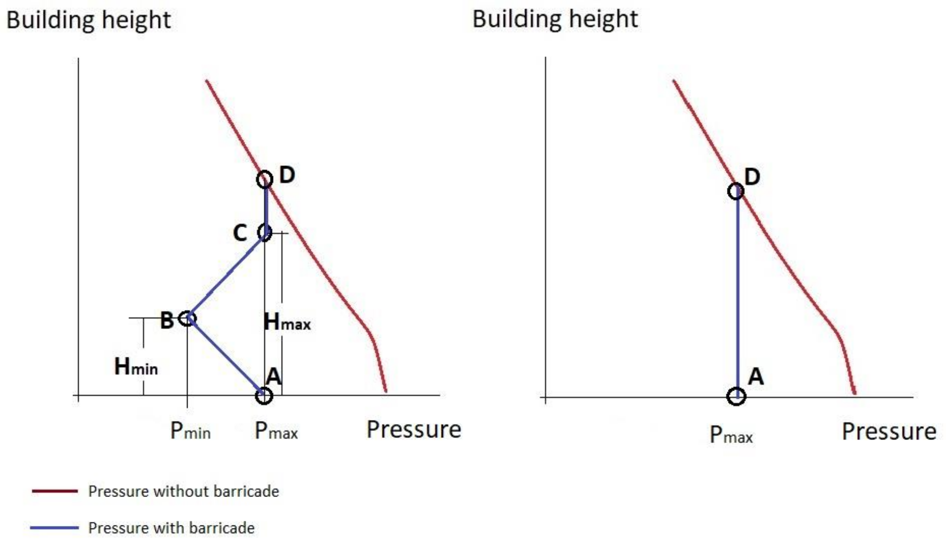

Figure 2 – Simplified profile of pressure and impulse reduction by barricades

For $(R-L)/H_B<4$, a local minimum of blast load occurs and the pressure and impulse profile on the building front is approximated by a curve according to the left side of figure 2.

For $(R-L)/H_B>4$ there is no local minimum and the pressure and impulse profile is following the curve on the right side of figure 2.

5.5 Fragments and debris

The throw of fragments and debris is often a dominant effect in explosion events. The Q-D concept for determination of safe distances is based on blast levels only. The throw of fragments and debris is only considered indirectly, as a certain hazard from throw is related in a very generalized way with a certain amount of explosive.

Therefore, models are needed for a more detailed characterization of fragments and debris generated by an explosion.

One tool is the calculation of trajectories for a representative choice of fragments and debris.

5.5.1. Trajectory calculation

Trajectories can be calculated by basic physical equations:

The model used in the ECA-tool (to be provided) takes into account gravity and drag forces and is considering dependency on density of air and of drag-coefficient on velocity. The tool is meant for irregularly shaped objects accelerated by explosion and does not consider spin-stabilized projectiles. The drag coefficient for natural fragments as provided in AASTP-1(Table 5-9) is chosen as a default.

Mach number	Drag coefficient
0.1 – 0.2	0.85
0.2 – 0.4	0.86
0.4 – 0.6	0.90
0.6 – 0.8	1.10
0.8 – 1.0	1.25
1.0 – 1.1	1.33
1.1 – 1.2	1.415
1.2 – 1.3	1.42
1.3 – 1.4	1.40
1.4 – 2.8	1.29
2.8 – 5.6	1.15
5. – 11.2	1.115

Table 18: Drag coefficient dependency on Mach number for natural fragments (fom AASTP-1, table 5-9)

Parameters to be provided for calculation are:

- ✓ Initial velocity of the fragment
- ✓ Shape of the fragment (approximated as a cuboid)
- ✓ Density of the fragment (or weight)
- ✓ Drag coefficient (to be chosen from given selection)

A full trajectory calculation needs to solve the following coupled differential equations.

General equation: $dU/dt=1/m*(F_{drag}+F_g)$	F_{drag}=drag force F_g=Gravity U=current velocity of the fragment (vector) t=time of travel of the fragment m=mass of the fragment
With u as the radial and v as the vertical component of the velocity vector U the equation can be written as two coupled differential equations:	
$\mathbf{du/dt=-\kappa*(u^2+v^2)^{1/2}*u}$ $\mathbf{dv/dt=-\kappa*(u^2+v^2)^{1/2}*v-g}$	K=ballistic coefficient (kg/m³) g=gravity constant
$K=S_n*\rho_a*C_D/(2*\rho_m^{2/3}*m^{1/3})$	S_n=shape number (2 for irregularly shaped fragments) ρ_m =material density of the fragment m=mass of the fragment C_D=drag coefficient (depending on velocity, see table 18)

Table 19: Trajectory calculation

5.5.2. Initial Fragment velocity

The *Gurney Equations*[14] are a range of formulae used in explosives engineering to predict how fast an explosive will accelerate a surrounding layer of metal or other material when the explosive detonates. This determines how fast fragments are released on detonation of an item of ammunition. This initial fragment velocity can then be used with other ballistic equations to predict either danger areas or fragment penetration. A popular model for the prediction of launching velocity of ammunition casing is the Gurney equation. The model assumes a material with high tensile strength, cast iron as a brittle material is not really covered by the model; according to literature the velocity for brittle iron achieves only 80% of the calculated values.

Cylindrical Charge Equation[15] $\mathbf{(V/\sqrt{2E}) = ((M/C_{exp}) + ½))^{-1/2}}$ *Spherical Charge Equation*[16] $\mathbf{(V/\sqrt{2E}) = ((M/C_{exp}) + 3/5))^{-1/2}}$	V = Initial Fragment Velocity (m/s) $\sqrt{2E}$ = Gurney Constant for a given explosive (m/s) M = Total mass of casing (kg)[17] C_{exp} = Explosive Charge Mass (kg)

Table 20: Gurney Equations[18]

The Gurney Constant $\sqrt{2E}$ is usually very close to 1/3 of the Detonation Velocity of the explosive. Table 21 contains the Gurney Constants for a range of high explosives:[19]

[14] *Gurney, R. W*. The Initial Velocities of Fragments from Bombs, Shells, and Grenades, BRL-405. Ballistic Research Laboratory, Aberdeen, Maryland. USA. 1943.

[15] First order approximation for most high explosive artillery shells, mortar bombs and missile warheads.

[16] Use for military grenades and some cluster bomblets.

[17] For an artillery shell this is usually the base for which an estimate of mass is made from the total body mass.

[18] There are other Gurney equations for symmetrical, asymmetrical, open faced and infinitely tamped sandwiches. These are beyond the scope of this IATG and have hence been excluded.

[19] Densities and detonation velocities are approximate as explosive mixtures vary.

Explosive [20]	Density (kg/m^3)	Detonation Velocity [21] (m/s)	Gurney Constant √2E (m/s)
Composition B	1.61	7,620	2,774
Composition C4	1.71	8,200	2,530
Octol 75/25	1.81	8.640	2,896
PETN	1.78	8,260	2,926
RDX	1.81	8,700	2,926
RDX / TNT 60/40 (Cyclotol)	1.68	7,800	2,402
Tetryl	1.71	7,570	2,499
TNT	1.61	6,900	2,438
Tritonal 80/20	1.70	5,480	2,316

Table 21: Gurney Constant for different explosives

5.5.3. Mass distribution of the fragments of ammunition casings

The Mass distribution of the fragments of ammunition casings is described by Mott´s equation, one of the earliest models. The model deals with a grenade as an expanding cylinder causing tensile stress and experiencing a tensile relief on fracture surfaces. Readily available data usually refer to mild steel as a casing material.

$N(m) = M_o/2*M_K^2*\exp(-m^{1/2}/M_K)$	N(m)=Number of fragments with mass larger than m M_o= Mass of the metal cylinder (lbs) M_K…..distribution factor
$M_K = B*t^{5/16}*d^{1/3}*(1+t/d)$	B=specific constant for a given explosive-metal pair (Mott Constant) t…wall thickness (inch) d…inside diameter of a cylinder (inch)
$N_t=M_o/2/M_K^2$	N_t=total number of fragments
$M_{av}=2*M_K^2$	M_{av}=average mass of the fragments

Table 22: Calculation of fragment distribution by Mott´s equation

Table 23 contains the Mott Constants for a range of high explosives:

[20] Details on a wide range of explosives can be found in the App "eXdata".

[21] The detonation velocity will vary dependent on the methodology used to measure it. This column includes examples.

Explosive [22]	Mott coefficient for Mild Steel Cylinders ($lb^{1/2}in^{-7/16}$)
Composition B	0.0554
H-6	0.0690
Pentolite	0,0620
RDX	0.0531
Tetryl	0.0682
TNT	0.0779

Table 23: Mott´s Constant for different explosives

5.5.4. Launch velocity and mass distribution of debris (reinforced concrete)

5.5.4.1. Launch velocity

The launch velocity as well as the mass distribution of debris of reinforced concrete structures, demolished by the blast can be estimated according to the formula developed by Van der Voort and Weerheijm[23].

$DLV = C *(NEQ/V^{2/3}/t/\rho)^{1/2}$	DLV=Debris Launch Velocity C=Constant (525m/s) T=wall thickness NEQ=net explosive weight (TNT-equivalent) V=room volume ρ = density of wall material

Table 24: Launch velocity of concrete debris

5.5.4.2. Length distribution of debris

The length distribution of concrete debris from exploding reinforced concrete structures can be described by a generalized Mott distribution (Van der Voort and Weerheijm).

$N(L)=N/L_{av}*\exp(-L/L_{av})$	N(L)=Number of fragments with length larger than L L_{av}=average length of debris
$M_{av}=6* \rho*L_{av}^3$	M_{av}=average mass of debris ρ= material density of debris
$N=M/M_{av}$	M=total mass of debris

Table 25: Length distribution of concrete debris

[22] Details on a wide range of explosives can be found in the App "eXdata".

[23] *M.M. van der Voort, J. Weerheijm*, A statistical descriptionn of explosion produced debris disperion, Inteernational Journal of Impact Engineering, 59, 29-37, 2013.

The essential parameter L_{av} has been determined by numerous large and small scale internal detonation experiments. The dependency of L_{av} on the relevant parameter combination is classified information and therefore not accessible, however.

Representative values might be deduced by use of accessible experimental data sets (KASUN[24], and SCIPAN[25] trials).

5.5.5. Calculation of Debris and fragment hazards by an empirical model

5.5.5.1. Empirical model of DDESB TP-14

Determination of fragment hazards by trajectory calculations is a very tedious process and beyond the scope of this IATG.

IATG 1.80 recommends a simpler estimation by an empirical model, which is in detail described in DDESB TP-14.

The US DoD tool SAFER is a software-tool based on the data provided in DDESB TP-14.

DDESB TP-14 provides an empirical method for calculation of debris generated by explosions of a choice of ammunition items in a selection of generalized building types.

Fragments are categorized by mass and energy bins and divided into fragments stemming from ammunition and the building. For building there is a discrimination between debris from concrete and from metal (stemming from constructive elements).

Bin	Kinetic energy MIN [ft lbs]	Kinetic energy average [ft lbs]	Kinetic energy MAX [ft lbs]	Average fragment mass, steel [lbs]	Average fragment mass, concrete [lbs]
1	100000	173000	<300000	35,7	75,4
2	30000	54000	100000	14,9	31,5
3	10000	17000	30000	6,34	13,4
4	3000	5000	10000	2,66	5,61
5	1000	1700	3000	1,13	2,38
6	300	547	1000	0,473	1,0
7	100	173	300	0,199	0,42
8	30	54	100	0,0852	0,18
9	10	17	30	0,0379	0,08
10	3	5	10	0,0142	0,03

Table 26: Mass and energy bin concept used in DDESB TP-14

The debris is divided into direct flying fragments, which will hit an ES on a side wall with residual velocity related to the trajectory, and high angle fragments, which will hit the ES from above with terminal velocity of free fall.

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[24] *R. Forsen, R. Berglund, G.A. Groensten,* The effects of cased ammunition explosions confined in concrete cubicles-KASUN-III, 34th DDESB Explosive Safety Seminar, Portland, OR, 2010.

[25] *R. Conway, J. Tatom, M. Swisdak*, SciPan4: Program description and test results, 34th DDESB Explosive Safety Seminar, Portland, OR, 2010.

The direct flying fragment are further split into fly-through fragments and side impact fragments, which have reached terminal velocity and are falling when they hit the wall of the ES.

The algorithms are considering effects of degree of destruction of the PES and the dependency of number and size of fragment of the loading density of explosive within the building,

The algorithm is further considering the shielding effect of a barrier and the shielding of the ES in terms of energy reduction due to energy loss by penetrating work of the debris.

In the end the algorithm provides a table with number of fragments for each energy bin and finally values for probabilities of fatal hits, hits causing major injuries and hits causing minor injuries.

For details and data refer to DDESB chapter 4.4 .1 to 4.4.9. and associated tables.

Table 27 shows one example of a fragment table.
Assumptions: 103 items of MK 82 bombs, representing 9600kg explosive, stored in an earth covered magazine. The table shows the fragment density in the open with a barricade of 5m height at 5 m distance to the ECM, and without, at a distance of 200m.

Debris density at 200m PES: ECM NEQ: 9600 kg	**without barricade**	**with barricade (5m height at 5 m distance to ECM)**
High angle debris table	pieces/m²	pieces/m²
Bin1 (234,6 kJ)	2,10E-02	2,10E-02
Bin2 (73,2 kJ)	1,50E-02	1,50E-02
Bin3 (23 kJ)	2,75E-02	2,75E-02
Bin4 (6780 J)	4,53E-02	4,53E-02
Bin5 (2300 J)	5,87E-02	5,87E-02
Bin6 (742 J)	8,32E-02	8,32E-02
Bin7 (235 J)	9,74E-02	9,74E-02
Bin8 (73 J)	2,09E-01	2,09E-01
Bin9 (23 J)	6,17E-01	6,17E-01
Bin10 (6,8 J)	6,37E+00	6,37E+00
Low angle debris table	pieces/m²	pieces/m²
Bin1 (234,6 kJ)	3,36E-04	1,49E-04
Bin2 (73,2 kJ)	6,13E-04	4,12E-04
Bin3 (23 kJ)	1,18E-03	9,98E-04
Bin4 (6780 J)	2,28E-03	2,14E-03
Bin5 (2300 J)	1,10E-02	5,64E-03
Bin6 (742 J)	4,49E-02	7,97E-03
Bin7 (235 J)	1,79E-01	9,25E-03
Bin8 (73 J)	5,72E-01	1,07E-02
Bin9 (23 J)	7,07E-01	1,53E-02
Bin10 (6,8 J)	6,27E-01	3,18E-02

Table 27 – Example of empirical fragment density estimation following the algorithm of DDESB TP-17

The table shows, that the barricade reduces the density of critical fragments (NATO criterion 79J; critical density is 1 piece/56m²) from 77 pieces/56m² to 33 pieces/56m².

AASTP-1 Estimation of fragment densities from ammunition stacks

AASTP-1 gives simple estimations on maximum fragment densities for fragments from ammunition stacks.

$q_f=Q_o/R^2*\exp(-(2M_f/M_o)^{1/2})$ If the critical mass M_{cr} is chosen, then q_f delivers the density of critical fragments (q_{cr})	R=distance Q_o=total number of fragments per unit solid angle emitted in target direction by an ammunition item. For spherical distribution: $Q_o=N_t/4/\pi$ (see Mott distribution 4.2.3) N_t=total number of fragments M_f=fragment mass under consideration (=all fragments with this and larger mass are under consideration
The critical mass M_{cr} can be estimated by an iterative procedure: $M_{cr\ (low\ angle)}=2*E_{cr}/V_i^2$ $M_{cr\ (high\ angle)}=(2*E_{cr}/9{,}81/L)^{3/4}$ $V_i=V_o*\exp(-R/L)$ $L=2*k^{2/3}/C_D/\rho_a$ Whichever gives the smaller value of $M_{cr\ (low\ angle)}$ and $M_{cr\ (high\ angle)}$ is used as M_{cr} for calculation of critical fragment density	E_{cr}=critical energy (79J) k=shape factor (4,74g/cm³) V_o=launch velocity (Gurney, see chapter 4.3.3) C_D=drag coefficient (see table 18) ρ_a=density of air L=length of flight path traveled after which the fragment velocity drops to the $(1/e)^{th}$ part
$Q_{o,eff}=Q_o*N_E$	$Q_{o,eff}$=effective value of Q_o
Stack in the open: $N_E=0{,}9*N_S+0{,}1*N_T$ Stack in an earth-covered magazine: $N_E=0{,}7*N_S+0{,}1*N_T$	N_S=number of items of ammunition on the side of the stack facing the potential target N_T=number of items of ammunition in the top layer of the stack

Table 28: simple estimation of critical fragment densities from ammunition stacks

5.6 Ground shock

Ground shock can be differentiated in shock induced by air blast and directly induced ground shock.

A simple approach for surface and near surface bursts is outlined in AASTP-1 (chapter 2.5.4.1 to 2.5.4.3, table 5-12 and table 5-14), which is recommended for rough estimations.

Usually the damage caused by ground shock is by far outreached by direct blast effects and damage by debris.

The formulas are evaluated for the range 0,2<Z<24 for masses from 0,5 to 500.000kg

The ground shock consists of an air blast induced component and a direct induced component. Both shock components act independently of each other. In the vicinity of the point of burst the air blast induced ground shock reaches the exposed side before the direct ground shock, with increasing distance the direct component catches up, resulting in superposition of both shock waves and finally with the leading direct induced wave at greater distance.

Airblast induced Ground shock	**Displacement D [m]**	**Velocity V [m/s]**	**Acceleration A [g]**
Vertical	D_v=Ii/(cp rho)	V_v=P_i/(cp rho)	A_v=122*P_i/(cp rho)
Horizontal	take vertical values as worst case		
Ii=incident impulse [Pa s] Pi=incident pressure [Pa]		c_p rho = acoustic impedance (see table 29)	

Table 29: Calculation of air blast induced ground shock (AASTP-1, table 5-12)

Soil description	**c_p rho (acoustic impedance) [kg/m²s]**
Heavy saturated clays and clay-shale	954000
Shale and marl - min	273000
Basalt	283000
Granite	457000
Limestone	605000
Sandstone	2686000
Volcanic rock min	3712000
Weathered rocks min	4175000

Table 30: Acoustic impedance for various types of soil (from AASTP-1, table 5-13)

Direct induced Ground shock, Vertical	**Displacement D_v [m]**	**Velocity V_v [m/s]**	**Acceleration A_v [g]**	
Rock	$(R*Q)^{1/3}/(37000*Z^{1/3})$	$0,95/Z^{1,5}$	1200/(Z*R)	R=distance Z=scaled distance Q=mass of explosive
Dry soil	$(R*Q)^{1/3}/(1000*Z^{1/3})$	$0,95/Z^{1,5}$	1200/(Z*R)	
Wet soil	$(R*Q)^{1/3}/(1000*Z^{1/3})$	$0,95/Z^{1,5}$	1200/(Z*R)	

Table 31: Calculation of direct induced ground shock, vertical direction (AASTP-1, table 5-14)

Direct induced Ground shock, Horizontal	**Displacement D_h [m]**	**Velocity V_h [m/s]**	**Acceleration A_h [g]**	
Rock	$0,5*D_v$	V_v	A_v	see table 30!
Dry soil	D_v	V_v	$0,5*A_v$	
Wet soil	D_v	V_v	A_v	

Table 32: Calculation of direct induced ground shock, horizontal direction (AASTP-1, table 5-14)

5.7 Thermal effects

Thermal effects might be the limiting threat for 1.3 ammunition, particularly propellant charges. AASTP-1 gives a rough estimation on the criterion of an energy flux of 167 kJ/m², which is reached at a certain distance R, to prevent propagation.

Distance of heat energy flux limit of 167kJ/m²	
$R=NEQ^{0,44}$	R(m) NEQ (kg)

Table 33: Heat flux limit for propagation (AASTP-1, chapter 2.5.6.2)

For estimation of thermal effects, the models of Baker et al.[26] and models presented in AASTP-4 (Swiss and Norwegian model have been harmonized using experimental data from M. Williams (Cranfield University)[27]. Calculation of thermal flux is done either with a point source model (if relation of fireball diameter and distance can be approximated by this assumption) or by use of diagrams provided by Baker et al.

Fireball characterization (Baker)	
Diameter of fireball [m]: $d=3,86*Q^{0,32}$	Q=burning mass [kg]
Duration of fireball [s]: $t=0,299*Q^{0,32}$	
Correction of burning temperature	
Factor for d: $f_d=(T_x/T_r)^{1/3}$ Factor for t: $f_t=(T_x/T_r)^{10/3}$	Reference burning temperature (T_r): 3600K Burning temperature of propellants (T_x): 2500K
Efficient duration of fireball [s]: $t_{eff}=t/f_t$	

Table 34: Fireball characterization

Thermal flux: point source model	
$q=0,4*Q*H_c/4/\pi/t_{eff}/R/R$ [kW/m²]	q=thermal flux H_c=heat of combustion (4600 kJ/kg for propellants) 0,4=radiation fraction of heat
Thermal energy $Q_{th} = q*t_{eff}$ [kJ/m²]	
Thermal dose: $q^{4/3}*t_{eff}$ [(kW/m²)$^{4/3}$s]	

Table 35: Calculation of thermal flux and thermal dose

[26] *W. E. Baker et al*. Explosion Hazards and Evaluation, Elsevier, (ISBN 0 444 42094 0). Amsterdam, 1983.

[27] *M. Williams*, Measuring radiated thermal output from pyrotechnics and propellants, Cranfield University, 2008.

6 Modelling of consequences

6.1 Simple correlations for planning of destruction of ammunition by open detonation[28]

6.1.1. Range safety distances

The following simple safety distances can be used to estimate range danger areas when planning the destruction of ammunition by open detonation. They may be used for 'quick planning' on demolition ranges with existing danger areas. If used on demolition areas with no formal danger areas the user should remember that the distance produced by these equations is that distance outside which no more than one fragment would be expected to fly. They are NOT absolutely safe.

For fragmenting munitions when public access is possible to the demolition range area. **$D = 634(AUW)^{1/6}$** *For bare exposed explosive only.* **$D = 130(AUW)^{1/3}$**	D = Distance (m) AUW = All Up Weight of Ammunition or Bare Explosives (kg)

Table 36: Simple Range Safety Distances

An Explosion Danger Area Calculator that uses these equations can be found in the IATG Implementation Support Toolkit[29].

The Australian Defence Science and Technology Organisation (DSTO) conducted research in March 1997 into multi-item demolition of ammunition and explosives. They concluded that fragmentation explosion danger areas for multi-item demolitions can be reduced to that of the largest Net Explosive Quantity single munition in the demolition . Underlying assumptions are:

a) the ordnance is arranged in a linear array and NOT a stack;

b) the ordnance is detonated simultaneously; and

c) the items are GREATER than one charge diameter apart.

$D = 370(AUW)^{1/5}$	D = Distance (m) AUW = All Up Weight of Ammunition or Bare Explosives (kg)

Table 37: Simple Range Safety Distances (Alternative)

6.1.2. Vertical danger areas

The equations to estimate the vertical danger areas necessary to warn air traffic of demolitions taking place on the ground differ slightly from Clauses 9.1 and 9.2 as no ballistic parabola needs to be taken into account.

[28] See Technical Note for Mine Action (TNMA) 10.20/01 *Estimation of Explosion Danger Areas* (Version 2.0). Geneva. GICHD. Further details on their use are available there.

[29] https://www.un.org/disarmament/un-saferguard/explosion-danger-area/

For single ammunition item only. **$D = 314(AUW)^{1/3}$** *For multi-item fragmenting munitions.* **$D = 470(AUW)^{1/5}$**	D = Distance (m) AUW = All Up Weight of Ammunition or Bare Explosives (kg)

Table 38: Vertical danger Areas

A Vertical Danger Area Calculator can be found in the IATG Implementation Support Toolkit[30].

6.1.3. Simple noise prediction

The following equation[31] can be used to predict the distance at which 140dB[32] of sound could be expected to be achieved, which is regarded as a critical level for impulse noise:

$D = 215\,(M_{exp})^{1/3}$	D = Distance (m) M_{exp} = Mass of Explosive (kg)

Table 39: Simple Noise Prediction

A simple calculator that uses this equation can be found in the IATG Implementation Support Tool[33]

[30] https://www.un.org/disarmament/un-saferguard/vertical-danger-area/

[31] Source: QinetiQ Shoeburyness, UK. 1999.

[32] The EU maximum permissible noise level for a single event.

[33] https://www.un.org/disarmament/un-saferguard/noise-prediction/

6.2 Blast effects on structures

The prediction of weapons effects on structures is a complex undertaking due to the large number of variables involved[34] and the impact that these variables have on structural response to blast loading.

6.2.1. Model by Scilly

Rough estimates for structural damage due to air blast may be obtained from empirically derived models based on an analysis of accidents, trials and war damage data. This analysis correlates the structural damage with the distance from the explosion and the charge mass involved.

The most extensive data is available for brick-built structures due to studies undertaken in World War 2. Explosion induced damage categories for brick built housing have been developed[35] which may be used in explosion consequence analysis to illustrate the potential severity of the effects of an undesirable explosion:

Category	Definition	Remarks
A	Houses completely demolished.	▪
B	Houses so badly damaged they are beyond repair and require demolition.	▪ 50% - 75% of external brickwork destroyed. ▪ Remaining walls have gaping cracks that are un-repairable.
C_B	Houses rendered uninhabitable but can be repaired with extensive work.	▪ Partial or total collapse of roof structure. ▪ Partial demolition of walls up to 25% of the whole. ▪ Severe damage to load bearing partitions necessitating demolition and replacement.
C_A	Houses rendered uninhabitable but can be repaired reasonably quickly.	▪ Does not exceed minor structural damage. ▪ Partitions and joinery wrenched from fittings.
D	Houses requiring repairs to remedy serious inconvenience but remain habitable.	▪ Damage to ceilings and tiling. ▪ Minor fragmentation effects on walls and glazing.

Table 40: Brick Built Housing Damage Categories

The data analysis used to produce Table 40 led to an empirically derived formula to estimate damage range (Table 41).

$R_x = (K_x \cdot M_{exp}^{1/3}) / (1 + (3175/M_{exp})^2)^{1/6}$	R_x = Range for Damage Level 'x' (m) K_x = Constant for Damage Level 'x' (See Table 29) M_{exp} = Mass of Explosive (kg)

Table 41: Damage Range to Buildings Estimation

[34] For example: 1) structure type; 2) structure material strength, elasticity and ductility; 3) structural response to blast loading; 4) diffraction loading effects; 5) drag loading effects; 6) building orientation to blast loading; 7) local topography etc.

[35] Through the work of: 1) *Scilly N F* and *High W G.* The blast effect of explosions. Loss prevention and safety promotion 5. 1986; and 2) *Jarrett D E*. Derivation of the British Explosives Safety Distances. Annals New York Academy of Sciences, 152, Article 1. 1968.

Values for K_x were initially derived by *Jarrett* and subsequently revised by *Gilbert, Lees and Scilly.*[36] The revised values take account of the casing factor, which is the degree of energy imparted to the primary fragments from the casing, thereby reducing the air blast energy available.

K_x for Damage Category	Jarrett	Gilbert, Lees and Scilly
A	3.8	4.8
B	5.6	7.1
C_B	9.6	12.4
C_A	28.0	21.3
D	56.0	42.6

Table 42: ‘K’ Factors for Table 41

6.2.2. US method for building damage based on composite PI-diagrams

The method is comprehensively described in DDESB TP-14. Pressure-Impulse diagrams are provided showing iso-damage curves for various degrees of destruction (DDESB TP-14, attachment 7, figures A7-1 to A7-16). The data were developed by ACTA for fifteen low-rise structure types. The diagrams are valid from yields ranging from 453,6kg to 2.268.000kg. Input parameters are incident pressure and incident impulse.
The types of ES-buildings assessed in DDESB TP-14 are tabulated in table 16.

Figure 3 provides one example.

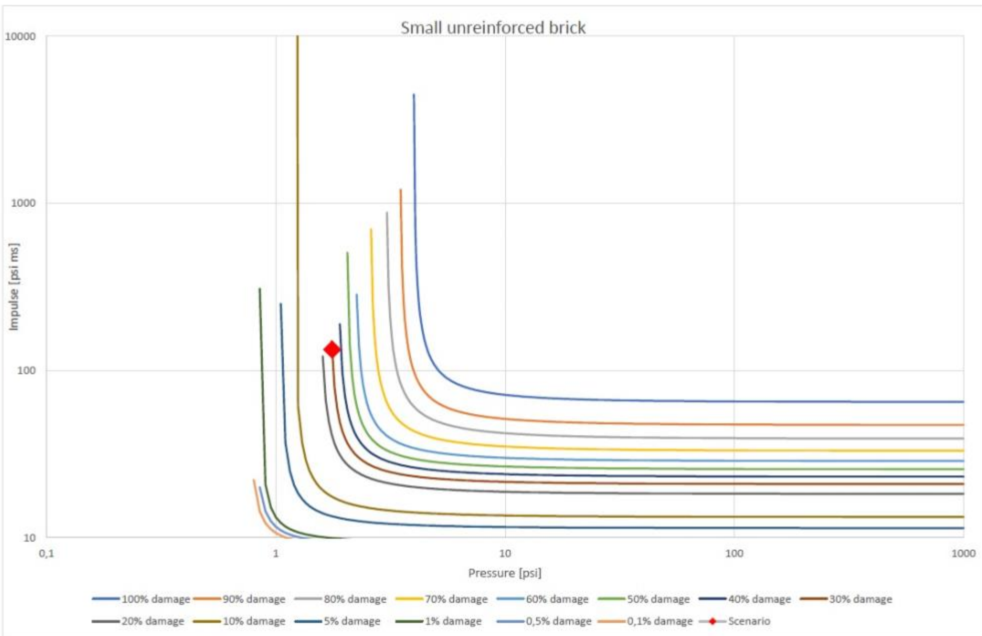

Figure 3 – Example of damage assessment by PI-diagrams (50000kg open detonation at 400m distance)

[36] *Gilbert S M, Lees F P and Scilly N F.* A Model Hazard Assessment of the Explosion of an Explosives Vehicle in a Built-Up Area. Minutes of the 26th US Department of Defense Explosives Safety Board Seminar. Miami. USA. 1994.

6.2.3. Breakage of windows

The breakage of windows by air-blast has been modelled in various research programs. The response of windows is obviously very much depending on construction and type of glass and is therefore also subject to regional building regulations and traditions.
In comparison of several available models the deviations are in a reasonable bandwidth.
The Swiss model[37] is easy to use and covers the whole width of model deviations. It was therefore chosen for implementation in the ECA-tool.
Nominally the model was adopted for the following specifications:

- ✓ Dual pane window
- ✓ Glass thickness 4-6mm
- ✓ Normal glass (annealed)
- ✓ Modern windows, less than 30 to 40 years old
- ✓ Size: Small: <1 m² Medium: 1-3m² Large: > 3m²

Degree of breakage is assessed by use of PI-diagrams which are constructed by a generic equation.

Figure 4 shows an example of a calculation.

(P-A)*(I-B)=C	P=actual pressure [kPa] I=actual impulse [kPa ms] A, B are constants defined by probit functions for each window type (see table 42)
C=exp(1,3+2,23*ln(A))	C=curvature of the PI-hyperbolas

Table 43: PI-diagrams for assessment of glass breakage by blast wave

Window size	Function (Pr=Probit)
Small	Pr=-1,013+3,356*ln(A) Pr=-2,558+1,932*ln(B)
Medium	Pr=0,796+3,356*ln(A) Pr=-0,788+1,932*ln(B)
Large	Pr=2,674+3,356*ln(A) Pr=0,983+1,932*ln(B)

Table 44: Probit functions for PI-diagrams for assessment of glass breakage by blast

Degree of damage (%)	99,9	99	90	70	50	30	10	1	0,13	0,011
Probit (Pr)	8,09	7,33	6,28	5,52	5,00	4,48	3,72	2,67	2,00	1,30

Table 45: Relation of Probit and degree of damage

[37] P. Kummer, Glass breakage and injury – yet another new model? 31st DDESB Explosives Safety Seminar, San Antonio, 2004.

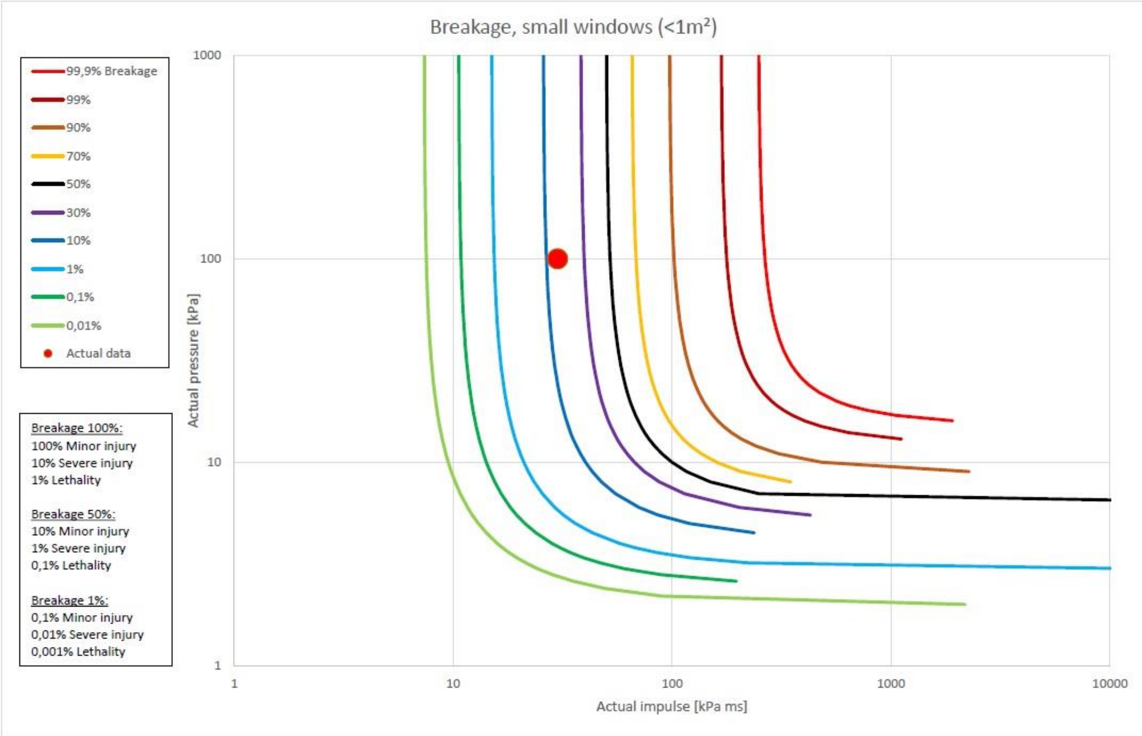

Figure 4 – Example of a calculation

The degree of breakage is related to a probability of an injury level in a generalized way according to table 46 below, as well as to more complicated probit functions.

Breakage	Minor injury	Major injury	Lethality
100%	100%	10%	1%
50%	10	1%	0,1%
1%	0,1%	0,01%	0,001%

Table 46: Degree of window breakage and injury levels

A second model provided is the empirical correlation on PI-diagrams provided by DDESB TP-14. Table A-19 in DDESB TP-14 is providing the coefficient for construction of the PI-curves, differentiating between dual pane, windows, annealed glass windows, and tempered glass windows. Note, that this approach does not take into account the size of the windows!

The degree of breakage is related to a probability of an injury level, described in section 4.3.1.1 in DDESB TP-14.

6.2.4. Ground shock damage

Ground shock is usually not the limiting cause for damage. The propagation of ground shock is very much depending on local discontinuities of the ground material.

A rough estimation of damage is provided by AASTP-1 in tables 5-20 to 5-25 (see also table below).

Degree of damage	V [m/s]
no	<0,05
minor/medium	0,05-0,14
heavy	0,14-0,19
complete	>0,19

Table 47: Damage related to oscillating velocity of ground shock (AASTP-1)

Type of building	Critical oscillating velocity [m/s]
Historical buildings	0,004
Dwelling and business building	0,008
Braced buildings	0,030

Table 48: Critical oscillating velocity to prevent damage (AASTP-1)

Equipment	A [g] no damage	A [g] heavy damage
Heavy weight machinery (engines, generators) >2000kg	10	80
Medium weight machinery (pumps, condensers)500-2000kg	15	120
Light weight machinery (small engines) <500kg	30	200
Duct work, piping	20	280
Electronic equipment	2	28

Table 49: Critical acceleration of ground shock for equipment (AASTP-1)

6.3 Personnel consequences

6.3.1. Blast

The evaluation of blast effects is traditionally linked to the criteria lung damage and eardrum rupture by direct blast and to injuries due to whole body-displacement by the blast wave (e.g. skull-fracture)[38].

There is strong indication on negative influences on the brain and central nervous system by blast effects but too little is known so far about mechanisms to set up criteria on evaluation of these effects[39].

The lung injury criterion is used as a lethality key-parameter. The correlation is dating back to trials in the 1960 with animals[40]. This is still the most comprehensive set of data and was subject to deeper evaluations several times over the years[41].

The recommended formula is taken from the TNO Green Book, 2nd edition[42].

$Pr=5{,}0+5{,}7*\ln(V)$	
$V=P_{scaled}/(4{,}17-0{,}00164*\ln(t)/t+0{,}0161/t)$	P_{scaled}=actual scaled overpressure t=scaled positive phase duration [s]
$P_{scaled}=P/po$	P=actual overpressure [Pa] po=ambient pressure [Pa]
$t=t_o*(C_9/m)^{1/3}*/p_o/p_{ref})^{1/2}$	p_{ref}=reference ambient pressure ($1{,}013*10^5$ Pa) C_9=70 (reference body weight [kg]) M= body weight [kg] t_o=duration of positive pressure wave [s]

Table 50: Probability of fatal lung injury by direct blast

The linkage of probit values to lethality is given in table 45.

38 "Green Book"; Methods for the determination of possible damage to people and objects resulting from release of hazardous materials, CPR 16E; The hague: Directorate-General of Labour of the Ministry of Social Affairs and Employment; 1992 (ISBN 90-5307-052-4), chapter 3.

39 *R.K. Gupta, A. Przekwas*, Mathematical models of blast induced TBI: current status, challenmges, and prospects, Frontiers in Neurology, Vol.4, 1-21, 2013.

40 N. Bowen, E. Fletcher, D. Richmond, Estimate of Man´s tolerance to the direct effects of air blast, DASA 2113, Lovelace Foundation, Albuquerque, 1968.

41 *K. Holm*, Beregning av doedelighet fra luftsjokk, FFI-rapport 2007/01896.

42 Green Book"; Methods for the determination of possible damage to people and objects resulting from release of hazardous materials, CPR 16E; The hague: Directorate-General of Labour of the Ministry of Social Affairs and Employment;2nd Edition, 2005.

A more recent well recognized model is the single-degree of freedom approach by Axelsson[43]. It describes the chest wall response of a human exposed to a given blast wave.
Originally it was developed on input of 4 pressure transducers in a blast device with 4 independent differential equations to solve. A simplified approach is just using a single point field pressure.
Figure 5 gives a visualization of a calculation example.

$M*d^2x/dt^2+J*dx/dt+K*x=A*(p(t)-p_{lung}(t))$ **$P_{lung}(t)=p_o*(V_o/(V_o-A*x))g$** **$v(t)=dx/dt$** **$V=\Sigma v(t)$**	M= effective mass (2,03 kg) A= effective area (0,082m²) V_o=lung gas volume at x=0 (0,00182m³) J=damping factor (696 Ns/m) K=spring constant (989 N/m) p_o=ambient pressure p(t)=blast loading pressure g=polytropic exponent for gas in lungs (1,2) x(t)=chest wall displacement v(t)=chest wall velocity V= chest wall velocity predictor
$ASII=(0,124+0,117*V)^{2,63}$	ASII=injury level for internal organs

Table 51: Single point lung injury model (Axelsson)

Injury level	ASII	V(m/s)
No injury	0,0 – 0,2	0,0 -3,6
Trace to slight	0,2 – 1,0	3,6-7,5
Slight to moderate	0,3 – 1,9	4,3-9,8
Moderate to extensive	1,0 – 7,1	7,5-16,9
>50% lethality	>3,6	>12,8

Table 52: Injury levels for internal organs in relation to Axelsson´s chest wall velocity predictor

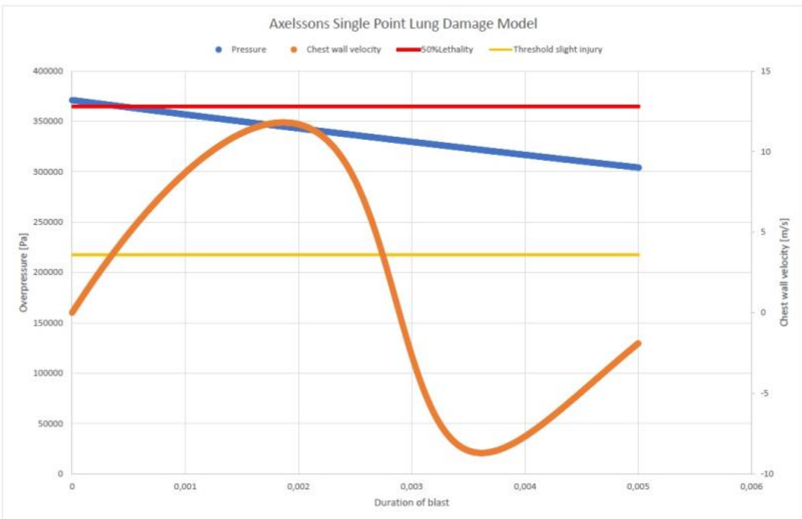

Figure 5 – Calculation example of Axelsson SP-model

[43] *J. Teland, J. van Doormaal, M.van der Horst,E. Svinsas*, A single point pressure approach as input for injury models with respect to complex blast loading conditions,34th DDESB Explosive Safety Seminar, Portland, OR, 2010.

FFI has developed PI-diagrams on combined primary and secondary blast injuries.

Figure 6 is showing an example corresponding to the scenario (Incident peak pressure P_i=1,27 bar, duration of positive phase t_o=56,5ms) for calculation of the Axelsson Single point model in figure 5.

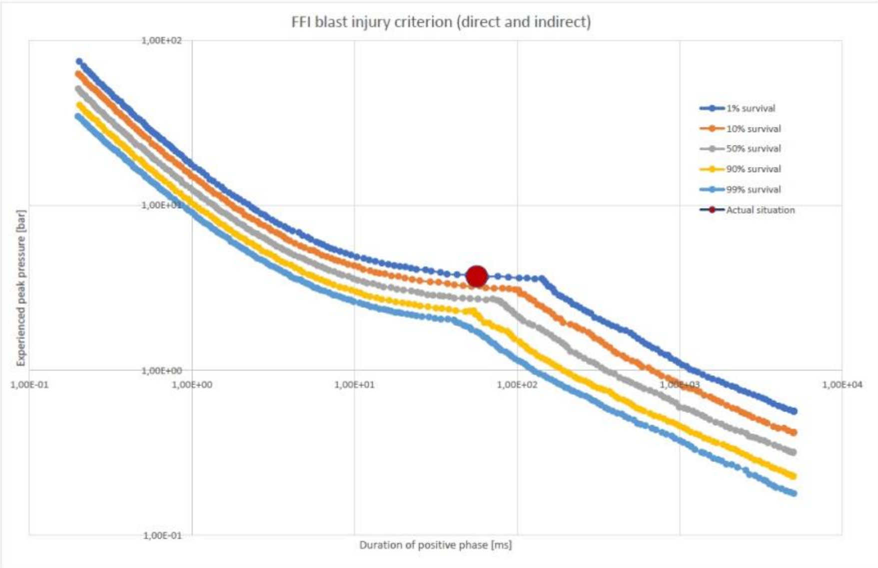

Figure 6 – Calculation example of FFI blast injury model

Table 53 gives a comparison of the different approaches for this scenario.

Criterion	Result
Bowen´s Criterion (lung injury)	50%survival
Axelsson´s Criterion (chest wall velocity)	Moderate to extensive injury
FFI Criterion (combined indirect and direct blast injury)	1%survival
TNO-criterion for direct blast lethality	11% lethality

Table 53: Comparison of different blast injury criteria

6.3.2. People in collapsing structures

Gilbert, Lees and *Scilly* developed probability values for building occupants suffering fatal, serious or light injuries. These are shown in Table 54.[44]

Damage Category	Damage Definition	Probability (Fatality)	Probability (Fatality or Serious Injury)	Probability (Fatality, Serious Injury or Light Injury)
		P(K)	P (K + I)	P (K + SI + LI)
A_a	Houses totally demolished.	0.96	1.0	1.0
A_b	Houses almost completely demolished.	0.57	0.66	0.82
A	Houses demolished.	0.62	0.71	0.84
B	Houses so badly damaged they are beyond repair and require demolition.	0.096	0.15	0.38
C_b	Houses rendered uninhabitable but can be repaired with extensive work.	0.009	0.043	0.13
C_a	Houses rendered uninhabitable but can be repaired reasonably quickly.	0	0.002	0.006
D	Houses requiring repairs to remedy serious inconvenience but remain habitable.	0	0	0

Table 54: Probability Values for Secondary

DDESB TP-14 also provides in section 4.3.1.2 an empirical correlation of probability of fatality, major and minor injury with degree of building damage.

[44] These equate to the damage levels at Table 51, with the addition of A_a for complete demolition and A_b for almost complete demolition.

6.3.3. Fragment and debris

AASTP-1 gives a simple estimate of probability of a hit by a critical fragment from debris stemming from open detonation of ammunition.

$P_f=1-\exp(-q_f*A_T)$	P_f=probability of impact of a fragment of mass M_f or greater (see also section 4.2.5.2) A_T=target area (e.g. 0,56m² for a person)

Table 55: Probability of hit from open stack fragments (AASTP-1)

A more elaborate empirical correlation is provided by DDESB TP-14, section 4.4.9.

It provides assessment of probability of fatal hits or hits causing a major injury or a minor injury on debris density calculated as described in IATG 1.80, 4.2.5.1.

A *concern area* for different degrees of injuries (fatal, major, minor) is defined, reflecting the critical body areas for different severity of a hit.

Each bin is further weighted by a so-called *vulnerability value*, which characterizes the potential of threat for the fragments represented by a bin.

The probability for a hit can be calculated for each type of consequence and every combined high-angle and low-angle debris table according to formula in table 56 below.

$P_{(x)(bin)}=V_{bin}*1-\exp(-C_{Abin}*N_{bin})$	$P_{(x)(bin)=}$probability of a consequence (fatality, major or minor injury) by a certain bin C_{Abin}=concern area for a bin V_{bin}=Vulnerability value for a bin N_{bin}=number of fragments of a fragment bin (10 bins for high-angle and 10 bins for low-angle fragments)

Table 56: Calculation of probability of consequences of fragment hit (DDESB TP-14)

The total probability is calculated using the additive rule for the union of non-mutually exclusive events (table 57):

$P_{(x)angle}=P_{(x)bin1}+P_{(x)bin2}*(1-P_{(x)bin1})+P_{(x)bin3}*(1-P_{(x)bin1})*(1-P_{(x)bin2})+\ldots$	$P_{(x)angle=}$probability of a consequence (fatality, major or minor injury) by a fragment category (high-angle or low-angle)
$P_{(x)total}=P_{(x)high\text{-}angle}+P_{(x)low\text{-}angle}*(1-P_{(x)high\text{-}angle})$	$P_{(x)totale=}$probability of a consequence (fatality, major or minor injury)

Table 57: Calculation of total probability of consequences of fragment hit

6.3.4. Thermal effects

The representative parameter for evaluation of thermal effects to human is the thermal dose (see table 35).

Criteria are taken from HSE[45].

Effect	**Thermal dose [(kW/m²)$^{4/3}$s]**	
	Mean	Range
Pain	92	86-103
Threshold first degree burn	105	80-130
Threshold second degree burn	290	240-350
Threshold third degree burn	1000	870-2600

Table 58: Thermal effects on human skin by heat radiation

Baker[46] has provided a diagram with an empirical correlation for pain threshold with relation to duration and intensity of thermal flux (figure 7).

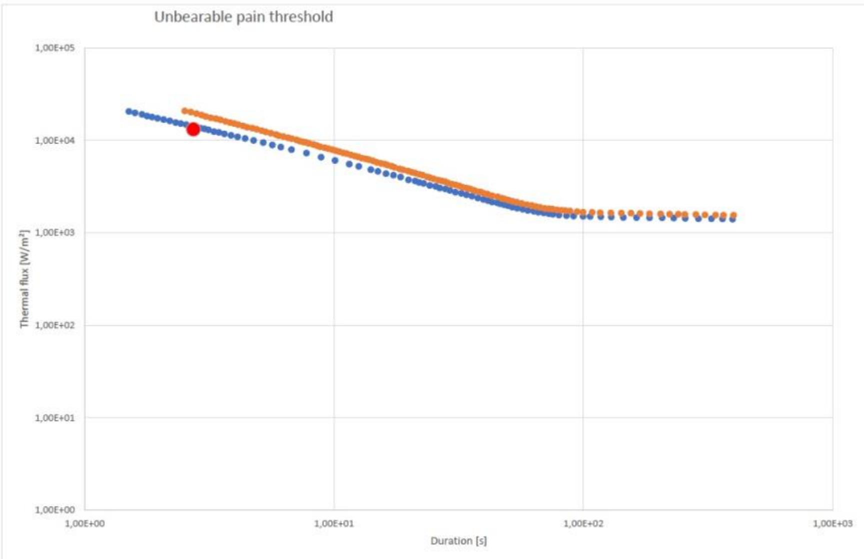

Figure 7 – Pain threshold in relation to thermal flux and duration (Baker et al.)

[45] *S. O´Sullivan, S Jagger*, Human Vulnerability to Thermal Radiation Offshore, Health&Safety Laboratory, HSL 2004/04.

[46] *W. E. Baker et al*. Explosion Hazards and Evaluation, Elsevier, (ISBN 0 444 42094 0). Amsterdam, 1983

Annex A
(normative)
References

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

a) IATG 01.40 Glossary of *terms, definitions and abbreviations*. UNODA. 2020.

b) AASTP-1, Edition B, Version 1, *NATO Guidelines for the Storage of Military Ammunition and Explosives*. NATO Standardization Office (NSO). December 2015.

c) AASTP-4, Edition 1, Change 4, *Explosives Safety Risk Analysis*. NATO Standardization Office (NSO). September 2016. (Note: Part 2 has restricted distribution);

d) Technical Paper 14. *Approved Methods and Algorithms for DoD Risk-Based Explosives Siting*. Revision 4. US Department of Defense Explosives Safety Board (DDESB), Alexandria, Virginia, USA. 17 March 2017;

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[47] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[47] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) IATG 02.10 *Introduction to Risk Management Principles and Processes*. UNODA. 2020;

b) *Selection and Use of Explosion Effects and Consequence Models for Explosives.* UK Health and Safety Executive. (ISBN 0 7176 1791 2). UK. 2000; and

c) UFC-3-340-02, *Structures to Resist the Effects of Accidental Explosions*. US Department of Defense. 05 December 2008; Change 2, 01 September 2014. www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-3-340-02

d) "Green Book"; Methods for the determination of possible damage to people and objects resulting from release of hazardous materials, CPR 16E; The hague: Directorate-General of Labour of the Ministry of Social Affairs and Employment; 1992 (ISBN 90-5307-052-4).

e) *Kingery, C. N. and Bulmash, G.,* Airblast Parameters From TNT Spherical Air Bursts and Hemispherical Surface Bursts, ARBRL-TR-02555, April 1984.

f) *G. Kinney, G. Graham.* Explosive Shocks in Air, 1985, Springer.

g) *Sachs R G*. The dependence of Blast on Ambient Pressure and Temperature. Technical Report 466. Ballistics Research Laboratory, Aberdeen Proving Ground, Maryland, USA. May 1944.

h) *A. Remennikov*, The state of the art of explosive loads characterization,2007, 1-25. https://ro.uow.edu.au/engpapers/4245.

i) *X.-Q. Zhou, H. Hao*, Prediction of airblast loads on structures behind a protective barrier, International Journal of Impact Engineering, 35(5), 363-375, 2008.

j) *Gurney, R. W*. The Initial Velocities of Fragments from Bombs, Shells, and Grenades, BRL-405. Ballistic Research Laboratory, Aberdeen, Maryland. USA. 1943.

k) *M.M. van der Voort, J. Weerheijm*, A statistical descriptionn of explosion produced debris disperion, Inteernational Journal of Impact Engineering, 59, 29-37, 2013.

l) *R. Forsen, R. Berglund, G.A. Groensten,* The effects of cased ammunition explosions confined in concrete cubicles-KASUN-III, 34th DDESB Explosive Safety Seminar, Portland, OR, 2010.

m) *R. Conway, J. Tatom, M. Swisdak*, SciPan4: Program description and test results, 34th DDESB Explosive Safety Seminar, Portland, OR, 2010.

n) *W. E. Baker et al*. Explosion Hazards and Evaluation, Elsevier, (ISBN 0 444 42094 0). Amsterdam, 1983.

o) *M. Williams*, Measuring radiated thermal output from pyrotechnics and propellants, Cranfield University, 2008.

p) Technical Note for Mine Action (TNMA) 10.20/01 *Estimation of Explosion Danger Areas* (Version 2.0). Geneva. GICHD. Further details on their use are available there.

q) *Scilly N F* and *High W G.* The blast effect of explosions. Loss prevention and safety promotion 5. 1986.

r) *Jarrett D E*. Derivation of the British Explosives Safety Distances. Annals New York Academy of Sciences, 152, Article 1. 1968

s) *Gilbert S M, Lees F P and Scilly N F.* A Model Hazard Assessment of the Explosion of an Explosives Vehicle in a Built-Up Area. Minutes of the 26th US Department of Defense Explosives Safety Board Seminar. Miami. USA. 1994.

t) P. Kummer, Glass breakage and injury – yet another new model? 31st DDESB Explosives Safety Seminar, San Antonio, 2004.

u) *R.K. Gupta, A. Przekwas*, Mathematical models of blast induced TBI: current status, challenmges, and prospects, Frontiers in Neurology, Vol.4, 1-21, 2013.

v) N. Bowen, E. Fletcher, D. Richmond, Estimate of Man´s tolerance to the direct effects of air blast, DASA 2113, Lovelace Foundation, Albuquerque, 1968.

w) *K. Holm*, Beregning av doedelighet fra luftsjokk, FFI-rapport 2007/01896.

x) Green Book"; Methods for the determination of possible damage to people and objects resulting from release of hazardous materials, CPR 16E; The hague: Directorate-General of Labour of the Ministry of Social Affairs and Employment;2nd Edition, 2005.

y) *J. Teland, J. van Doormaal, M.van der Horst,E. Svinsas*, A single point pressure approach as input for injury models with respect to complex blast loading conditions,34th DDESB Explosive Safety Seminar, Portland, OR, 2010.

z) *S. O´Sullivan, S Jagger*, Human Vulnerability to Thermal Radiation Offshore, Health&Safety Laboratory, HSL 2004/04.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[48] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[48] Where copyright permits.

Annex C

Reference scenarios

The following scenarios have been chosen for reference of the application of the formulae:

Scenario A:

Earth covered magazine containing 1200 pieces of 155mm shells with 6,85 kg Composition B as explosive filling. The side of the magazine is facing an ammunition process building at a distance of 100m. The building is 15x15m in area and 4m high and doesn´t have a protected roof. On each of the side walls and the rear wall of the building there are two small windows (0,6 x 1,0m) of 4mm annealed glass.

In the moment of the explosion one person is standing close to the wall facing the earth covered magazine and one close to the back wall.

At a distance of 400m in the opposite direction, there is a sanatorium building, with 30% window area on the side facing the magazine.

There is a barricade surrounding the magazine at a distance of 6m with 5m height.

Scenario B:

Ammunition process building, containing 1000kg TNT, subject to accidental detonation. A large office building is situated at 600m distance; designed with large windows representing 50% of the wall area.

A Public traffic route is passing at 100m distance. One person is passing in free field at 50m distance.

Scenario C:

Open detonation of 1000kg Nitropenta. A brick building, two storeys high, of the dimension 20m width, 30m length and 7m height, is situated at 500m distance, designed with medium sized windows representing 20% of the wall area facing the explosion at an angle of 45 degrees. One person inside and one on the rear side of the building.

Scenario D:

Open detonation of 64 155mm shells, arranged in an array of 8x8, and open burning of 1000kg propellant. The safety requirements have to assessed.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 01.90

Third edition
March 2021

Ammunition management personnel competences

IATG 01.90:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for ‘through-life management’ approach to ammunition management. The IATG can be applied at the guidelines’ **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The nature of ammunition and explosives, with their potential for unplanned, violent reaction, makes it necessary to develop recommendations and guidelines for safe conventional ammunition management. The effective implementation of IATG requires well-trained and educated individuals with specialist knowledge.

There are no international standards which lay down exactly what competences are required for the various roles within an ammunition management system. There was a project within the European Union, EUExcert,[3] (2003 – 2013) which aimed to establish a stable fundament and framework for vocational education of people in the European explosives sector. In parallel, the UK was also examining the development of competency standards for use in the explosives sector. The UK work has resulted in a set of National Occupational Standards for Explosive Substances and Articles.[4] These were adopted by EUExcert as '*best practice*' and are now being rolled out across the European explosives industry under the EUExImp[5] [6] project, which is part of the wider EU ERASMUS programme for education, training, youth and sport. It therefore makes sense that the IATG personnel competences are based on this '*best practice*' work.

There are regional competency standards for explosive ordnance disposal (EOD) available, Test and Evaluation Protocol 09.30/01/2014 Version 1.0 dated 30 October 2014 Explosive Ordnance Disposal (EOD) Competency Standards, which should be used for many of the activities covered by IATG 10.10:2020[E] *Demilitarization and destruction* and IATG 11.302020[E] *ASA Explosions – EOD clearance*

This IATG module therefore provides a series of competences for the various generic roles of individuals engaged in conventional ammunition stockpile management.

[3] *Certifying Expertise in the Explosives Sector.* EUExcert. www.euexcert.org.

[4] Listed at http://www.cogent-ssc.com/CM/ExplosivesNOS.pdf.

[5] European explosives sector implementation of occupational standards.

[6] Current participating States are Estonia, Germany, Portugal, Sweden and UK.

Ammunition management personnel competences (LEVEL 2 and 3)

1 Scope

This IATG module introduces the concept of competences, competency and occupational standards to be used for the training and assessment of personnel, at all levels, to safely work with ammunition and explosives, or within explosive facilities.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40:2020 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'competence' refers to *the ability of an individual to do the job properly.*

The term 'competency' refers to *the related knowledge, skills, abilities, attributes and behavioural traits of an individual.*

The term 'standard' refers to *a documented agreement containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes and services are fit for their purpose.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background [7]

There are no international standards, and very few national standards,[8] that lay down exactly what competences are required for the various roles within an ammunition management system. Although many nations have formal military technical training for conventional ammunition stockpile management (See Clause 7.2), the development of which will have utilized a Training Needs Analysis to determine the syllabus, this does not necessarily involve the use of competency and is more qualification based.

There was a project within the European Union, EUExcert,[9] (2003 – 2013) which aimed to establish a stable fundament and framework for vocational education of people in the European explosives sector. In parallel, the UK was also examining the development of competency standards for use in the explosives sector. The UK work has resulted in a set of National Occupational Standards for Explosive Substances and Articles.[10] These were adopted by EUExcert as '*best practice*' and are now being rolled out within the European explosives industry under the EUExImp[11] [12] project, which is part of the wider EU ERASMUS programme for education, training, youth and sport. The NOS ESA have also been developed, and comply, with the principles of the European Credit System for Vocational Education and Training (ECVET).[13] It therefore makes sense that the IATG personnel competences are based on this '*best practice*' as there is not yet any other body of work available.

There are regional competency standards for explosive ordnance disposal (EOD) available, Test and Evaluation Protocol 09.30/01/2014 Version 1.0 dated 30 October 2014 Explosive Ordnance Disposal (EOD) Competency Standards, which should be used for many of the activities covered by IATG 10.10:2020[E] *Demilitarization and destruction* and IATG 11.20:2020[E] *ASA Explosions – EOD clearance*.

Training alone does not necessarily guarantee an individual's ability to successfully and safely perform a task within an explosive environment. The outcome of the training is more important than the inputs, with an individuals' ability to do a task being more important than how long they have trained to do the task. Similarly, the length of time someone has been doing a particular task does not necessarily mean that they are doing that task in the safest and most efficient manner. Thus the ability of an individual to perform a task is determined by a combination of their knowledge, skills, experience and attitude.
The recognition of this aspect of performance ability in the early 1980s has led to the development of vocational qualifications and assessments being used in parallel to the attainment of theoretical knowledge demonstrated by more formal or academic qualifications.

The generic area of competence and competency is constantly evolving and to date there are no internationally agreed definitions for each of the terms. There is, however, a degree of consensus as to the terms at Clause 3, hence their use within this IATG.

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[7] An excellent overview of competences in the explosives sector is provided in *Introduction to Explosive Substances and Articles National Occupational Standards.* Denise Clarke. HSQ Ltd in SAFEX Newsletter 44, 1st Quarter, 2013. Much of the content of this clause is developed from this reference and due attribution is made. More useful information on explosives sector competences may be found on the HSQ website www.homelandsecurityqualifications.co.uk.

[8] Outside the EUExcert nations who have adopted the UK NOS ESA the only other nation that has a formal qualification based on competency is the South African Qualification Agency that has a national qualification for an Ammunition Fitter, (similar to that of Ammunition Technician Class 1). pcqs.saqa.org.za/viewQualification.php?id=90652.

[9] *Certifying Expertise in the Explosives Sector.* EUExcert. www.euexcert.org.

[10] Listed at http://www.cogent-ssc.com/CM/ExplosivesNOS.pdf.

[11] European explosives sector implementation of occupational standards.

[12] Current participating States are Estonia, Germany, Portugal, Sweden and UK.

[13] www.ecctis.co.uk/ecvet/Default.aspx. EC Recommendation 2009/C155/02 dated 18 June 2009. eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2009:155:0011:0018:EN:PDF

4.1 Competence model

To achieve competence at a task requires an individual to perform in three areas; 1) behavioural competences; 2) technical competences; and 3) the achievement of targets and objectives. This is represented in the competence model at Figure 1:

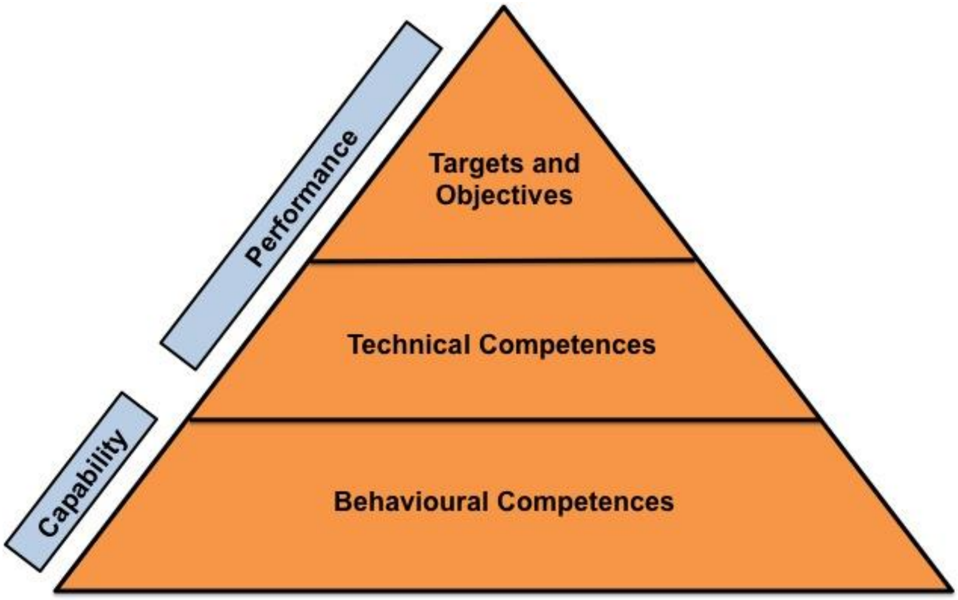

Figure 1: Competence Model

4.2 Behavioural competencies

These are the personal qualities that an organization requires of the individuals they employ, for example: 1) trustworthy; 2) honest; 3) self-motivator; 4) verbal communication skills; etc. Cultural and organizational environments will have an influence on the qualities an organization may require and this falls beyond the scope of this IATG.

4.3 Technical competences

These are the competences that individuals require to meet organizations' standards of good practice. They describe what individuals must do to perform safely and effectively. They are often also referred to as functional competences or competency standards, and represent the performance required of an individual to achieve the quality standard for a particular task. These are the competences covered in this IATG.

4.4 Targets and objectives

These represent the output of an individuals' performance. For example, an ammunition worker may be required to inspect 55 rounds of artillery ammunition per day as part of a long-term surveillance task. As these are set by the organization, and should be agreed with the individual, they fall outside the scope of this IATG.

5 Aim

The aim of the technical competences for personnel engaged in conventional ammunition stockpile management processes shall be to:

a) provide agreed competences that may be used by organizations engaged in the stockpile management of conventional ammunition;

b) assist in developing a commonality of approach across the international community;

c) provide objective criteria to assist organizations in the recruitment of appropriately qualified and experienced personnel;

d) provide a benchmark for the development of conventional ammunition stockpile management training;

e) contribute towards a reduction of accidents during conventional ammunition stockpile management processes; and

f) contribute towards the maintenance and enhancement of safety during conventional ammunition stockpile management.

6 Categories of ammunition personnel

There are a large number of roles and job titles used within the explosives sector, many dependent on the historical development of the explosives industry or military organizations within a nation. It is neither possible nor feasible to list them all and develop a competency for each as this shall be a national responsibility. For the purposes of this IATG the following generic categories of personnel have been determined as being commonly used within the international community during the stockpile management of ammunition and explosives. The related competence requirement at Annex C to H should therefore be used as guidance should nations wish to develop a job competency for specific roles and job titles:

LEVEL	Category	Role
1	**Ammunition Handler**	Assist in the handling and movement of ammunition and explosive substances and articles during issue, receipt, storage and distribution.
2A	**Ammunition Processor**	Inspect, maintain and repair ammunition or other explosive substances and articles.
2B	**Ammunition Accountant**	Accurately account for ammunition and explosive substances and articles.
3	**Ammunition Supervisor**	Supervise the issue, receipt, storage, distribution and maintenance and disposal of ammunition and explosive substances and articles.
4	**Ammunition Manager**	Manage the storage, issue, receipt, distribution, maintenance and stockpile management of ammunition and explosive substances and articles.
5	**Ammunition Inspector**	Develop, implement and audit the policy and technical instructions for all aspects of the stockpile management of ammunition and explosive substances and articles.
6	**Ammunition Regulator**	Develop national policy and technical instructions for all aspects of the stockpile management of ammunition and explosive substances and articles.[14]

Table 1: Categories of ammunition personnel

NOTE 1 It should be noted that the competences listed do not necessarily correspond to the actual tasks carried out by each generic personnel category on a routine basis. For example, an Ammunition Manager is very unlikely to have the need to routinely issue or receive ammunition, yet the individual must have demonstrated previous competence in that area to be able to manage or supervise effectively, or develop policy relating to safety for that particular task.

[14] An Ammunition Regulator should be a highly experienced and capable Ammunition Inspector. Thus, the personnel competences will be the same.

National authorities may choose to develop sub-categories with a more limited range of competences. For example, if an ammunition depot manager has no need to be competent at managing ammunition processing, as there is no processing facility at the depot the individual manages, then a sub-category of Ammunition Manager (Storage) could be developed with a more limited range of competencies. Similarly, you may choose to implement a sub-category of Ammunition Supervisor (Processing) with a more limited range of competences.

7 Assessment

7.1 General

Assessment of someone's competence may still require the determination of an individual's theoretical knowledge by examination, but this is not a valid stand-alone test to determine their ability to translate this knowledge into effective and efficient activity in the workplace. Other evidence should be required to enable an individual's competence to be measured and assessed. This evidence may include:

a) observation of an individual performing a task;

b) witness testimony from colleagues and managers;

c) examples of documentation produced by the individual;

d) examples of technical calculations performed by an individual; and/or

e) verbal examination of an individual's knowledge of the task.

Stockpile management organizations shall be responsible for developing appropriate competence based systems[15] for the assessment of an individual's competence during recruitment and then on a regular basis during their employment. Suitably qualified and accredited assessors, who are occupationally competent themselves in ammunition management, shall be used to assess an individual's competence. As security institutions strive to increase diversity in their recruitment and promotion practices, they should analyse assessors and the assessment process itself to avoid the inclusion of criteria that, while irrelevant to the individual's performance, may introduce intentional or unintentional biases favouring male candidates.

7.2 Retrospective qualifications

There are a range of qualifications currently extant that have required individuals to previously demonstrate competence in conventional ammunition stockpile management.

Annex M lists those qualifications that have initially been deemed to require individuals to have formally demonstrated their competence during their initial qualification and training. This is not exhaustive and qualifications may be retrospectively added to this list at any time after mapping to the relevant NOS for ESA and clearance by the IATG Technical Review Board (TRB)/Strategic Co-ordination Group (SCG).[16] States and conventional ammunition stockpile management organizations are actively encouraged to contribute to this list in order to identify a wider pool of available expertise in this area.

[15] Further guidance on this issue may be found in *Assessing people against the Explosive Substances and Articles National Occupational Standards.* Denise Clarke, HSQ Ltd, in SAFEX Newsletter 50, 3rd Quarter, 2014. www.homelandsecurityqualifications.co.uk/wp-content/uploads/2014/10/NL50.pdf

[16] Recommendations for inclusion in this list should be forwarded to the IATG Project Manager using the contact details in the copyright notice.

NOTE 2 Organisations should be aware that just because an individual has qualified on one of the qualification courses listed at Annex M it does not necessarily mean that the individual's competency is current. The qualification should be backed up by proof of regular employment, and successful performance, in a conventional ammunition stockpile management related area since their initial attendance on the qualification course.

7.3 Other competences

IATG 12.10:2020[E] Multinational Operations includes the competences required of the Force Explosives Safety Officer. These are included at Annex L for information.

Annex A
(normative)
References

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

a) Test and Evaluation Protocol 09.30/01/2014 Version 1.0 dated 30 October 2014 Explosive Ordnance Disposal (EOD) Competency Standardsb) IATG 01.40:2020[E] *Glossary of terms, definitions and abbreviations*. UNODA. 2015; and

c) *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Eighteenth revised edition), ST/SG/AC.10/1/Rev.18, (ISBN 978-92-1-139146Ed-6), New York and Geneva, United Nations, 2013. *(Referred to as the UN Model Regulations).*

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[17] used in this guide. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/un-saferguard/.

National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[17] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guide:

a) *Assessing people against the Explosive Substances and Articles National Occupational Standards.* Denise Clarke, HSQ Ltd, in SAFEX Newsletter 50, 3rd Quarter, 2014;

b) ESA NOS KR1 *Research, Design and Development (Key Role 1)*. UK Standards Setting Body (SSB) for Explosives, Munitions and Search Occupations. February 2006;

c) *Introduction to Explosive Substances and Articles National Occupational Standards.* Denise Clarke, HSQ Ltd, in SAFEX Newsletter 44, 1st Quarter, 2013;

d) National Occupational Standards for Explosives. UK Commission for Employment and Skills (UK CES)[18]; and

e) *Use of Explosive Substances and Articles National Occupational Standards*. HSQ UK. 15 July 2010.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UN ODA) holds copies of all references[19] used in this guide. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UN ODA, and can be read on the IATG website: www.un.org/disarmament/un-saferguard/.

National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[18] Enter the search term 'Explosives' in this website http://www.ukstandards.org.uk/ to obtain all relevant NOS on the explosives sector. The full list is at Annex K.

[19] Where copyright permits.

Annex C
(normative)
Competences – Ammunition Handler

Competence: Ammunition Handler			
Employment Category:	Ammunition Handler		
Role:	Assist in the handling and movement of ammunition, in an explosive storage area during issue, receipt, storage and distribution processes.		
Responsibilities:			
Assist in the packing and unpacking of ammunition[20] to and from transit frames, containers or packaging.			
Assist in the selection for issue of the correct ammunition from storage by batch/lot number.			
Assist in the receipt of the correct explosive substance or article into storage by batch/lot number.			
Assist in the correct loading and unloading of ammunition to and from transit frames, containers or packaging.			
Ensure cleanliness and good housekeeping in the explosive storage area.			
Authorities:			
Ensure compliance with the safe system of work contained within the IATG series.			
Ensure compliance with IATG for the safe handling and storage of ammunition.			
IATG Code[21]	**Competencies**	**IATG[22]**	**NOS ESA Reference[23]**
Storage			
7.1	Move Ammunition Manually	03.20 06.30	COGESA7.1
7.3	Receive and Place Ammunition into Storage	03.20 06.30	COGESA7.3
7.7	Select and Prepare Ammunition for Despatch	03.20 06.30	COGESA7.7
7.8	Despatch Ammunition	03.20 06.30	COGESA7.8
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.17	Operate Specialized Plant and Machinery to Performance Requirements for Ammunition	05.50	COGESA7.17
7.18	Lift, Transfer and Position Ammunition Loads	06.30	COGESA7.18
Transport			
8.4	Load the Vehicle with Ammunition [24]	08.10	COGESA8.4

[20] In competences the term ammunition includes all explosive substances and article.

[21] The IATG competence code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[22] The task primarily falls within the requirements of the IATG listed.

[23] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UNODA and also reproduced on the IATG SaferGuard website. One example is included in IATG in order that users may understand the system and is at Annex J.

[24] The Driver of the vehicle, and the management of his organization, is responsible for ensuring that the vehicle is of an appropriate type to carry explosives and has all the relevant safety equipment and hazard signs. See *United Nations*

Competence: Ammunition Handler			
8.6	Unload Ammunition from the Vehicle	08.10	COGESA8.6
GV1	Prepare the Vehicle for Driving	N/A	SFLDGV1
GV2	Protect the Vehicle and the Load	N/A	SFLDGV2
GV3	Operate and Monitor the Vehicle Systems	N/A	SFLDGV3
GV4	Manoeuvre the Vehicle in Restricted Spaces	N/A	SFLDGV4
8.15	Escort the Ammunition Load	08.10	COGESA8.15
Generic Applications			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
SA13.12	Pack or Re-Pack Ammunition	07.30	COGESA13.12
SA13.13	Unpack Ammunition	07.30	COGESA13.13
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6
SA13.15	Prepare and Care for Equipment in an Explosives Environment	05.50	COGESA13.15

Recommendations on the Transport of Dangerous Goods Model Regulations, (Eighteenth revised edition), ST/SG/AC.10/1/Rev.18, (ISBN 978-92-1-139146Ed-6), New York and Geneva, United Nations, 2013. *(Referred to as the UN Model Regulations).*

Annex D
(normative)
Competences – Ammunition Processor

Competence: Ammunition Processor [25]			
Employment Category:	Ammunition Processor		
Role:	Participate in the inspection, repair and surveillance of ammunition processes within an explosives storage area.		
Responsibilities:			
Packing and unpack ammunition[26] from its primary packaging.			
Identify the correct ammunition for processing by batch/lot number.			
Undertake ammunition processing tasks for the inspection, repair and surveillance of ammunition on which they have being trained.			
Assist in the correct loading and unloading of ammunition to and from transit frames, containers or packaging.			
Ensure cleanliness and good housekeeping in the ammunition process area.			
Authorities:			
Ensure compliance with the safe system of work contained within the IATG series.			
Ensure compliance with IATG for the safe handling and storage of ammunition.			
Ensure compliance with IATG for the safe processing of ammunition.			
IATG Code[27]	**Competencies**	**IATG[28]**	**NOS ESA Reference[29]**
Maintenance (Inspection, Repair, Surveillance and Proof)			
5.4	Implement the Inspection of Ammunition	07.20 07.30	COGESA5.4
5.5	Implement the Adjustment of Ammunition	07.20 07.30	COGESA5.5
5.6	Implement the Complex Removal of Ammunition	07.20 07.30	COGESA5.6
5.7	Implement the Routine Removal of Ammunition	07.20 07.30	COGESA5.7
5.8	Implement the Complex Assembly of Ammunition	07.20 07.30	COGESA5.8
5.9	Implement the Routine Assembly of Ammunition	07.20 07.30	COGESA5.9
5.11	Implement the Complex Repair of Ammunition	07.20 07.30	COGESA5.11

[25] See Note 1 to Clause 6 on competence versus role.

[26] In competences the term ammunition includes all explosive substances and article.

[27] The IATG competence code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[28] The task primarily falls within the requirements of the IATG listed.

[29] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. One example is included in IATG in order that users may understand the system and is at Annex J.

Competence: Ammunition Processor [25]			
5.12	Implement the Routine Repair of Ammunition	07.20 07.30	COGESA5.12
5.15	Implement Configuration Activities for Ammunition	07.20 07.30	COGESA5.15
Storage			
7.1	Move Ammunition Manually	03.20 06.30	COGESA7.1
7.3	Receive and Place Ammunition into Storage	03.20 06.30	COGESA7.3
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.17	Operate Specialized Plant and Machinery to Performance Requirements for Ammunition	05.50	COGESA7.17
7.18	Lift, Transfer and Position Ammunition Loads	06.30	COGESA7.18
Transport			
8.2	Obtain Information on the Ammunition Load	01.50	COGESA8.2
8.4	Load the Vehicle with Ammunition [30]	08.10	COGESA8.4
8.6	Unload Ammunition from the Vehicle	08.10	COGESA8.6
GV1	Prepare the Vehicle for Driving [31]	N/A	SFLDGV1
GV2	Protect the Vehicle and the Load	N/A	SFLDGV2
GV3	Operate and Monitor the Vehicle Systems	N/A	SFLDGV3
GV4	Manoeuvre the Vehicle in Restricted Spaces	N/A	SFLDGV4
8.15	Escort Ammunition Load	08.10	COGESA8.15
Generic Applications			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6
SA13.12	Pack or Re-Pack Ammunition	07.30	COGESA13.12
SA13.13	Unpack Ammunition	07.30	COGESA13.13
SA13.15	Prepare and Care for Equipment in an Explosives Environment	05.50	COGESA13.15

[30] The Driver of the vehicle, and the management of his organization, is responsible for ensuring that the vehicle is of an appropriate type to carry explosives and has all the relevant safety equipment and hazard signs. See *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Eighteenth revised edition), ST/SG/AC.10/1/Rev.18, (ISBN 978-92-1-139146Ed-6), New York and Geneva, United Nations, 2013. *(Referred to as the UN Model Regulations).*

[31] GV1 to GV4 for only within the Explosives Storage Area.

Annex E
(normative)
Competences – Ammunition Accountant

Competence: Ammunition Accountant			
Employment Category:	Ammunition Accountant		
Role:	To accurately account for ammunition during its service life.		
Responsibilities:			
Identify the correct ammunition for issue, receipt, storage or processing by batch/lot/BKI number.			
Accurately account for ammunition for issue, receipt, storage or processing by batch/lot/BKI number.			
Accurately complete all documentation relating to the issue, receipt, storage or processing of ammunition by batch/lot/BKI number.			
Authorities:			
Ensure compliance with the safe system of work contained within the IATG series.			
Ensure compliance with IATG for the safe handling and storage of ammunition.			
Ensure compliance with IATG for the safe processing of ammunition.			
IATG Code[32]	**Competencies**	**IATG[33]**	**NOS ESA Reference[34]**
Maintenance (Inspection, Repair, Surveillance and Proof)			
5.17	Accurately account for the processing of ammunition by batch/lot/BKI number.	03.10	N/A
Storage			
7.13	Manage Stock Levels and Stock Inventories of Ammunition	03.10	COGESA7.13
7.14	Audit Stock Levels and Stock Inventories for Ammunition	03.10 03.20	COGESA7.14
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.16	Maintain Stock Control Systems for Ammunition	03.10 03.20	COGESA7.16
7.19	Accurately account for the issue, receipt or storage of ammunition by batch/lot/BKI number.	03.10	N/A
Generic Applications			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
LD5	Allocate and Check Work in your Team	N/A	CFAMLD5
LB5	Provide Leadership for your Team	N/A	CFAMLB5

[32] The IATG competence code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[33] The task primarily falls within the requirements of the IATG listed.

[34] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. One example is included in IATG in order that users may understand the system and is at Annex J.

Competence: Ammunition Accountant			
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6

Annex F
(normative)
Competences – Ammunition Supervisor

Competence: Ammunition Supervisor [35]			
Employment Category:	Ammunition Supervisor		
Role:	The supervision of all issue, receipt, storage, inspection, surveillance, repair and distribution processes for ammunition within an explosivesstorage area.		
Responsibilities:			
Oversee those conducting issue, receipt, storage, distribution and maintenance of ammunition and other explosive substances and articles			
Supervise the selection for issue of the correct ammunition from storage by batch/lot number.			
Supervise the receipt of the correct explosive substance or article into storage by batch/lot number.			
Ensure the correct ammunition is processed by batch/lot number.			
Supervise ammunition processing tasks for the inspection, repair and surveillance of ammunition.			
Supervise the correct loading and unloading of ammunition to and from transit frames, containers or packaging.			
Ensure cleanliness and good housekeeping in the explosive storage area.			
Authorities:			
Ensure compliance with the safe system of work contained within the IATG series.			
Ensure compliance with IATG for the safe handling and storage of ammunition.			
Ensure compliance with IATG for the safe processing of ammunition.			
IATG Code[36]	**Competencies**	**IATG[37]**	**NOS ESA Reference[38]**
Safety Management			
2.7	Implement the Organisational Safety Policy and/or Strategy for Explosives	01.30	COGESA2.7
3.2.9A	Implement Risk Control Measures for Ammunition Safety	06.10	COGESA3.2.9A
Maintenance (Inspection, Repair, Surveillance and Proof)			
5.3	Manage the Maintenance Plan for Ammunition	01.30 07.20	COGESA5.3
5.4	Implement the Inspection of Ammunition	07.20 07.30	COGESA5.4
5.5	Implement the Adjustment of Ammunition	07.20 07.30	COGESA5.5
5.6	Implement the Complex Removal of Ammunition	07.20 07.30	COGESA5.6

[35] See Note 1 to Clause 6 on competence versus role.

[36] The IATG competence code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[37] The task primarily falls within the requirements of the IATG listed.

[38] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. One example is included in IATG in order that users may understand the system and is at Annex J.

Competence: Ammunition Supervisor [35]			
5.7	Implement the Routine Removal of Ammunition	07.20 07.30	COGESA5.7
5.8	Implement the Complex Assembly of Ammunition	07.20 07.30	COGESA5.8
5.9	Implement the Routine Assembly of Ammunition	07.20 07.30	COGESA5.9
5.10	Assess the Feasibility of an Explosive Substance or Article Repair	01.50	COGESA5.10
5.11	Implement the Complex Repair of Ammunition	07.20 07.30	COGESA5.11
5.12	Implement the Routine Repair of Ammunition	07.20 07.30	COGESA5.12
5.14	Manage Configuration Activities for Ammunition	07.20 07.30	COGESA5.14
5.15	Implement Configuration Activities for Ammunition	07.20 07.30	COGESA5.15
5.16	Audit the Effectiveness of Configuration Activities for Ammunition	06.70	COGESA5.16
5.17	Accurately account for the processing of ammunition by batch/lot/BKI number.	03.10	N/A
Storage			
7.1	Move Ammunition Manually	03.20 06.30	COGESA7.1
7.2	Supervise the Placing of Ammunition into Storage	03.20 06.30	COGESA7.2
7.3	Receive and Place Ammunition into Storage	03.20 06.30	COGESA7.3
7.4	Supervise the Receiving of Ammunition into Storage	03.20 06.30	COGESA7.4
7.5	Supervise the Maintenance of Storage Conditions for Ammunition	06 Series	COGESA7.5
7.6	Maintain the Quality of Ammunition in Storage	06 Series	COGESA7.6
7.7	Select and Prepare Ammunition for Despatch	03.20 06.30	COGESA7.7
7.8	Despatch Ammunition	03.20 06.30	COGESA7.8
7.9	Supervise the Selection, Preparation and Despatch of Ammunition	03.20 06.30	COGESA7.9
7.10	Manage the Receipt of Ammunition	03.20 06.30	COGESA7.10
7.11	Manage the Storage of Ammunition	06 Series	COGESA7.11
7.12	Manage the Despatch of Ammunition	03.20 06.30	COGESA7.12
7.13	Manage Stock Levels and Stock Inventories of Ammunition	03.10	COGESA7.13
7.14	Audit Stock Levels and Stock Inventories for Ammunition	03.10 03.20	COGESA7.14

Competence: Ammunition Supervisor [35]			
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.16	Maintain Stock Control Systems for Ammunition	03.10 03.20	COGESA7.16
7.17	Operate Specialized Plant and Machinery to Performance Requirements for Ammunition	05.50	COGESA7.17
7.18	Lift, Transfer and Position Ammunition Loads	06.30	COGESA7.18
7.19	Accurately account for the issue, receipt or storage of ammunition by batch/lot/BKI number.	03.10	N/A
Transport			
8.2	Obtain Information on the Ammunition Load	01.50	COGESA8.2
8.3A	Plan the Route and Timings for the Delivery and Collection of Ammunition by Road	08.10 09.10	COGESA8.3A
8.3B	Obtain Information on the Destination and Schedule of the Ammunition Load by Rail	08.10 09.10	COGESA8.3B
8.3C	Obtain Information on the Destination and Schedule of the Ammunition Load by Sea	08.10 09.10	COGESA8.3C
8.3D	Obtain Information on the Destination and Schedule of the Ammunition Load by Air	08.10 09.10	COGESA8.3D
8.4	Load the Vehicle with Ammunition [39]	08.10	COGESA8.4
8.5	Supervise the Loading of the Vehicle with Ammunition by Others	08.10	COGESA8.5
8.6	Unload Ammunition from the Vehicle	08.10	COGESA8.6
8.7	Supervise the Unloading of Ammunition from the Vehicle by Others	08.10	COGESA8.7
Generic Applications			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
13.4	Manage Continuous Improvement in Activities for Explosive Substances and Articles	N/A	COGESA13.4
LD5	Allocate and Check Work in your Team	N/A	CFAMLD5
LB5	Provide Leadership for your Team	N/A	CFAMLB5
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6
IO3.13	Conduct an Assessment of Risks in the Workplace in Processing Industries Operations	02.10	COGPIO3.13
SA13.14	Manage Equipment in an Explosives Environment	05.50	COGESA13.14
SA13.15	Prepare and Care for Equipment in an Explosives Environment	05.50	COGESA13.15

[39] The Driver of the vehicle, and the management of his organization, is responsible for ensuring that the vehicle is of an appropriate type to carry explosives and has all the relevant safety equipment and hazard signs. See *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Eighteenth revised edition), ST/SG/AC.10/1/Rev.18, (ISBN 978-92-1-139146Ed-6), New York and Geneva, United Nations, 2013. *(Referred to as the UN Model Regulations).*

Competence: Ammunition Supervisor [35]			
SA13.16	Manage Explosives Safely	All	COGESA13.16
SA13.17	Certify as Free from Explosives (FFE)	07.20	COGESA13.17
SA13.18	Supervise Explosives Safety	All	COGESA13.18

Annex G
(normative)
Competences – Ammunition Manager

Competence: Ammunition Manager [40]			
Employment Category:	Ammunition Manager		
Role:	The safe and efficient management of all ammunition related processes within an explosives storage area.		
Responsibilities:			
Manage all storage processes for ammunition within an explosives storage area.			
Manage all ammunition processing tasks for the inspection, repair and surveillance of ammunition with an explosives storage area.			
Implement all explosive safety processes and requirements within an explosives storage area.			
Authorities:			
Ensure compliance with the safe system of work contained within the IATG series.			
Ensure compliance with IATG for the safe handling and storage of ammunition.			
Ensure compliance with IATG for the safe processing of ammunition.			
IATG Code[41]	**Competencies**	**IATG[42]**	**NOS ESA Reference[43]**
Safety Management			
2.2	Determine the Classification of Ammunition	01.50	COGESA2.2
2.4	Analyse the Acceptability of Safety Control Measures for Specific Ammunition	02.10	COGESA2.4
2.4A	Review Safety Control Measures for Specific Ammunition	02.10	COGESA3.2.4A
2.7	Implement the Organisational Safety Policy and/or Strategy for Explosives	01.30	COGESA2.7
2.8	Analyse and Identify Aggregated Hazards and Risks for Explosives	02.10	COGESA2.8
3.2.8A	Assess the Suitability of Explosives Facilities	02.10 02.20	COGESA3.2.8A
2.9	Determine and Implement Aggregated Risk Control Measures for Explosives	02.10 06.10	COGESA2.9
3.2.9A	Implement Risk Control Measures for Ammunition Safety	06.10	COGESA3.2.9A
2.10	Develop and Implement Assurance Systems for Explosives Safety	02.10 06.10	COGESA2.10
2.11	Develop Emergency Response Systems and Procedures for Explosives Safety	02.10 11.10	COGESA2.11
3.2.12A	Contribute to the Investigation of Explosives Safety Incidents	11.10	COGESA3.2.12A

[40] See Note 1 to Clause 6 on competence versus role.

[41] The IATG competence code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[42] The task primarily falls within the requirements of the IATG listed.

[43] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. One example is included in IATG in order that users may understand the system and is at Annex J.

Competence: Ammunition Manager [40]			
2.14	Prepare and Submit an Explosives Licence Application	02.20 02.30	COGESA2.14
Maintenance (Inspection, Repair, Surveillance and Proof)			
5.3	Manage the Maintenance Plan for Ammunition	01.30 07.20	COGESA5.3
5.4	Implement the Inspection of Ammunition	07.20 07.30	COGESA5.4
5.5	Implement the Adjustment of Ammunition	07.20 07.30	COGESA5.5
5.6	Implement the Complex Removal of Ammunition	07.20 07.30	COGESA5.6
5.7	Implement the Routine Removal of Ammunition	07.20 07.30	COGESA5.7
5.8	Implement the Complex Assembly of Ammunition	07.20 07.30	COGESA5.8
5.9	Implement the Routine Assembly of Ammunition	07.20 07.30	COGESA5.9
5.10	Assess the Feasibility of an Explosive Substance or Article Repair	01.50	COGESA5.10
5.11	Implement the Complex Repair of Ammunition	07.20 07.30	COGESA5.11
5.12	Implement the Routine Repair of Ammunition	07.20 07.30	COGESA5.12
5.14	Manage Configuration Activities for Ammunition	07.20 07.30	COGESA5.14
5.15	Implement Configuration Activities for Ammunition	07.20 07.30	COGESA5.15
5.17	Accurately account for the processing of ammunition by batch/lot/BKI number.	03.10	N/A
Storage			
7.1	Move Ammunition Manually	03.20 06.30	COGESA7.1
7.2	Supervise the Placing of Ammunition into Storage	03.20 06.30	COGESA7.2
7.3	Receive and Place Ammunition into Storage	03.20 06.30	COGESA7.3
7.4	Supervise the Receiving of Ammunition into Storage	03.20 06.30	COGESA7.4
7.5	Supervise the Maintenance of Storage Conditions for Ammunition	06 Series	COGESA7.5
7.6	Maintain the Quality of Ammunition in Storage	06 Series	COGESA7.6
7.7	Select and Prepare Ammunition for Despatch	03.20 06.30	COGESA7.7
7.8	Despatch Ammunition	03.20 06.30	COGESA7.8
7.9	Supervise the Selection, Preparation and Despatch of Ammunition	03.20 06.30	COGESA7.9

Competence: Ammunition Manager [40]			
7.10	Manage the Receipt of Ammunition	03.20 06.30	COGESA7.10
7.11	Manage the Storage of Ammunition	06 Series	COGESA7.11
7.12	Manage the Despatch of Ammunition	03.20 06.30	COGESA7.12
7.13	Manage Stock Levels and Stock Inventories of Ammunition	03.10	COGESA7.13
7.14	Audit Stock Levels and Stock Inventories for Ammunition	03.10 03.20	COGESA7.14
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.16	Maintain Stock Control Systems for Ammunition	03.10 03.20	COGESA7.16
7.17	Operate Specialized Plant and Machinery to Performance Requirements for Ammunition	05.50	COGESA7.17
7.18	Lift, Transfer and Position Ammunition Loads	06.30	COGESA7.18
7.19	Accurately account for the issue, receipt or storage of ammunition by batch/lot/BKI number.	03.10	N/A
Transport			
8.1A	Plan and Manage the Safe and Secure Transportation by Road of Explosive Substances and Articles	08.10 09.10	COGESA8.1A
8.1B	Plan and Manage the Safe and Secure Transportation by Rail of Explosive Substances and Articles	08.10 09.10	COGESA8.1B
8.1C	Plan and Manage the Safe and Secure Transportation by Sea of Explosive Substances and Articles	08.10 09.10	COGESA8.1C
8.1D	Plan and Manage the Safe and Secure Transportation by Air of Explosive Substances and Articles	08.10 09.10	COGESA8.1D
8.2	Obtain Information on the Ammunition Load	01.50	COGESA8.2
8.3A	Plan the Route and Timings for the Delivery and Collection of Ammunition by Road	08.10 09.10	COGESA8.3A
8.3B	Obtain Information on the Destination and Schedule of the Ammunition Load by Rail	08.10 09.10	COGESA8.3B
8.3C	Obtain Information on the Destination and Schedule of the Ammunition Load by Sea	08.10 09.10	COGESA8.3C
8.3D	Obtain Information on the Destination and Schedule of the Ammunition Load by Air	08.10 09.10	COGESA8.3D
8.4	Load the Vehicle with Ammunition [44]	08.10	COGESA8.4
8.5	Supervise the Loading of the Vehicle with Ammunition by Others	08.10	COGESA8.5
8.6	Unload Ammunition from the Vehicle	08.10	COGESA8.6
8.7	Supervise the Unloading of Ammunition from the Vehicle by Others	08.10	COGESA8.7

[44] The Driver of the vehicle, and the management of his organization, is responsible for ensuring that the vehicle is of an appropriate type to carry explosives and has all the relevant safety equipment and hazard signs. See *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Eighteenth revised edition), ST/SG/AC.10/1/Rev.18, (ISBN 978-92-1-139146Ed-6), New York and Geneva, United Nations, 2013. *(Referred to as the UN Model Regulations).*

Competence: Ammunition Manager [40]			
Explosive Facilities Management			
9.3	Conduct Safety Checks on Explosives Facilities	06.70	COGESA9.3
9.4	Develop and Implement the Explosives Facility Decommissioning Plan	10.10	COGESA9.4
9.5	Conduct Decommissioning Tasks on Explosives Facility	10.10	COGESA9.5
Disposal			
11.1	Assess the Ammunition for Disposal	07.30	COGESA11.1
11.2	Determine the Existence of a Suitable Disposal Procedure for Ammunition	Demil Task	COGESA11.2
11.3	Adapt an Existing Disposal Procedure for Ammunition	Demil Task	COGESA11.3
11.6	Plan the Disposal of Explosives Substances and/or Articles (Non-Complex)	10.10	COGESA11.6
11.7	Manage Tasks for the Disposal of Ammunition	Demil Task	COGESA11.7
11.8	Carry Out Pre-Disposal Tasks for Ammunition	Demil Task	COGESA11.8
11.9	Contribute to Pre-Disposal Tasks for Ammunition	Demil Task	COGESA11.9
1110	Dispose of Ammunition by Complex Mechanical Breakdown Procedures	Demil Task	COGESA11.10
11.13	Dispose of Ammunition by Complex Burning Procedures	Demil Task	COGESA11.13
11.14	Dispose of Ammunition by Complex Incineration Procedures	Demil Task	COGESA11.14
11.15	Dispose of Ammunition by Complex Deflagration Procedures	Demil Task	COGESA11.15
11.16	Dispose of Ammunition by Complex Detonation Procedures	Demil Task	COGESA11.16
11.10A	Dispose of Ammunition by Non-Complex Mechanical Breakdown Procedures	Demil Task	COGESA11.10A
11.13A	Dispose of Ammunition by Non-Complex Burning Procedures	Demil Task	COGESA11.13A
11.14A	Dispose of Ammunition by Non-Complex Incineration Procedures	Demil Task	COGESA11.14A
11.15A	Dispose of Ammunition by Non-Complex Deflagration Procedures	Demil Task	COGESA11.15A
11.16A	Dispose of Ammunition by Non-Complex Detonation Procedures	Demil Task	COGESA11.16A
11.17	Dispose of Ammunition by Function as Intended Procedures	Demil Task	COGESA11.17
11.18	Contribute to the Ammunition Disposal Task	Demil Task	COGESA11.18
11.19	Carry Out Post-Disposal Tasks for Ammunition	Demil Task	COGESA11.19
11.20	Contribute to Post-Disposal Tasks for Ammunition	Demil Task	COGESA11.20
Generic Applications			

Competence: Ammunition Manager [40]			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
13.4	Manage Continuous Improvement in Activities for Explosive Substances and Articles	N/A	COGESA13.4
LD5	Allocate and Check Work in your Team	N/A	CFAMLD5
LB5	Provide Leadership for your Team	N/A	CFAMLB5
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6
IO3.13	Conduct an Assessment of Risks in the Workplace in Processing Industries Operations	02.10	COGPIO3.13
SA13.9	Provide Technical or Safety Advice and/or Guidance to Others on Explosives	All	COGESA13.9
SA13.10	Make Presentations on Explosives Matters	N/A	COGESA13.10
SA13.11	Hand Over Ammunition	03.10 03.20	COGESA13.11
SA13.12	Pack or Re-Pack Ammunition	07.30	COGESA13.12
SA13.13	Unpack Ammunition	07.30	COGESA13.13
SA13.14	Manage Equipment in an Explosives Environment	05.50	COGESA13.14
SA13.15	Prepare and Care for Equipment in an Explosives Environment	05.50	COGESA13.15
SA13.16	Manage Explosives Safely	All	COGESA13.16
SA13.17	Certify as Free from Explosives (FFE)	07.20	COGESA13.17
SA13.18	Supervise Explosives Safety	All	COGESA13.18

Annex H
(normative)
Competences – Ammunition Inspector

Competence: Ammunition Inspector [45]			
Employment Category:	Ammunition Inspector		
Role:	The safe and efficient management of all ammunition related processes within a national inventory.		
Responsibilities:			
Plan and manage all storage processes for ammunition within an explosives storage area.			
Plan and manage all ammunition processing tasks for the inspection, repair and surveillance of ammunition with an explosives storage area.			
Develop, plan and manage all explosive safety processes and requirements within an explosives storage area.			
Develop and supervise the implementation of all technical instructions, standing operating procedures and ammunition related documentation for the national ammunition inventory.			
Undertake ammunition accident investigations.			
Plan, manage and implement the safe disposal of ammunition.			
Authorities:			
Ensure compliance with the safe system of work contained within the IATG series.			
Ensure compliance with IATG for the safe handling and storage of ammunition.			
Ensure compliance with IATG for the safe processing of ammunition.			
IATG Code[46]	**Competencies**	**IATG[47]**	**NOS ESA Reference[48]**
	Safety Management		
2.1	Formulate National Policy for Explosive Substances and Articles	01.30	COGESA2.1
2.2	Determine the Classification of Ammunition	01.50	COGESA2.2
3.2.2A	Make Recommendations for the Classification of Ammunition	01.50	COGESA3.2.2A
2.3	Review the Factors Affecting the Safety of Specific Ammunition	02.10	COGESA2.3
3.2.3A	Make Recommendations on the Factors Affecting the Safety of Specific Ammunition	02.10	COGESA3.2.3A
2.4	Analyse the Acceptability of Safety Control Measures for Specific Ammunition	02.10	COGESA2.4
2.4A	Review Safety Control Measures for Specific Ammunition	02.10	COGESA3.2.4A
2.5	Review an Organisation's Safety Management System for Explosives	02.10	COGESA2.5

[45] See Note 1 to Clause 6 on competence versus role.

[46] The IATG competence code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[47] The task primarily falls within the requirements of the IATG listed.

[48] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. One example is included in IATG in order that users may understand the system and is at Annex J.

Competence: Ammunition Inspector [45]			
2.5A	Assess an Organisation's Explosives Safety Management System	06.70	COGESA3.2.5A
2.6	Develop the Organisational Safety Policy and/or Strategy for Explosives	01.30	COGESA2.6
2.7	Implement the Organisational Safety Policy and/or Strategy for Explosives	01.30	COGESA2.7
2.8	Analyse and Identify Aggregated Hazards and Risks for Explosives	02.10	COGESA2.8
3.2.8A	Assess the Suitability of Explosives Facilities	02.10 02.20	COGESA3.2.8A
2.9	Determine and Implement Aggregated Risk Control Measures for Explosives	02.10 06.10	COGESA2.9
3.2.9A	Implement Risk Control Measures for Ammunition Safety	06.10	COGESA3.2.9A
2.10	Develop and Implement Assurance Systems for Explosives Safety	02.10 06.10	COGESA2.10
3.2.10A	Carry Out Assurance Audit of Systems for Explosives Safety	06.70	COGESA3.2.10A
2.11	Develop Emergency Response Systems and Procedures for Explosives Safety	02.10 11.10	COGESA2.11
2.12	Investigate Explosives-Related Safety Incidents	11.10	COGESA2.12
3.2.12A	Contribute to the Investigation of Explosives Safety Incidents	11.10	COGESA3.2.12A
2.13	Assess Explosives Licence Applications	02.20 02.30 02.40	COGESA2.13
2.14	Prepare and Submit an Explosives Licence Application	02.20 02.30	COGESA2.14
Maintenance (Inspection, Repair, Surveillance and Proof)			
5.1	Plan the Maintenance Programme for Ammunition	07.20	COGESA5.1
5.2	Manage the Maintenance Programme for Ammunition	01.30 07.20	COGESA5.2
5.3	Manage the Maintenance Plan for Ammunition	01.30 07.20	COGESA5.3
5.4	Implement the Inspection of Ammunition	07.20 07.30	COGESA5.4
5.5	Implement the Adjustment of Ammunition	07.20 07.30	COGESA5.5
5.6	Implement the Complex Removal of Ammunition	07.20 07.30	COGESA5.6
5.7	Implement the Routine Removal of Ammunition	07.20 07.30	COGESA5.7
5.8	Implement the Complex Assembly of Ammunition	07.20 07.30	COGESA5.8
5.9	Implement the Routine Assembly of Ammunition	07.20 07.30	COGESA5.9
5.10	Assess the Feasibility of an Explosive Substance or Article Repair	01.50	COGESA5.10

Competence: Ammunition Inspector [45]			
5.11	Implement the Complex Repair of Ammunition	07.20 07.30	COGESA5.11
5.12	Implement the Routine Repair of Ammunition	07.20 07.30	COGESA5.12
5.13	Plan Configuration Activities for Ammunition	07.20 07.30	COGESA5.13
5.14	Manage Configuration Activities for Ammunition	07.20 07.30	COGESA5.14
5.15	Implement Configuration Activities for Ammunition	07.20 07.30	COGESA5.15
5.16	Audit the Effectiveness of Configuration Activities for Ammunition	06.70	COGESA5.16
Procurement			
6.2	Define the Procurement Strategy for Ammunition	01.30	COGESA6.2
6.3	Contribute to the Identification of the Requirement and Specification for Ammunition	01.30	COGESA6.3
6.5	Provide Explosives-Related Technical Input to Assist in Identifying Potential Suppliers and/or Articles	N/A	COGESA6.5
6.8	Manage the Contract for the Supply of Ammunition	N/A	COGESA6.8
6.9	Ensure Compliance with Contract Terms for the Supply of Ammunition	N/A	COGESA6.9
Storage			
7.1	Move Ammunition Manually	03.20 06.30	COGESA7.1
7.2	Supervise the Placing of Ammunition into Storage	03.20 06.30	COGESA7.2
7.3	Receive and Place Ammunition into Storage	03.20 06.30	COGESA7.3
7.4	Supervise the Receiving of Ammunition into Storage	03.20 06.30	COGESA7.4
7.5	Supervise the Maintenance of Storage Conditions for Ammunition	06 Series	COGESA7.5
7.6	Maintain the Quality of Ammunition in Storage	06 Series	COGESA7.6
7.7	Select and Prepare Ammunition for Despatch	03.20 06.30	COGESA7.7
7.8	Despatch Ammunition	03.20 06.30	COGESA7.8
7.9	Supervise the Selection, Preparation and Despatch of Ammunition	03.20 06.30	COGESA7.9
7.10	Manage the Receipt of Ammunition	03.20 06.30	COGESA7.10
7.11	Manage the Storage of Ammunition	06 Series	COGESA7.11
7.12	Manage the Despatch of Ammunition	03.20 06.30	COGESA7.12
7.13	Manage Stock Levels and Stock Inventories of Ammunition	03.10	COGESA7.13

Competence: Ammunition Inspector [45]			
7.14	Audit Stock Levels and Stock Inventories for Ammunition	03.10 03.20	COGESA7.14
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.16	Maintain Stock Control Systems for Ammunition	03.10 03.20	COGESA7.16
7.17	Operate Specialized Plant and Machinery to Performance Requirements for Ammunition	05.50	COGESA7.17
7.18	Lift, Transfer and Position Ammunition Loads	06.30	COGESA7.18
7.19	Accurately account for the issue, receipt or storage of ammunition by batch/lot/BKI number.	03.10	N/A
Transport			
8.1A	Plan and Manage the Safe and Secure Transportation by Road of Explosive Substances and Articles	08.10 09.10	COGESA8.1A
8.1B	Plan and Manage the Safe and Secure Transportation by Rail of Explosive Substances and Articles	08.10 09.10	COGESA8.1B
8.1C	Plan and Manage the Safe and Secure Transportation by Sea of Explosive Substances and Articles	08.10 09.10	COGESA8.1C
8.1D	Plan and Manage the Safe and Secure Transportation by Air of Explosive Substances and Articles	08.10 09.10	COGESA8.1D
8.2	Obtain Information on the Ammunition Load	01.50	COGESA8.2
8.3A	Plan the Route and Timings for the Delivery and Collection of Ammunition by Road	08.10 09.10	COGESA8.3A
8.3B	Obtain Information on the Destination and Schedule of the Ammunition Load by Rail	08.10 09.10	COGESA8.3B
8.3C	Obtain Information on the Destination and Schedule of the Ammunition Load by Sea	08.10 09.10	COGESA8.3C
8.3D	Obtain Information on the Destination and Schedule of the Ammunition Load by Air	08.10 09.10	COGESA8.3D
8.4	Load the Vehicle with Ammunition [49]	08.10	COGESA8.4
8.5	Supervise the Loading of the Vehicle with Ammunition by Others	08.10	COGESA8.5
8.6	Unload Ammunition from the Vehicle	08.10	COGESA8.6
8.7	Supervise the Unloading of Ammunition from the Vehicle by Others	08.10	COGESA8.7
Explosive Facilities Management			
9.1	Define Explosives Facilities Requirement	02.20 02.30 02.40	COGESA9.1
9.2	Ensure Explosives Facilities are Fit for Purpose	06.70	COGESA9.2
9.3	Conduct Safety Checks on Explosives Facilities	06.70	COGESA9.3

[49] The Driver of the vehicle, and the management of his organization, is responsible for ensuring that the vehicle is of an appropriate type to carry explosives and has all the relevant safety equipment and hazard signs. See *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Eighteenth revised edition), ST/SG/AC.10/1/Rev.18, (ISBN 978-92-1-139146Ed-6), New York and Geneva, United Nations, 2013. *(Referred to as the UN Model Regulations).*

Competence: Ammunition Inspector [45]			
9.4	Develop and Implement the Explosives Facility Decommissioning Plan	10.10	COGESA9.4
9.5	Conduct Decommissioning Tasks on Explosives Facility	10.10	COGESA9.5
Disposal			
11.1	Assess the Ammunition for Disposal	07.20	COGESA11.1
11.2	Determine the Existence of a Suitable Disposal Procedure for Ammunition	Demil Task	COGESA11.2
11.3	Adapt an Existing Disposal Procedure for Ammunition	Demil Task	COGESA11.3
11.4	Design a New Disposal Procedure for Ammunition	Demil Task	COGESA11.4
11.5	Plan the Disposal of Explosives Substances and/or Articles (Complex)	10.10	COGESA11.5
11.6	Plan the Disposal of Explosives Substances and/or Articles (Non-Complex)	10.10	COGESA11.6
11.7	Manage Tasks for the Disposal of Ammunition	Demil Task	COGESA11.7
11.8	Carry Out Pre-Disposal Tasks for Ammunition	Demil Task	COGESA11.8
11.9	Contribute to Pre-Disposal Tasks for Ammunition	Demil Task	COGESA11.9
1110	Dispose of Ammunition by Complex Mechanical Breakdown Procedures	Demil Task	COGESA11.10
11.11	Dispose of Ammunition by Complex Chemical Breakdown Procedures	Demil Task	COGESA11.11
11.12	Dispose of Ammunition by Complex Biological Breakdown Procedures	Demil Task	COGESA11.12
11.13	Dispose of Ammunition by Complex Burning Procedures	Demil Task	COGESA11.13
11.14	Dispose of Ammunition by Complex Incineration Procedures	Demil Task	COGESA11.14
11.15	Dispose of Ammunition by Complex Deflagration Procedures	Demil Task	COGESA11.15
11.16	Dispose of Ammunition by Complex Detonation Procedures	Demil Task	COGESA11.16
11.10A	Dispose of Ammunition by Non-Complex Mechanical Breakdown Procedures	Demil Task	COGESA11.10A
11.11A	Dispose of Ammunition by Non-Complex Chemical Breakdown Procedures	Demil Task	COGESA11.11A
11.12A	Dispose of Ammunition by Non-Complex Biological Breakdown Procedures	Demil Task	COGESA11.12A
11.13A	Dispose of Ammunition by Non-Complex Burning Procedures	Demil Task	COGESA11.13A
11.14A	Dispose of Ammunition by Non-Complex Incineration Procedures	Demil Task	COGESA11.14A
11.15A	Dispose of Ammunition by Non-Complex Deflagration Procedures	Demil Task	COGESA11.15A

Competence: Ammunition Inspector [45]			
11.16A	Dispose of Ammunition by Non-Complex Detonation Procedures	Demil Task	COGESA11.16A
11.17	Dispose of Ammunition by Function as Intended Procedures	Demil Task	COGESA11.17
11.18	Contribute to the Ammunition Disposal Task	Demil Task	COGESA11.18
11.19	Carry Out Post-Disposal Tasks for Ammunition	Demil Task	COGESA11.19
11.20	Contribute to Post-Disposal Tasks for Ammunition	Demil Task	COGESA11.20
Generic Applications			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
13.4	Manage Continuous Improvement in Activities for Explosive Substances and Articles	N/A	COGESA13.4
LD5	Allocate and Check Work in your Team	N/A	CFAMLD5
LB5	Provide Leadership for your Team	N/A	CFAMLB5
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6
IO3.13	Conduct an Assessment of Risks in the Workplace in Processing Industries Operations	02.10	COGPIO3.13
SA13.9	Provide Technical or Safety Advice and/or Guidance to Others on Explosives	All	COGESA13.9
SA13.10	Make Presentations on Explosives Matters	N/A	COGESA13.10
SA13.14	Manage Equipment in an Explosives Environment	05.50	COGESA13.14
SA13.15	Prepare and Care for Equipment in an Explosives Environment	05.50	COGESA13.15
SA13.16	Manage Explosives Safely	All	COGESA13.16
SA13.17	Certify as Free from Explosives (FFE)	07.30	COGESA13.17
SA13.18	Supervise Explosives Safety	All	COGESA13.18

Annex J
(normative)
Example Competence Criteria and Requirements [50]

[50] Details of the Performance Criteria and Knowledge Requirements for each competence in IATG can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. Alternatively enter the search term 'Explosives' in this website http://www.ukstandards.org.uk/ to obtain all relevant NOS on the explosives sector.

Details of the Performance Criteria and Knowledge Requirements for each competence in IATG can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website. Alternatively enter the search term 'Explosives' in this website http://www.ukstandards.org.uk/ to obtain all relevant NOS on the explosives sector.

Some examples follow of performance criteria and requirements for different competences.

IATG Code[51]	7.3	**NOS ESA Reference**	COGESA7.3
Receive and Place Ammunition into Storage			
Performance Criteria *You must be able to:*			
P1 Work safely at all times, complying with health and safety, environmental and other relevant regulations, legislation and guidelines.			
P2 Confirm that the transit, stabling and storage locations are suitable.			
P3 Adhere to the storage plan.			
P4 Use handling equipment correctly, to meet all tasking requirements.			
P5 Resolve any storage or resource problems, within your level of authority.			
P6 Confirm that the type, quality and quantity of the goods is in accordance with receipts documentation, and report any discrepancies.			
P7 Take action, in accordance with procedures, where explosive substances and/or articles are received in a suspect or damaged state.			
P8 Ensure that all documentation is correctly completed.			
Knowledge and Understanding *You need to know and understand:*			
K1 The health, safety and environmental and other statutory legislation, regulations and safe working practices and procedures governing explosives, and their implications for your area of work.			
K2 The relevance of personal protective equipment (PPE).			
K3 The actions to be taken in response to an unplanned event.			
K4 The storage needs, and any environmental conditions required.			
K5 The rules governing mixing hazard divisions and compatibility groups.			
K6 The resource requirements of the task.			
K7 What could go wrong with the explosive substances and/or articles, and the action you should take.			
K8 How to implement contingency plans.			
K9 Stock receipt, recording and controlling systems.			
K10 How to give and receive constructive feedback.			
K11 Your level of authority.			
K12 When and from whom to seek advice or assistance.			

[51] The code equates to the numbers of the NOS ESA Reference for ease of future amendment.

IATG Code[52]	2.1	**NOS ESA Reference**	COGESA2.1
Formulate National Policy for Explosive Substances and Articles			
Performance Criteria *You must be able to:*			
P1 Work safely at all times, complying with health and safety, environmental and other relevant regulations, legislation and guidelines.			
P2 Establish the extent to which a relevant national policy currently exists.			
P3 Identify areas for improvement in the existing national policy.			
P4 Identify the need for new policy, where none currently exists.			
P5 Recommend changes that address the areas for improvement.			
P6 Establish the constraints that may influence the policy.			
P7 Evaluate the potential impact of the proposed policy.			
P8 Secure commitment from appropriate stakeholders to the proposed policy.			
P9 Review periodically the extent to which the policy delivers requirements.			
P10 Confirm that your recommendations, and their implications, are clearly understood.			
P11 Publish the policy, in the appropriate format.			
Knowledge and Understanding *You need to know and understand:*			
K1 The health, safety and environmental and other statutory legislation, regulations and safe working practices and procedures governing explosives, and their implications for your area of the following.			
K2 The relevance of personal protective equipment (PPE).			
K3 The nature, characteristics, hazards and risks of the explosive substances and/or articles.			
K4 The actions to be taken in response to an unplanned event.			
K5 The interface between the explosives safety policy and other relevant safety and environmental policies.			
K6 The nature of any constraints (including international requirements).			
K7 Best practice in explosives safety management.			
K8 The acceptability of risk to society, relating to explosives.			
K9 Key organizations in the explosives industry, and the nature of their interest.			
K10 The stakeholders, and the nature of their interest.			
K11 The potential impact of your recommendations.			
K12 The role and mechanisms of the consultative process.			

[52] The code equates to the numbers of the NOS ESA Reference for ease of future amendment.

Annex K
(normative)
Full List of Competences [53]

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
Research, Design and Development			
1.1	Create the Complex Specification for Ammunition	Research Role [57]	COGESA1.1
1.2	Create the Specification for an Explosive Substance or Article	01.50	COGESA1.2
1.3	Assimilate and Evaluate the Information on Ammunition	Research Role	COGESA1.3
1.4	Gather and Interpret the Information on Ammunition	Research Role	COGESA1.4
1.5	Identify and Gather the Information on Ammunition	Research Role	COGESA1.5
1.6	Prepare the Research Strategy for Ammunition	Research Role	COGESA1.6
1.7	Prepare the Research Programme for Ammunition	Research Role	COGESA1.7
1.8	Submit Proposals for Research Work for Ammunition	Research Role	COGESA1.8
1.9	Plan the Research into Ammunition	Research Role	COGESA1.9
1.10	Carry Out the Research Strategy and Analyse the Information Collected on Ammunition	Research Role	COGESA1.10
1.11	Carry Out Investigations and Analyse the Information Collected on Ammunition	11.10	COGESA1.11
1.12	Contribute to Carrying Out Investigations and Analysing the Information Collected on Ammunition	11.10	COGESA1.12
1.13	Evaluate and Document Complex Research and Findings on Ammunition	Research Role	COGESA1.13
1.14	Assess and Document Research and Findings on Ammunition	Research Role	COGESA1.14
1.15	Develop a Dissemination Plan for Ammunition	Research Role	COGESA1.15
1.16	Carry Out Small Scale Processing for Ammunition	07.20 07.30	COGESA1.16
1.17	Design the Scale-Up Process for Ammunition	Research Role	COGESA1.17
1.18	Create the Specification for the Design of Complex Explosive Articles	Research Role	COGESA1.18
1.19	Create the Specification for the Design of an Explosive Article	Research Role	COGESA1.19
1.20	Identify and Analyse the Factors Applicable to the Explosive Article Design Specification	Research Role	COGESA1.20

[53] This is the full list of explosive sector competences from the UK ESA NOS. Many of this do not apply to conventional ammunition stockpile management, but have been included for information.

[54] The code equates to the numbers of the NOS ESA Reference for ease of future amendment.

[55] The task primarily falls within the requirements of the IATG listed.

[56] Details of the Performance Criteria and Knowledge Requirements for each competence can be obtained from the documents held by UN ODA and also reproduced on the IATG SaferGuard website.

[57] Ammunition Inspector (Level 5) with an MSc in an appropriate subject may be capable of this task.

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
1.21	Generate Design Options for Explosive Articles	Research Role	COGESA1.21
1.22	Evaluate Design Options for Explosive Articles	Research Role	COGESA1.22
1.23	Gather Information to Assist in Generating Explosive Article Design Options	Research Role	COGESA1.23
1.24	Build Prototype(s) of Selected Design(s) for Complex Explosive Articles	Research Role	COGESA1.24
1.25	Build Prototype(s) of Selected Design(s) for Explosive Articles	Research Role	COGESA1.25
2-03	Use Information Recording Systems for Scientific or Technical Activities	Research Role	SEMLATA2-03
2-04	Carry Out Routine Maintenance, Cleaning and Checking of Scientific or Technical Equipment	Research Role	SEMLATA2-04
2-05	Maintain Stocks of Resources, Equipment and Consumables for Scientific or Technical Use	Research Role	SEMLATA2-05
2-06	Prepare Compounds and Solutions for Scientific or Technical Use	Research Role	SEMLATA2-06
2-07	Demonstrate Scientific or Technical Methods, Techniques and Skills to Others in the Workplace	Research Role	SEMLATA2-07
2-08	Prepare Resources and Equipment for Scientific or Technical Learning Activities	Research Role	SEMLATA2-08
2-10	Provide Support for Scientific or Technical Learning Activities	Research Role	SEMLATA2-10
2-11	Prepare New Scientific or Technical Methods, Resources and Equipment for Learning Activities	Research Role	SEMLATA2-11
2-12	Carry Out Simple Scientific or Technical Tests Using Manual Equipment	Research Role	SEMLATA2-12
2-13	Carry Out Simple Scientific or Technical Tests Using Automated Equipment	Research Role	SEMLATA2-13
2-14	Prepare Scientific or Technical Samples for Testing Activities	Research Role	SEMLATA2-14
2-15	Carry Out Sampling Operations for Scientific or Technical Tests	Research Role	SEMLATA2-15
3-03	Carry Out Scientific or Technical Testing Operations	Research Role	SEMLATA3-03
3-03	Assess and Communicate Scientific or Technical Information to Authorised Personnel	Research Role	SEMLATA3-04
3-05	Provide Technical Advice and Guidance for Scientific or Technical Activities	Research Role	SEMLATA3-05
3-06	Plan Scientific or Technical Sampling and Testing Activities	Research Role	SEMLATA3-06
3-07	Carry Out Complex Scientific or Technical Testing Operations	Research Role	SEMLATA3-07
3-08	Carry Out Complex Scientific or Technical Sampling Operations	Research Role	SEMLATA3-08
3-09	Carry Out Scientific or Technical Investigations	Research Role	SEMLATA3-09
3-10	Carry Out Small Scale Processing	07.20	SEMLATA3-10
3-11	Diagnose Faults, Repair and Maintain Scientific or Technical Equipment for Workplace Activities	Research Role	SEMLATA3-11

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
3-12	Measuring, Weighing and Preparing Compounds and Solutions for Laboratory Use	Research Role	SEMLATA3-12
3-13	Maintain and Control Stocks of all Resources, Equipment and Consumables for Workplace Scientific or Technical Activities	03.10	SEMLATA3-13
3-16	Provide Training for Scientific or Technical Activities in the Workplace	Research Role	SEMLATA3-16
3-19	Evaluate and Provide Scientific or Technical Assistance for Learning Activities	Research Role	SEMLATA3-19
3-20	Demonstrate Scientific or Technical Methods, Techniques and Skills to Others in the Workplace	Research Role	SEMLATA3-20
3-21	Improve the Quality and Reliability of Scientific or Technical Activities in the Workplace	Research Role	SEMLATA3-21
3-22	Test and Evaluate New Scientific or Technical Methods and Equipment for Learning Activities	Research Role	SEMLATA3-22
4-0	Plan and Run Scientific or Technical Projects for Workplace Activities	Research Role	SEMLATA4-05
4-06	Write Scientific or Technical Reports for Workplace Activities	Research Role	SEMLATA4-06
4-09	Develop and Provide Training for Scientific or Technical Activities in the Workplace	Research Role	SEMLATA4-09
Safety Management			
2.1	Formulate National Policy for Explosive Substances and Articles	01.30	COGESA2.1
2.2	Determine the Classification of Ammunition	01.50	COGESA2.2
3.2.2A	Make Recommendations for the Classification of Ammunition	01.50	COGESA3.2.2A
2.3	Review the Factors Affecting the Safety of Specific Ammunition	02.10	COGESA2.3
3.2.3A	Make Recommendations on the Factors Affecting the Safety of Specific Ammunition	02.10	COGESA3.2.3A
2.4	Analyse the Acceptability of Safety Control Measures for Specific Ammunition	02.10	COGESA2.4
2.4A	Review Safety Control Measures for Specific Ammunition	02.10	COGESA3.2.4A
2.5	Review an Organisation's Safety Management System for Explosives	02.10	COGESA2.5
2.5A	Assess an Organisation's Explosives Safety Management System	06.70	COGESA3.2.5A
2.6	Develop the Organisational Safety Policy and/or Strategy for Explosives	01.30	COGESA2.6
2.7	Implement the Organisational Safety Policy and/or Strategy for Explosives	01.30	COGESA2.7
2.8	Analyse and Identify Aggregated Hazards and Risks for Explosives	02.10	COGESA2.8
3.2.8A	Assess the Suitability of Explosives Facilities	02.10 02.20	COGESA3.2.8A
2.9	Determine and Implement Aggregated Risk Control Measures for Explosives	02.10 06.10	COGESA2.9

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
3.2.9A	Implement Risk Control Measures for Ammunition Safety	06.10	COGESA3.2.9A
2.10	Develop and Implement Assurance Systems for Explosives Safety	02.10 06.10	COGESA2.10
3.2.10A	Carry Out Assurance Audit of Systems for Explosives Safety	06.70	COGESA3.2.10A
2.11	Develop Emergency Response Systems and Procedures for Explosives Safety	02.10 11.10	COGESA2.11
2.12	Investigate Explosives-Related Safety Incidents	11.10	COGESA2.12
3.2.12A	Contribute to the Investigation of Explosives Safety Incidents	11.10	COGESA3.2.12A
2.13	Assess Explosives Licence Applications	02.20 02.30 02.40	COGESA2.13
2.14	Prepare and Submit an Explosives Licence Application	02.20 02.30	COGESA2.14
Test and Evaluation			
3.1	Establish the Performance Criteria for Ammunition	N/A	COGESA3.1
3.2	Determine the Existence of a Suitable Trial or Test Procedure for Ammunition	02.10	COGESA3.2
3.3	Design a New Trial Procedure for Ammunition	TCO[58] Task	COGESA3.3
3.4	Design a New Test Procedure for Ammunition	TCO Task	COGESA3.4
3.5	Adapt an Existing Trial Procedure for Ammunition	TCO Task	COGESA3.5
3.6	Adapt an Existing Test Procedure for Ammunition	TCO Task	COGESA3.6
3.7	Validate a Trial or Test Procedure for Ammunition	TCO Task	COGESA3.7
3.8	Plan the Trial of Ammunition	TCO Task	COGESA3.8
3.9	Plan the Test of Ammunition	TCO Task	COGESA3.9
3.10	Manage the Trial of Ammunition	TCO Task	COGESA3.10
3.11	Manage the Test of Ammunition	TCO Task	COGESA3.11
3.12	Carry Out Pre-trial or Pre-Test Tasks Relating to Ammunition	TCO Task	COGESA3.12
3.13	Contribute to Pre-Trial or Pre-Test Tasks Relating to Ammunition	TCO Task	COGESA3.13
3.14	Carry Out Trials of Ammunition	TCO Task	COGESA3.14
3.15	Carry Out Tests of Ammunition	TCO Task	COGESA3.15

[58] Trials Conducting Officer. (Ammunition Inspector Level 5 is generally qualified for this role)

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
3.16	Contribute to Conducting Trial or Test of Ammunition	TCO Task	COGESA3.16
3.17	Evaluate the Results of Trials of Ammunition	TCO Task	COGESA3.17
3.18	Evaluate the Results of Tests of Ammunition	TCO Task	COGESA3.18
3.19	Carry Out Post-Trial or Post-Test Tasks Relating to Ammunition	TCO Task	COGESA3.19
3.20	Contribute to Post-Trial or Post-Test Tasks Relating to Ammunition	TCO Task	COGESA3.20
Manufacture			
4.1	Develop and Update Explosives Standard Operating Procedure/s	01.30 02.10	COGESA4.1
4.2	Contribute to the Validation and Optimisation of New or Modified Explosives Processes and Equipment	Manufacture Task	COGESA4.2
4.3	Resolve Explosives Operational Problems	Manufacture Task	COGESA4.3
4.4	Prepare the Explosives Process Area and Equipment	06 Series	COGESA4.4
4.5	Move Materials Within the Explosives Process	08.10	COGESA4.5
4.6	Prepare Explosives Process Materials	Manufacture Task	COGESA4.6
4.7	Supervise the Preparation of the Explosives Processing Operation	Manufacture Task	COGESA4.7
4.8	Monitor and Control Explosives Processing	Manufacture Task	COGESA4.8
4.9	Supervise Explosives Processing	Manufacture Task	COGESA4.9
4.10	Solve Explosives Process Problems	Manufacture Task	COGESA4.10
4.10	Shut Down the Explosives Process	Manufacture Task	COGESA4.11
4.10	Supervise the Shutdown of Explosives Processing	Manufacture Task	COGESA4.12
4.10	Separate Recoverable Materials and Waste Produced by the Explosive Process	Manufacture Task	COGESA4.13
4.14	Contribute to Explosives Standard Operating Procedure/s (SOP)	All	COGESA4.14
Maintenance (Inspection, Repair, Surveillance and Proof)			
5.1	Plan the Maintenance Programme for Ammunition	07.20	COGESA5.1
5.2	Manage the Maintenance Programme for Ammunition	01.30 07.20	COGESA5.2
5.3	Manage the Maintenance Plan for Ammunition	01.30 07.20	COGESA5.3
5.4	Implement the Inspection of Ammunition	07.20 07.30	COGESA5.4
5.5	Implement the Adjustment of Ammunition	07.20 07.30	COGESA5.5
5.6	Implement the Complex Removal of Ammunition	07.20 07.30	COGESA5.6
5.7	Implement the Routine Removal of Ammunition	07.20 07.30	COGESA5.7

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
5.8	Implement the Complex Assembly of Ammunition	07.20 07.30	COGESA5.8
5.9	Implement the Routine Assembly of Ammunition	07.20 07.30	COGESA5.9
5.10	Assess the Feasibility of an Explosive Substance or Article Repair	01.50	COGESA5.10
5.11	Implement the Complex Repair of Ammunition	07.20 07.30	COGESA5.11
5.12	Implement the Routine Repair of Ammunition	07.20 07.30	COGESA5.12
5.13	Plan Configuration Activities for Ammunition	07.20 07.30	COGESA5.13
5.14	Manage Configuration Activities for Ammunition	07.20 07.30	COGESA5.14
5.15	Implement Configuration Activities for Ammunition	07.20 07.30	COGESA5.15
5.16	Audit the Effectiveness of Configuration Activities for Ammunition	06.70	COGESA5.16
5.17	Accurately account for the processing of ammunition by batch/lot/BKI number.	03.10	N/A
Procurement			
6.1	Identify the Requirement and Specification for Ammunition	N/A	COGESA6.1
6.2	Define the Procurement Strategy for Ammunition	01.30	COGESA6.2
6.3	Contribute to the Identification of the Requirement and Specification for Ammunition	01.30	COGESA6.3
6.4	Identify Potential Suppliers of Ammunition	N/A	COGESA6.4
6.5	Provide Explosives-Related Technical Input to Assist in Identifying Potential Suppliers and/or Articles	N/A	COGESA6.5
6.6	Negotiate and Award Contracts for Ammunition	N/A	COGESA6.6
6.7	Place Orders for the Supply of Ammunition	N/A	COGESA6.7
6.8	Manage the Contract for the Supply of Ammunition	N/A	COGESA6.8
6.9	Ensure Compliance with Contract Terms for the Supply of Ammunition	N/A	COGESA6.9
Storage			
7.1	Move Ammunition Manually	03.20 06.30	COGESA7.1
7.2	Supervise the Placing of Ammunition into Storage	03.20 06.30	COGESA7.2
7.3	Receive and Ammunition into Storage	03.20 06.30	COGESA7.3
7.4	Supervise the Receiving of Ammunition into Storage	03.20 06.30	COGESA7.4
7.5	Supervise the Maintenance of Storage Conditions for Ammunition	06 Series	COGESA7.5

Explosive Sector Competences			
Code[54]	Competencies	IATG[55]	NOS ESA Reference[56]
7.6	Maintain the Quality of Ammunition in Storage	06 Series	COGESA7.6
7.7	Select and Prepare Ammunition for Despatch	03.20 06.30	COGESA7.7
7.8	Despatch Ammunition	03.20 06.30	COGESA7.8
7.9	Supervise the Selection, Preparation and Despatch of Ammunition	03.20 06.30	COGESA7.9
7.10	Manage the Receipt of Ammunition	03.20 06.30	COGESA7.10
7.11	Manage the Storage of Ammunition	06 Series	COGESA7.11
7.12	Manage the Despatch of Ammunition	03.20 06.30	COGESA7.12
7.13	Manage Stock Levels and Stock Inventories of Ammunition	03.10	COGESA7.13
7.14	Audit Stock Levels and Stock Inventories for Ammunition	03.10 03.20	COGESA7.14
7.15	Carry Out Stock Checks of Ammunition	03.10 03.20	COGESA7.15
7.16	Maintain Stock Control Systems for Ammunition	03.10 03.20	COGESA7.16
7.17	Operate Specialized Plant and Machinery to Performance Requirements for Ammunition	05.50	COGESA7.17
7.18	Lift, Transfer and Position Ammunition Loads	06.30	COGESA7.18
7.19	Accurately account for the issue, receipt or storage of ammunition by batch/lot/BKI number.	03.10	N/A
Transport			
8.1A	Plan and Manage the Safe and Secure Transportation by Road of Explosive Substances and Articles	08.10 09.10	COGESA8.1A
8.1B	Plan and Manage the Safe and Secure Transportation by Rail of Explosive Substances and Articles	08.10 09.10	COGESA8.1B
8.1C	Plan and Manage the Safe and Secure Transportation by Sea of Explosive Substances and Articles	08.10 09.10	COGESA8.1C
8.1D	Plan and Manage the Safe and Secure Transportation by Air of Explosive Substances and Articles	08.10 09.10	COGESA8.1D
8.2	Obtain Information on Explosive Substances and Articles Load	01.50	COGESA8.2
8.3A	Plan the Route and Timings for the Delivery and Collection of Explosive Substances and Articles by Road	08.10 09.10	COGESA8.3A
8.3B	Obtain Information on the Destination and Schedule of the Explosive Load by Rail	08.10 09.10	COGESA8.3B
8.3C	Obtain Information on the Destination and Schedule of the Explosive Load by Sea	08.10 09.10	COGESA8.3C
8.3D	Obtain Information on the Destination and Schedule of the Explosive Load by Air	08.10 09.10	COGESA8.3D
8.4	Load the Vehicle with Explosive Substances and Articles	08.10	COGESA8.4

Explosive Sector Competences			
Code[54]	Competencies	IATG[55]	NOS ESA Reference[56]
8.5	Supervise the Loading of the Vehicle with Explosive Substances and Articles by Others	08.10	COGESA8.5
8.6	Unload Explosive Substances and Articles from the Vehicle	08.10	COGESA8.6
8.7	Supervise the Unloading of Explosive Substances and Articles from the Vehicle by Others	08.10	COGESA8.7
GV1	Prepare the Vehicle for Driving	N/A	SFLDGV1
GV2	Protect the Vehicle and the Load	N/A	SFLDGV2
GV3	Operate and Monitor the Vehicle Systems	N/A	SFLDGV3
GV4	Manoeuvre the Vehicle in Restricted Spaces	N/A	SFLDGV4
GV5	Drive the Vehicle on Public Roads in a Fuel Efficient Manner	N/A	SFLDGV5
GV10	Couple and Uncouple the Vehicle	N/A	SFLDGV10
8.14B	Couple and Uncouple the Train	N/A	COGESA8.14B
8.15	Escort the Explosive Substances and Articles Load	08.10	COGESA8.15
Explosive Facilities Management			
9.1	Define Explosives Facilities Requirement	02.20 02.30 02.40	COGESA9.1
9.2	Ensure Explosives Facilities are Fit for Purpose	06.70	COGESA9.2
9.3	Conduct Safety Checks on Explosives Facilities	06.70	COGESA9.3
9.4	Develop and Implement the Explosives Facility Decommissioning Plan	10.10	COGESA9.4
9.5	Conduct Decommissioning Tasks on Explosives Facility	10.10	COGESA9.5
BL2	Contribute to Health and Safety in the Blasting Workplace	N/A	PROBL2
BL3	Receive, Store and Issue Explosive Materials	03.10 03.20	PROBL3
BL4	Receive and Handle Explosive Materials On-Site	03.10 03.20	PROBL4
BL5	Charge Blast Holes to Specification	N/A	PROBL5
BL6	Blast to Specification	N/A	PROBL6
BL7	Deal with Misfires	N/A	PROBL7
BL8	Determine the Blast Requirements	N/A	PROBL8
BL9	Design and Arrange for the Authorisation of the Blast Specification	N/A	PROBL9
BL10	Produce Profiles of Rock Faces and Landforms	N/A	PROBL10
BL11	Supervise the Blasting Operation	N/A	PROBL11
BL16	Contribute to an Efficient and Effective Drilling or Blasting Environment	N/A	PROBL16
Other Applications			
10.12	Design the Complex Explosive Display	EOD Task	COGESA10.12
10.13	Design the Explosive Display	EOD Task	COGESA10.13

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
10.14	Prepare and Position Explosive Effects	EOD Task	COGESA10.14
10.15	Contribute to the Preparation and Positioning of Explosive Effects	EOD Task	COGESA10.15
10.16	Initiate the Explosive Effect	EOD Task	COGESA10.16
10.17	Modify Explosive Effects Delivery Systems	EOD Task	COGESA10.17
	Disposal		
11.1	Assess the Ammunition for Disposal	07.30	COGESA11.1
11.2	Determine the Existence of a Suitable Disposal Procedure for Ammunition	Demil Task	COGESA11.2
11.3	Adapt an Existing Disposal Procedure for Ammunition	Demil Task	COGESA11.3
11.4	Design a New Disposal Procedure for Ammunition	Demil Task	COGESA11.4
11.5	Plan the Disposal of Explosives Substances and/or Articles (Complex)	10.10	COGESA11.5
11.6	Plan the Disposal of Explosives Substances and/or Articles (Non-Complex)	10.10	COGESA11.6
11.7	Manage Tasks for the Disposal of Ammunition	Demil Task	COGESA11.7
11.8	Carry Out Pre-Disposal Tasks for Ammunition	Demil Task	COGESA11.8
11.9	Contribute to Pre-Disposal Tasks for Ammunition	Demil Task	COGESA11.9
1110	Dispose of Ammunition by Complex Mechanical Breakdown Procedures	Demil Task	COGESA11.10
11.11	Dispose of Ammunition by Complex Chemical Breakdown Procedures	Demil Task	COGESA11.11
11.12	Dispose of Ammunition by Complex Biological Breakdown Procedures	Demil Task	COGESA11.12
11.13	Dispose of Ammunition by Complex Burning Procedures	Demil Task	COGESA11.13
11.14	Dispose of Ammunition by Complex Incineration Procedures	Demil Task	COGESA11.14
11.15	Dispose of Ammunition by Complex Deflagration Procedures	Demil Task	COGESA11.15
11.16	Dispose of Ammunition by Complex Detonation Procedures	Demil Task	COGESA11.16
11.10A	Dispose of Ammunition by Non-Complex Mechanical Breakdown Procedures	Demil Task	COGESA11.10A
11.11A	Dispose of Ammunition by Non-Complex Chemical Breakdown Procedures	Demil Task	COGESA11.11A
11.12A	Dispose of Ammunition by Non-Complex Biological Breakdown Procedures	Demil Task	COGESA11.12A
11.13A	Dispose of Ammunition by Non-Complex Burning Procedures	Demil Task	COGESA11.13A

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG[55]**	**NOS ESA Reference[56]**
11.14A	Dispose of Ammunition by Non-Complex Incineration Procedures	Demil Task	COGESA11.14A
11.15A	Dispose of Ammunition by Non-Complex Deflagration Procedures	Demil Task	COGESA11.15A
11.16A	Dispose of Ammunition by Non-Complex Detonation Procedures	Demil Task	COGESA11.16A
11.17	Dispose of Ammunition by Function as Intended Procedures	Demil Task	COGESA11.17
11.18	Contribute to the Ammunition Disposal Task	Demil Task	COGESA11.18
11.19	Carry Out Post-Disposal Tasks for Ammunition	Demil Task	COGESA11.19
11.20	Contribute to Post-Disposal Tasks for Ammunition	Demil Task	COGESA11.20
Munition Clearance and Search			
12.1	Plan Munition Clearance and Search Operations and Programmes	EOD Task	COGESA12.1
12.2	Manage Munition Clearance and Search Operations and Programmes	EOD Task	COGESA12.2
12.3	Evaluate and Improve the Effectiveness of Munition Clearance and Search Operations and Programmes	EOD Task	COGESA12.3
12.4	Provide Advice on Munition Clearance and Search-Related Matters	EOD Task	COGESA12.4
12.5	Define the Boundaries of the Area to be Searched for Munitions	EOD Task	COGESA12.5
12.6	Identify and Record the Location and Disposition of Potential Munitions within Boundaries	EOD Task	COGESA12.6
12.7	Contribute to Locating the Disposition of Potential Munitions	EOD Task	COGESA12.7
12.8	Confirm the Presence of Munition(s)	EOD Task	COGESA12.8
12.9	Contribute to Confirming the Presence of Munition(s)	EOD Task	COGESA12.9
12.1A	Plan Specified Targets Search Operations	EOD Task	COGESA12.1A
12.2A	Manage Specified Targets Search Operations	EOD Task	COGESA12.2A
12.3A	Organise and Supervise the Delivery of Specified Targets Search Plans	EOD Task	COGESA12.3A
12.4A	Evaluate the Effectiveness of Specified Targets Search Operations	EOD Task	COGESA12.4A
12.5A	Provide Advice on Specified Targets Search Matters	EOD Task	COGESA12.5A
12.6A	Identify and Describe the Area to be Searched	EOD Task	COGESA12.6A
12.7A	Contribute to Identifying and Describing the Area to be Searched	EOD Task	COGESA12.7A

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG**[55]	**NOS ESA Reference**[56]
12.8A	Detect and Locate Specified Targets and Other Risks	EOD Task	COGESA12.8A
12.9A	Contribute to Locating and Gaining Access to Specified Targets	EOD Task	COGESA12.9A
12.10A	Assist in Searching for Specified Targets	EOD Task	COGESA12.10A
12.10	Remove the Threat of Munitions	EOD Task	COGESA12.10
12.11	Contribute to Removing the Threat of Munitions	EOD Task	COGESA12.11
12.12	Move and Transport Munitions	08.10 09.10	COGESA12.12
12.13	Contribute to the Movement or Transportation of Munitions	08.10 09.10	COGESA12.13
12.14	Enable Areas Cleared of Munitions or Specified Targets to be Remediated	EOD Task	COGESA12.14
12.15	Complete Munitions or Specified Targets Search Reports	EOD Task	COGESA12.15
12.16	Assist in Locating the Position of the Munition	EOD Task	COGESA12.16
12.17	Assist with the Movement and Transportation of Munitions	08.10 09.10	COGESA12.17
12.18	Use and Maintain Search or Munition Clearance Equipment	EOD Task	COGESA12.18
12.19	Assist with the Preparation, Maintenance and Use of Search or Munition Clearance Equipment	EOD Task	COGESA12.19
12.20	Work Safely	EOD Task	COGESA12.20
12.21	Evacuate Casualties	07.20 11.10	COGESA12.21
12.22	Develop your Competence in Working with Munitions or Specified Targets	EOD Task	COGESA12.22
Generic Applications			
13.1	Work Effectively in a Team Involved in Activities for Ammunition	N/A	COGESA13.1
LA1	Manage your own Resources	N/A	CFAMLA1
LA2	Manage your own Resources and Professional Development	N/A	CFAMLA2
13.4	Manage Continuous Improvement in Activities for Explosive Substances and Articles	N/A	COGESA13.4
LD5	Allocate and Check Work in your Team	N/A	CFAMLD5
LB5	Provide Leadership for your Team	N/A	CFAMLB5
LB6	Provide Leadership in your Area of Responsibility	N/A	CFAMLB6
IO3.13	Conduct an Assessment of Risks in the Workplace in Processing Industries Operations	02.10	COGPIO3.13

Explosive Sector Competences			
Code[54]	**Competencies**	**IATG**[55]	**NOS ESA Reference**[56]
SA13.9	Provide Technical or Safety Advice and/or Guidance to Others on Explosives	All	COGESA13.9
SA13.10	Make Presentations on Explosives Matters	N/A	COGESA13.10
SA13.11	Hand Over Ammunition	03.10 03.20	COGESA13.11
SA13.12	Pack or Re-Pack Ammunition	07.30	COGESA13.12
SA13.13	Unpack Ammunition	07.30	COGESA13.13
SA13.14	Manage Equipment in an Explosives Environment	05.50	COGESA13.14
SA13.15	Prepare and Care for Equipment in an Explosives Environment	05.50	COGESA13.15
SA13.16	Manage Explosives Safely	All	COGESA13.16
SA13.17	Certify as Free from Explosives (FFE)	07.20	COGESA13.17
SA13.18	Supervise Explosives Safety	All	COGESA13.18

Annex L
(normative)
Competences – Force Explosives Safety Officer (FESO)

A Force Explosives Safety Officer, of an appropriate rank/grade, shall be designated in writing by the Force Commander, or the Operational Headquarters. The FESO shall be responsible for advising the Force Commander on all ammunition and explosives safety matters. The mandate of the FESO to implement explosive safety activities within the deployed force should be considered and designated by the Force Commander.

L.1 Force generation

An appropriately qualified and experienced officer[59] shall be appointed as the Force Explosive Safety officer. This officer shall have the following competencies:

a) have a detailed technical knowledge and understanding of the full scope of IATG;

a) be able to calculate the appropriate Quantity Distances / Temporary Distances (QD/TD) to be applied from Potential Explosion Sites (PES) to other PES and to Exposed Sites (ES);

b) be able to plan an Ammunition/Explosives Storage Area in accordance with IATG 04.10: *Temporary storage*. (For example the number of PES required, barricade requirements, appropriate QD/TD);

c) be able to organize a field or temporary ammunition depot based on economical storage principles and procedures;

d) have a detailed knowledge and understanding of lightning protection system and fire prevention requirements;

e) be able to immediately visually identify explosive safety standard shortcomings during a survey or inspection of ammunition storage and maintenance operations;

f) be knowledgeable of accident reporting procedures and capable of investigating ammunition accidents from first principles of ammunition technology and explosive engineering;

g) be able to determine the risk and consequences of deviations from the regulations and communicate with the Operational Commander the mitigating efforts necessary to reduce or eliminate hazards. This will inevitably include the requirement to develop Explosion Consequence Analysis (ECA) reports based on first principles of ammunition technology and explosive engineering;

h) have a detailed knowledge of appropriate mitigation and protective construction design techniques and methodologies;

i) be able to prepare explosives limits licences based on QD, TD and ECA.

During Disarmament, Demobilization and Reintegration (DDR) operations the FESO should also be capable of advising the Force Commander on;

j) Explosive Ordnance Disposal (Conventional Munition Disposal) matters;

k) the safe collection of ammunition and explosives from the civilian population in accordance with MOSAIC 05.40 *Collection*;

l) the safe destruction of weapons recovered from the civilian population in accordance with MOSAIC 05.50 *Destruction: Weapons*; and

[59] The range of competencies required of this appointment means that it is unlikely to be effectively filled by an officer who is not Ammunition Technical Officer (ATO) qualified (or national equivalent).

m) the safe destruction of ammunition and explosives recovered from the civilian population in accordance with IATG 10.10 *Demilitarization and destruction*.

Should a FESO not be identified with the skills necessary to advise on k) to n) above, then an appropriately qualified individual should also be appointed to the Force Headquarters.

It is recommended that during the planning process, provision should be made to involve appropriately qualified personnel in the storage, management and safe logistic disposal of ammunition and explosives. This should, ideally, be the FESO designated for the Force.

Annex M
(normative)
Accepted retrospective qualifications

Qualification [60]	Level	IATG Category	Awarding Nations
Ammunition Fitting (SAQA 90652)	3	Ammunition Supervisor	South Africa[61]
Ammunition Officer (2340)	5	Ammunition Inspector	USA[62]
Ammunition Specialist (89B)	3	Ammunition Supervisor	USA[66]
Ammunition Supplier	1 - 2	Ammunition Handler	Australia[63]
Ammunition Technical Officer (ATO)	5	Ammunition Inspector	Australia[67], Bangladesh, Barbados[64], Belgium, Belize[68], Canada[68] [65], Germany[66], India, Ireland[67], Jamaica[68], Kenya[68], Kuwait[68], Luxembourg, Malaysia[68], Netherlands, New Zealand[67] [68], Nigeria[68], Pakistan, Saudi Arabia[68], Singapore[68], Trinidad and Tobago[68] and UK[68] [68]
Ammunition Technician (AT 1)	5	Ammunition Inspector	
Ammunition Technician (AT 2)	2	Ammunition Processor	
Ammunition Technician (2311)	2	Ammunition Processor	USA[66]
Ammunition Warrant Officer (890A)	4	Ammunition Manager	USA[66]
Explosives Safety Officer (Ammo-74)	1 - 2	Introduction Course	USA[66]

[60] The code in brackets refers to the Military Occupational Specialist code or equivalent.
[61] Held at South African Army School of Ordnance.
[62] Held at Defense Ammunition Center, McAlester, USA.
[63] Held at Army Logistic Training Centre, Bandiana, Victoria, Australia.
[64] Attended UK Army School of Ammunition (<2004) or UK DEMSS (>2014).
[65] Held at Canadian Forces Logistics Training Centre in Borden, Ontario, Canada or attended UK DEMS.
[66] Held at Land Systems School of Technology and Army Technical College, Aachen, Germany.
[67] Held at Irish Defence Force School of Ordnance.
[68] Held at Defence Explosives, Munitions and Search School (DEMSS), Kineton, UK. ATO also attends the Defence Academy for specialist training.

Qualification [60]	Level	IATG Category	Awarding Nations
Explosives Safety Specialist	5	Ammunition Inspector	USA[69]
International Ammunition Technician	3	Ammunition Inspector	Commercial company ISSEE[70]
Material Maintenance and Munitions Management Officer (91A)	5	Ammunition Inspector	USA[66]
Technical Munitions Officer	5	Ammunition Inspector	South Africa[65]

Table 2: Retrospective qualification for competence

[69] Training will be dependent on which service the individual is in support of.

[70] www.issee.co.uk. This is the 24 week International Ammunition technician Course.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 02.10

Third edition
March 2021

Introduction to risk management principles and processes

IATG 02.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Content

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

A critical element of conventional ammunition stockpile management planning and operations should be the implementation of a robust, effective and integrated risk management system, preferably in accordance with the ISO guidance. This system should examine organisational, management, administrative and operational processes and procedures.

The requirements of ISO Guide 51 have been integrated within the IATG modules, which, in themselves, form part of a risk management process. Adherence to the guidelines will mean that a conventional ammunition stockpile management organisation is already implementing many components of an integrated risk management system. The generic risk management process from ISO Guide 51 is explained within this IATG with emphasis on its application to conventional ammunition storage.

The physical phenomena of blast, fragmentation and thermal radiation resulting from explosions are well understood, as are the mechanisms that cause fatalities, injury and damage as a result of these effects. As a result of this understanding a range of techniques and models have been developed by which these effects can be estimated; these techniques and models form a key element of the overall risk management process. The term ‘estimated’ is important because the range of variables involved means that exact damage effects are unlikely to be accurately predicted; appropriate safety margins are therefore engineered into preventative measures.

Explosion effects and consequence predictive techniques and models have been developed by a number of states and organizations to support risk assessments. Some are qualitative, while others are quantitative, and they will vary in sophistication dependent on the purpose for which they have been designed. Some provide a rough indication of casualties and damage, whereas others will provide more precise estimates of explosion effects. Quite often risk assessments will involve a combination of both qualitative and quantitative risk assessment methods and tools, based on available information and techniques and models being used. Regardless of the techniques and models used to assess risk and/or consequences, it is important that those utilizing such tools in the support of risk assessments understand what those tools do, how they work, and fully comprehend any conditions and limitations associated with those tools.

Explosion effect models and predictive techniques that are relatively easy to implement have been engineered into the IATG software, which is designed to support conventional ammunition stockpile risk management.

A range of techniques for estimating risk is contained within this IATG, with emphasis placed on their application to conventional ammunition stockpile management. Risk based approaches take many forms and can be used as tools to aid in a variety of decision-making processes. New applications are always being defined, and this IATG also provides references to other options to those contained within the guideline.

Risk management should be seen by States as a fundamental preventative measure to support safe conventional ammunition stockpile management. Decisions based on more complete knowledge can be made if the likelihood of an explosive accident can be taken into account as well as the consequences. The techniques covered or referred to in this IATG module (or their equivalent) should therefore be applied.

Introduction to risk management principles and processes

1 Scope

This IATG module introduces the concept of risk management and explains the activities necessary to ensure appropriate risk management within a conventional ammunition management system. It concentrates primarily on the risks to the civilian community from ammunition storage but also provides guidance on risk estimation techniques that may be used for other functional areas of conventional ammunition stockpile management.

Risk based approaches take many forms, vary in degrees of complexity and are constantly evolving. This IATG introduces the principles of risk management and provides guidelines for relatively straightforward risk assessment techniques that can be used in the widest range of circumstances. More complex systems may be found in the informative references.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.[3]

The term 'explosive event' refers to *an unexpected and undesired initiation of an explosive substance or article within an ammunition depot leading to significant or catastrophic consequences.*

The term 'harm' refers to *physical injury or damage to the health of people, or damage to property or the environment*.

The term 'hazard' refers to *a potential source of harm*.

The term 'risk' refers to *a combination of the probability of occurrence of harm and the severity of that harm*.

The term 'risk evaluation' refers to *the process based on risk analysis to determine whether the tolerable risk has been achieved*.

The term 'risk assessment' refers to *the overall process comprising a risk analysis and a risk evaluation*.

The term 'risk management' refers to *the complete risk-based decision-making process*.

The term risk mitigation is used to describe the measures taken to reduce the effects should an explosion or deflagration occur. Examples would be following compatibility mixing rules to prevent an item in an incompatible group exacerbating the effects of an explosion, and keeping inhabited buildings outside the yellow line (inhabited building distance).

[3] All risk related terms and definitions are from ISO Guide 51 (a normative reference at Annex A).

The term 'risk reduction' refers to *actions taken to lessen the probability, negative consequences or both, associated with a particular risk*. Within ammunition management, risk reduction refers to those measures to be taken to reduce the risk of ammunition exploding or deflagrating. It also refers to the methods used to make the ammunition more secure. Examples would be continuous surveillance of ammunition to ensure any safety problems are detected at an early stage and storing ammunition in optimum conditions in secure areas and buildings.

The term 'safety' refers to *the reduction of risk to a tolerable level.*

The term 'tolerable risk' refers to *the risk that is accepted in a given context based on the current values of society.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Introduction

Risk is defined as *Risk = Likelihood x Consequence*. Once a measure of risk is chosen, then the terms *Likelihood* and *Consequence* can be expanded using accepted mathematical protocol. One measure of risk (see Clause 6.2) may be the likelihood that a person will be killed during one year of exposure (Annual Individual Risk of Fatality ($IR_{Fatality}$)).

Likelihood may then be expanded into the probability of a hazardous event per year (P_{Event}).

Consequence may then be defined as the probability that the continuously exposed person is killed if an event occurs ($P_{Fatality|Event}$). From which follows:

$$\text{Annual Individual Risk of Fatality } (IR_{Fatality}) \Rightarrow (P_{Event}) \times (P_{Fatality|Event})$$

Yet an individual can only be harmed if they are present during a hazardous process. Therefore, the risk (per year) is reduced in proportion to the fraction of the year they are actually exposed to a hazardous process/situation (a dimensionless ratio). If the probability of the person being present or exposed is denoted by (E_P), then:

$$\text{Annual Individual Risk of Fatality } (IR_{Fatality}) = (P_{Event}) \times (P_{Fatality|Event}) \times (E_P)$$

Other similar equations may be developed from this to meet different requirements, and the level of detail increased based on sound explosive science and engineering.

Risk-based decision-making should be a fundamental ethos embedded within conventional ammunition stockpile management processes. Risk-based decisions are routinely and instinctively made on a very frequent basis and should be generated dependent on the level of knowledge of the parameters in Table 1.

Parameter	Generic Risk Types	Example Knowledge Requirement
Frequency	▪ Individual Risk ($I_{(R)}$) ▪ Collective Risks ▪ Perceived Risks	▪ How often are there undesirable explosive events within ammunition depots in country A?
Physical Effects		▪ How much explosive is stored within a depot? ▪ What will be the blast over-pressure and impulse levels against range if it detonates?
Consequences		▪ What is the distance at which fatalities and injuries may be expected? ▪ What is the distance at which structural damage is to be expected?
Exposure		▪ How many civilian buildings are within the danger area, and what levels of damage should each expect? ▪ How many civilians are in the blast and fragmentation danger area at any one time?

Table 1: Parameters for risk-based decisions

The target of conventional ammunition stock holding organisations should be the safe, effective and efficient stockpile management of conventional ammunition, explosives, propellants and pyrotechnics.[4] There are potential hazards in this process:

a) inadequate storage conditions for conventional ammunition may result in undesired explosive events during storage;[5]

b) ineffective physical inspection and chemical analysis of ammunition as part of a technical surveillance system may result in undesired explosive events during storage due to deteriorated ammunition; and

c) inappropriate handling and processing of conventional ammunition has the potential to cause death or injury to workers or observers.

Additional to these hazards there are a range of potential causes of an undesirable explosive event:

a) accidental fire in a vehicle, magazine or explosive storehouse;

b) human error due to accident, fatigue or inappropriate handling;

c) environmental (e.g. lightning strike);

d) intruder initiated (e.g. sabotage); or

e) enemy action (in periods of conflict) (e.g. improvised explosive device, direct or indirect fire).

A major objective of the risk management process during conventional ammunition stockpile management shall be to promote a culture where the stockpile management organisation seeks to achieve the target of safety by:

a) developing and applying appropriate management and operating procedures;

b) managing, and assessing, the condition of the conventional ammunition stockpile and taking appropriate actions when a dangerous condition is identified with such stocks;

c) establishing and continuously improving the skills of managers and workers;

d) ensuring that conventional ammunition is stored and processed within an appropriate physical infrastructure; and

[4] Referred to as conventional ammunition for the remainder of this IATG.

[5] Annex C summarises the general effects of explosions.

e) procuring safe, effective and efficient equipment.

5 The concept of safety

Safety is achieved by reducing risk to a tolerable level, which is defined in this IATG as tolerable risk. There can be no absolute safety; some risk will remain - this is the residual risk. [ISO Guide 51: 2014(E)].

Therefore, in the context of conventional ammunition stockpile management the enabling processes of storage, handling, destruction etc. can never be absolutely safe; they can only be relatively safe. This is an inevitable fact of life, which does not mean that all efforts to ensure safety are not being made. It just means that it cannot be proved, with 100% confidence, that absolute safety is being achieved. The risk management systems recommended in IATG, and used within the IATG software, aim to be as close to that 100% ideal confidence level as is realistically possible, whilst allowing stockpile management organisations to determine what is the tolerable risk that they are prepared to accept in their particular environments.

6 The generic risk management process[6]

Risk management is a complex area for which there is a significant body of work to provide guidance. It would be impracticable to cover all the various options and techniques in this IATG, and therefore only those risk management processes with a proven application in conventional ammunition stockpile management have been included.

Risks may be classified as falling into one or more of three categories:

a) risks for which there may be some evidence, but where the connection between cause and injury to any one individual cannot be traced;

b) risks for which statistics of identified casualties may be available; and

c) risks for which best estimates of probability of events that have not yet happened are made by specialists.

Risks inherent in conventional ammunition stockpile management will be classified as falling under categories (b) and/or (c) above. Statistical evidence of previous explosive events within ammunition storage areas is available,[7] and established techniques to estimate risk based on empirical models or scientific equation exist.[8]

6.1 Components of risk management

Risk management is sometimes a misunderstood term, within which there are common misconceptions in terms of the relationship between, for example, risk assessment and risk analysis. Within the IATG risk management is the complete risk-based decision-making process. The matrix at Table 2 identifies the relationship between the different components of risk management that shall be used in the IATG:

[6] From ISO Guide 51.

[7] See *The Threat from Explosive Events in Ammunition Storage Areas*. Explosive Capabilities Limited. UK. 26 September 2009.

[8] See IATG 01.80 *Formulae for ammunition management*.

Risk Management			
	Risk Assessment		
		Risk Analysis	
			Hazard Identification and Analysis
			Risk Estimation
		Risk and ALARP[9] Evaluation	
	Risk Reduction and Mitigation		
	Risk Acceptance		
	Risk Communication		

Table 2: Risk management matrix

Further explanations of each component of risk management, together with recommended techniques that should be used during the risk management process for conventional ammunition stockpile management are at Clauses 7 - 12. These techniques are also included in the IATG software, which automates many of the more technical processes of risk management for conventional ammunition stockpile management.

6.2 Types of risk

There are two generic types of risk that may be considered during the risk management process for explosive facilities:

a) individual risk (I_R). This is the chance of a fatality or serious injury to a particular individual in a specific location as a result of an accidental initiation of explosives; and

b) societal risk (S_R). This expresses the probability of the largest number of people that might be fatalities or seriously injured as a result of an explosives accident.

As the criteria for I_R or S_R are derived from different sources, the risk levels that have been estimated during the risk management process shall be clearly annotated to indicate whether the estimate is for I_R or S_R. The respective limits of tolerability for I_R and S_R are usually independent of each other. In practice, I_R would normally be used during the risk assessment process as S_R is often more difficult to estimate. This is because societal risk concerns often involve a much wider range of potential outcomes.

It is possible that tolerable risk may be achieved using one set of criteria but not achieved using the other criteria. In this case, remedial action should be taken to ensure that both sets of criteria are met. If this is not possible or practicable then the national technical authority shall exercise best judgment and also seek formal political approval for the continued use of the explosive facility.

6.3 Determining tolerable risk

Tolerable risk is determined by the search for absolute safety contrasted against factors such as:

a) the inherent explosive safety hazards of storing, handling and processing ammunition;

b) available resources;

c) the conventions of the society where the ammunition is being stored; and

d) the financial costs.

It follows that there is therefore a need to continually review the tolerable risk that underpins the concept behind stockpile management operations in a particular environment.

[9] As Low As Reasonably Practicable.

The level of tolerable risk shall be determined by the appropriate national authority, but it should not be less than the tolerable risk accepted, for example, in manufacturing or industrial processes. The levels of tolerable risk (based on individual risk criteria) shown in Table 3 could be considered as reasonable and practicable:

‘At Risk’ Group	Tolerable Risk Level (I_R)	Remarks
Workers in Explosives Facility[10] (Maximum Tolerable Limit)	1×10^{-3}	▪ Workers may be exposed to this risk level on an occasional basis. ▪ A non-standard explosive limit licence should be issued at this risk level.[11] ▪ If the I_R is greater than 1×10^{-3} then a special case for licensing shall be submitted to the national technical authority, and political acceptance of the risk, in writing, shall be formally sought.
Workers in Explosives Facility (Warning Level)	1×10^{-4}	▪ This should be the maximum level of risk that workers are exposed to on a regular basis. ▪ A non-standard explosive limit licence should be issued at this risk level.[12]
Workers in Explosives Facility (Acceptable Limit)	1×10^{-6}	▪ This should be the ideal level of risk for daily exposure. ▪ A standard explosive limit licence should be issued at this risk level.[13]
General Public (Maximum Tolerable Limit)	1×10^{-4}	▪ The general public may be exposed to this risk level on an occasional basis and in exceptional circumstances. ▪ A non-standard explosive limit licence should be issued at this risk level.[14] ▪ If the I_R is greater than 1×10^{-3} then a special case for licensing shall be submitted to the national technical authority, and political acceptance of the risk, in writing, shall be formally sought.
General Public (Warning Level)	1×10^{-5}	▪ This should be the maximum level of risk that the general public is exposed to on a regular basis. ▪ A non-standard explosive limit licence should be issued at this risk level.[15]
General Public (Acceptable Limit)	1×10^{-6}	▪ This should be the ideal level of risk for daily exposure. ▪ A standard explosive limit licence should be issued at this risk level.[16]

Table 3: Suggested tolerable risk levels

[10] This includes all staff that work within the explosives facility. It may be further sub-divided into Explosives Workers, who work directly with the ammunition and explosives, and Explosives Support Workers, who provide the administrative support.

[11] See IATG 02.30 *Licensing of explosive storage areas.*

[12] Ibid.

[13] Ibid.

[14] Ibid.

[15] Ibid.

[16] Ibid.

A suggested tolerable level of societal risk (S_R) should be that the maximum probability of an accident in any year that causes the death of 50 people or more shall be less than 1 in 5,000.[17]

A protocol should be established that formally records how the tolerable risk was determined and which authority accepted it. Table 4 summarises the requirements of a 'Tolerable Risk Protocol'.

Generic Area / Activity	Specific Area / Activity	Remarks
Risk Management	Identify and nominate specific individual responsible for risk management policy in explosive facilities.	▪
Risk Analysis	Identify 'Explosives Facilities'.	▪
Risk Analysis	Identify 'At Risk' Groups.	▪ Workers in Explosive Area (Unqualified) ▪ Workers in Explosive Area (Explosives Qualified). ▪ General Public Residing in Proximity to Explosive Facility. ▪ General Public Transiting in Proximity to Explosive Facility.
Risk Analysis	Decide on the appropriate level of Tolerable Risk in terms of I_R and S_R.	▪ Risk levels should be comparable with other industrial processes.
Risk Acceptance	Obtain written Approval[18] for Tolerable Risk levels.	▪ This ensures that appropriate risk acceptance authority is aware of the risk, and of their responsibilities to allocate appropriate resources to manage the risk and maintain it within tolerable levels.
Risk Communication	Widely communicate the Tolerable Risk levels being applied to Explosive Facilities.	▪ Communities in close proximity should be made aware of the risks they are exposed to by their political class. ▪ Means of communication should account for literacy and access differentials between men/women, as well as for the presence of linguistic minorities and transient populations to ensure maximum reach.

Table 4: Tolerable risk protocol

Tolerable risk is achieved by the iterative process of risk assessment (risk analysis and risk evaluation) and risk reduction. See Figure 1.

[17] S_R units are the number of accidents per year. So this suggested tolerable risk level is equivalent to 1 accident at the facility every 5,000 years that kills 50 people or more.

[18] The local authority has to define the appropriate approval authorities for the Tolerable Risk levels. Due to the potential consequences of an explosion event, It is not unusual that the issue of risk acceptance may reach quite high levels of government and the political level.

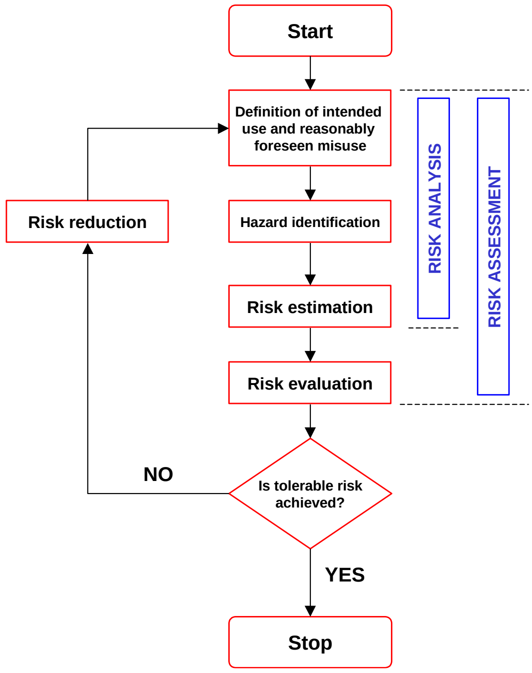

Figure 1: Iterative process of risk assessment[19]

Effective risk assessment has a range of benefits that include:

a) it helps in ranking the importance of individual risk contributions to the overall risk;

b) it helps to identify risks that are easily reduced or eliminated;

c) it helps to clarify what is known and what is not known about the potential risk;

d) it can provide an objective basis for decisions on controlling risks, especially those applying to the local civilian communities near ammunition storage areas;

e) it can provide important quantitative information as input to decisions for allocating resources to conventional ammunition stockpile management;

f) it makes it possible to rank risk reduction or remediation alternatives in terms of risk to workers, the environment, and the public; and

g) it can provide a process for consensus-building and a forum for the participation of stakeholders—including women and other traditionally underrepresented groups—in the development of the risk assessment process and the identification of tolerable risk. This process will hopefully lead to greater acceptance of that risk.

6.4 Achieving tolerable risk

The following generic procedure should be used to reduce risks to a tolerable level during conventional ammunition stockpile management:

a) identify the likely stakeholders in the conventional ammunition stockpile management process, (i.e. local civilian community including women, ethnic minorities, transient and nomadic populations and other traditionally underrepresented groups, ammunition depot workers, management etc.);

[19] This flow process, slightly amended, will appear in other IATG where required.

b) identify each hazard (including any hazardous situation and harmful event) arising in all stages of the stockpile management process;

c) estimate and evaluate the risk to each identified user or group, (for example the consequences of an explosive event in terms of fatalities, injuries, property damage, environmental pollution and financial loss);

d) judge if that risk is tolerable (e.g. by comparison with other risks to the user and with what is acceptable to society); and

e) if the risk is not tolerable then reduce or mitigate the risk until it becomes tolerable.

When conducting the risk reduction process, the order of priority should be as follows:

a) inherently safe design of equipment and processes;

b) imposition of appropriate safe separation distances between ammunition storage and exposed sites;

c) inherently safe operating procedures, where the risk has been reduced or mitigated to a tolerable level for each procedure and activity;

d) appropriate and effective training of staff;

e) use of personal protective equipment during ammunition processing, where appropriate; and

f) information for stockpile management personnel and local communities.

7 Risk assessment (ammunition storage)

7.1 Qualitative risk assessment

Qualitative risk assessments are descriptive, rather than using measurable or calculable data, and they are by far the most widely used approach to risk analysis in many circumstances. Probability data is not required and only estimated potential loss is used. A qualitative risk assessment can be a helpful first step, when a State decides to implement risk assessment procedures, but they should not be used as a replacement for the scientifically accepted and proven techniques which are available to allow for a more quantitative risk assessment. They may be used though for specific processes that support ammunition management where little quantitative data is available, such as technical procedures for ammunition processing tasks.

An example of a Qualitative Risk Assessment technique is at clause 8.2.4.

7.2 Quantitative risk assessment

Quantitative Risk Assessment (QRA) is a powerful tool for the investigation and reduction of risk. It should be used to estimate the approximate probability of an accidental explosion during ammunition storage and then estimate the fatalities, injuries, damage and other losses from such an explosion (referred to as the consequences). This enables professional judgement to be applied as to whether or not the risk meets the ALARP[20] principal.

QRA provides an advantage over more subjective methods in that a more complete set of available information is used to quantify ‘risk’ as a parameter. This allows for consistency and repeatability from decision to decision, (for example when comparing the hazard presented by each explosive storehouse within an ammunition depot).

The primary limitation of some of the techniques used within QRA (for explosives) is a degree of inherent uncertainty in the calculated parameter (see Clause 14); this is often due to the wide range

[20] As Low As Reasonably Practicable. Technical and explosive engineering judgement is required to determine whether the level achieved is as low as reasonably practicable.

of variables. Nevertheless, accuracy in the absolute or overall sense can be discussed within 'orders of magnitude' (factors of 10) and still allow for appropriate decision-making. Fidelity[21] may be quite good, and relative options can be compared with a degree of confidence (within a factor of 2 or better).

An example of a Quantitative Risk Assessment technique is at Annex E.

8 Risk analysis

8.1 Hazard identification and analysis

Hazard identification and analysis is a reasonably simple process for the risk management process that supports conventional ammunition storage. As hazards are defined as a potential source of harm, then the hazard from, for example, individual explosive storehouses (ESH) will depend on the quantity, hazard classification,[22] physical condition and chemical stability of the ammunition contained within that ESH.

If the inter-magazine distances (IMD) are not in accordance with the recommendations contained in IATG 02.20, *Quantity and separation distances,* then further risk analysis will be required. Normally each ESH is considered to be an individual Potential Explosion Site (PES). Yet, if there is a risk of practically instantaneous propagation (PIP) due to inadequate IMD between the ESH, then they may have to be treated as one PES, and the explosive quantity aggregated.

8.2 Risk estimation

As 'risk' is defined as *a combination of the probability of occurrence of harm and the severity of that harm*, then for explosive events in ammunition storage areas the estimation of risk should establish and/or estimate:

a) the probability of an unplanned and undesirable explosive event;

b) the physical effects of such an explosion;

c) the number of casualties to be expected; and

d) the levels of damage to be expected.

Clauses 8.2 b) to d) above cover what is known as the 'consequence analysis' (see Clause 13.3).

8.2.1. Probability estimation of an undesirable explosive event (LEVEL 1)

In many cases, it will be difficult to establish the probability of an unplanned and undesirable explosive event at a particular explosive storage area. Yet data is available on the number of such events annually[23] and a stockpile management organisation should be aware of previous similar events in their region; this will assist the organisation in assessing frequency, and hence probability. This is known as the 'historical' approach and an example model is at Clause 8.2.1.1. A more qualitative approach is at Clause 8.2.1.2.

Alternative methods for establishing frequency, and hence the probability of explosive events, during the risk estimation process include analytical techniques such as attempts to define and quantify all of the potential scenarios in which an explosive event can occur. Logic or fault tree approaches are often used depending upon the complexity of and number of proposed scenarios leading to an event. It can be a complex and sophisticated process, and further guidance is available in the informative references at Annex B.

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[21] Fidelity in this case means 'the extent to which the QRA model is likely to be in comparison to a real life event'.

[22] See IATG 01.50 *UN explosive hazard classification systems and codes.*

[23] Approximately 20+ per annum.

8.2.1.1. Example probability estimate model (historical) (LEVEL 1)

The following example probability model for an undesirable explosive event due to inappropriate stockpile management systems or processes may be used, or adapted, if there is no other data or evidence available. Data for this simple model is based on the following:

a) there are 193 UN Member States. If it is conservatively assumed that the average of ammunition depots of a significant size in each State is 10, then there are 1,930 significantly sized ammunition depots globally;

b) it is then further assumed, based on experience gained during site visits by international observers, that at least 60% of these depots are not in line with international best practices for explosive safety; and

c) there is also documented evidence[24] of an average of 24.5 known undesirable explosive events taking place annually from 2002 to 2017; the vast majority of which took place where inadequate stockpile management processes were in place.

It could therefore be reasonably argued that the annual probability of an undesirable explosive event taking place within an ammunition depot, with inadequate stockpile management systems or processes, is currently approximately:

$$P_{Event} = (24.5/(1930 \times 0.6) = 0.021 = 2.1 \times 10^{-2} \;\; (2.1\%)$$

This probability estimate is certainly within one order of magnitude and may be used for planning purposes.

A probability of 2.1×10^{-2} for an explosive event at an ammunition depot with inappropriate stockpile management processes may be perceived as fairly high when assessed against tolerable risk in most societies. Particularly as the impact in terms of the average fatality rate (2002 – May 2017) for each undesirable explosive event in an ammunition storage area is 13.85 fatalities,[25] with a casualty (injured) rate of 47.08 per explosive event.[26]

If we attribute one accident per year (which is probably very high) to a well-managed depot we can calculate 1/(1930 x 0.4) = 0.13% which is sufficient to state that a poorly managed depot is (at least) over 16 times more likely to have an accident.

8.2.1.2. Example probability estimate model (qualitative) (LEVEL 1)

Table 5 illustrates a more qualitative means of estimating the probability of an explosive event:

Generic Description	Probability	Qualitative Definition
Likely	Frequent	▪ Expected to occur once or more times.
	Almost Certain	
	Very Probable	
	Probable	
Occasional	Possible	▪ Unlikely, but possible to occur.
Unlikely	Seldom	▪ It may be assumed that it will not occur.

[24] Small Arms Survey Unexpected Explosions at Munition Sites (UEMS) database. www.smallarmssurvey.org/weapons-and-markets/stockpiles/unplanned-explosions-at-munitions-sites.html

[25] 5,100 fatalities and 17,326 injuries during2,760 fatalities during 20024 –2017. Source Ibid.

[26] 22,426 combined (deaths and injuries) casualties averaging 61 casualties/incident during 2002 –2017, Source Ibid. The actual rate is likely to be higher.

Generic Description	Probability	Qualitative Definition
	Rare	
	Improbable	

Table 5: Qualitative estimation of explosive event probability

8.2.2. Physical effects estimation of an unplanned or undesirable explosive event (LEVEL 2)

The physical effects of an undesirable explosive event within an ammunition depot can be estimated by using the appropriate equation contained within IATG 01.80 *Formulae for ammunition management* (Clause 6.2). This can be used to determine the blast over-pressure and impulse at the distance from a potential explosion site to an exposed site from a known explosive mass.

Threshold blast over-pressures for effects on humans have been established by experimentation, (34,5kPa for onset of hearing damage, 207kPa for lung damage and 690kPa for fatality),[27] and therefore if the population density is known within the appropriate ranges an estimate of the total number of fatalities and casualties can then be derived. Alternatively, the *ESTC Outdoor Model* may be used. (Both in Clause 11.2 to IATG 01.80 *Formulae for ammunition management*).

Similarly, the effects of blast on buildings within and outside the perimeter of the ammunition depot can be estimated. (Clause 10 of IATG 01.80 *Formulae for ammunition management)*.

8.2.3. Individual risk estimation (LEVEL 2)

Risk is defined as '*likelihood x consequences*'. Where national data on accidents of all types is available the Individual Risk of Fatality ($IR_{fatality}$) (Table 6) as a result of an undesired explosion may be compared to the accepted 'tolerable risk' of other activities or industrial processes. From Clause 4, the annual IR is defined as:

$IR_{Fatality} \Rightarrow P_e \text{ x } P_{Fatality\|Event} \text{ x } E_p$	$IR_{Fatality}$ = Annual Individual Risk of Fatality P_e = Probability of hazardous event per Year $P_{Fatality\|Event}$ = Probability of Fatality[28] E_p = Probability of Exposure to Hazard

Table 6: Annual Individual Risk of Fatality ($IR_{Fatality}$)

As an example, if the estimated data from Clause 8.2.1 is used for an exposed site that is within the appropriate separation distance[29] for a fatal blast over-pressure at an exposed site (i.e. outside a civilian house) should there be an explosive event, then the IR at that house can be estimated as follows:

- P_e (Probability of hazardous event per Year) = 2.1×10^{-2}
- $P_{f\,l\,e}$ = Probability of Fatality = 0.99
- E_p = Probability of Exposure to Hazard = 0.0833 (Assuming an individual is outside their home for 2 hours)[30]
- $IR_{Fatality} = 2.1 \times 10^{-2} \times 0.99 \times 0.0833 = 1.73 \times 10^{-3}$ (0.18%)

[27] *Estimate of Mans Tolerance to the Direct Effects of Air Blast*. Bowen. October 1968.

[28] For a continually exposed person.

[29] See IATG 02.20 *Quantity and separation distances.*

[30] For individuals inside the house this method must be used in parallel with those at Clauses 10 and 11.3 of IATG 01.80 *Formulae for ammunition management.*

An alternative qualitative categorization of risk is contained within Table 7:

Description	Qualitative Definition
Catastrophic	▪ Undesirable event leading to multiple fatalities and/or serious injury to individuals and/or significant loss or damage to critical equipment or infrastructure.
Major	▪ Undesirable event leading to some fatalities and/or serious injury to individuals and/or significant loss or damage to critical equipment or infrastructure.
Minor	▪ Undesirable event leading to minor injuries to individuals and minimal impact on equipment or infrastructure.

Table 7: Qualitative categorization of risk

8.2.4. Qualitative risk index

A combination of the qualitative estimates at Tables 5 and 7 may then be used to develop a qualitative risk index as shown at Table 8:

THERE IS A RISK THAT:
Unexploded and/or abandoned ammunition, including stockpiles, if left unmanaged will pose an unacceptable hazard to people, the environment and infrastructure.

				LIKELIHOOD				
	PEOPLE NOT WORKING DIRECTLY WITH THE EXPLOSIVES AND AMMUNITION	ENVIRONMENT OUTSIDE THE IMMEDIATE EXPLOSIVE AREA	INFRASTRUCTURE OUTSIDE THE IMMEDIATE EXPLOSIVE AREA	A. VERY UNLIKELY Permanent, controlled storage and management in place at appropriately located, designed and secured site.	B. UNLIKELY Temporary storage facilities, remote from communities with basic controls and management in operation.	C. POSSIBLE Ammunition made safe where possible by destruction in-situ and where not possible safely transferred to demolition site or if salvaged moved to a suitably located field store.	D. LIKELY Ammunition is randomly distributed in easily accessible areas in the form of UXO, AXO and/or stockpiles. There are no adequate controls or management of the ammunition.	E. VERY LIKELY Ammunition is randomly distributed as UXO, AXO and/or stockpiles. It is damaged and/or degrading. There are inadequate controls in place.
CONSEQUENCE 1. NEGLIGABLE	Minor injury to one or a few people requiring minor medical attention	Minor isolated, low volume release or discharge with no further pollution controls required.	Insignificant marking of land or structures, no tangible damage.					
CONSEQUENCE 2. MODERATE	Individual casualty with injuries requiring local treatment and no long term disability	Pollution of land or water requiring local treatment with no long term impact.	Damage to isolated individual items of infrastructure repaired with local resources and with no long term impact.					
CONSEQUENCE 3. SIGNIFICANT	Casualty with serious injuries requiring hospitalization and long-term rehabilitation.	Pollution of land and/or water sources rendering land or water un-useable during a crop rotation.	Destruction of the local built environment resulting in a partially reduced public service / transport supply line.					
CONSEQUENCE 4. SEVERE	Multiple seriously injured and likelihood of some mortality	Pollution of land and/or water sources rendering land or water un-useable for more than a calendar year.	Destruction of the local built environment resulting in a reduced public service / transport supply line in immediate 3 month period after incident					
CONSEQUENCE 5. CATASTROPHIC	Mass casualty scenario with high levels of mortality and seriously injured overwhelming in-situ medical care capabilities	Pollution of land and water sources via chemical discharge, pollution of air via gaseous emissions and contamination of land and water via unexploded ordnance	Destruction of the local built environment, shelters, public buildings, medical facilities and transport systems.					

Risk	Minor	Moderate	Major	Severe

Table 8: Qualitative risk index

9 Risk and ALARP evaluation

The aim of risk evaluation is to compare the estimated effects, in terms of human fatalities and injuries, financial costs and political impact of an explosive event against what is tolerable in society. If the risk is assessed as tolerable then no remedial action should be required, although it should also be considered if that risk is As Low as Reasonably Practicable (ALARP).

A method of assessing the estimated $IR_{Fatality}$ against tolerable risk in a particular society may be to compare against other $IR_{Fataility}$ that may be available for events such as: 1) fatalities due to road traffic accident; 2) fatalities from industrial processes; or 3) fatality through disease[31] etc.

If the risk is not assessed as being tolerable, then appropriate remedial action should be taken in order to reduce the risk (see Clause 10).

10 Risk reduction and mitigation

In order to reduce the estimated risk from an unplanned or undesirable explosive event at an ammunition storage area, one or a combination of the following actions should be taken:

a) closure of the ammunition depot and the transfer of stocks to an ammunition depot with spare capacity, mitigation; (LEVEL 1) or

b) a reduction of ammunition stock levels within the explosive storage area until appropriate predicted blast over-pressure levels are reached at the exposed site, mitigation; (LEVEL 1)

c) the probable impact of the estimated risk to the local community is formally accepted at the appropriate political level, acceptance. (LEVEL 1)

d) an increase in the separation distance between the potential explosion site and the exposed site until tolerable blast over-pressure levels are reached at the exposed site, mitigation; (LEVEL 1)

e) improvements in the physical infrastructure of ammunition storage to achieve tolerable estimated blast over-pressure levels at the exposed site, mitigation; (LEVEL 2 and 3)[32]

f) instigation of effective ammunition surveillance and proof systems to identify ammunition and propellant that has deteriorated to a dangerous condition (see IATG 07.20 *Surveillance and proof*), reduction; (LEVEL 3)

11 Risk acceptance (LEVEL 1)

Risk acceptance criteria will result from three factors:

a) local perceptions of societal risk and hence the detailed specification of 'tolerable risk';

b) the potential economic cost and losses due to an undesired explosive event (which will include: 1) explosive ordnance disposal remediation costs; 2) reconstruction costs (for public and civilian buildings); 3) injury compensation costs; and 4) ammunition replacement costs). A supporting cost benefit analysis (CBA) may be required before the risk may be formally accepted as it could impact on tolerable risk and hence require a reiteration of the risk assessment process (see Clause 15); and

c) environmental impact.

Where tolerable risk has been achieved, and, if necessary, supported by CBA, then that risk and the residual risk should be formally accepted by the appropriate authority within a conventional ammunition stockpile management organisation. In terms of ammunition storage this should usually take the form of issuing Explosive Licences for the ammunition storage area (see IATG 02.30 *Licensing of explosive storage areas*).

[31] Information on this is available by country from the World Health Organization Information Statistics (WHOIS) database. www.who.int/whois.

[32] The degree of improvement will determine the appropriate Level achieved.

Where tolerable risk has not been achieved, and where resources are not being made available to achieve tolerable risk in the short term, then the residual risk should be formally accepted in writing by the entity responsible for the allocation of resources to the stockpile management organisation. Provided measures to achieve tolerable risk have been identified, then the residual risk is now an issue of resource allocation and not one of technical knowledge.

Should the resource allocation entity refuse to formally accept the risk in writing, then the issue should be referred to the next level of government for reconciliation of the issue. If this stage is reached it is then a political responsibility to free up the required resources, or the risk should be formally accepted in writing at that level of government. Formal acceptance of risk means taking individual and personal responsibility should there be future consequences; hence it is likely that the issue of risk acceptance may reach quite high levels of government and the political level. This assures accountability should there be an undesirable explosive event in the future, as politicians should have accepted the consequences of a decision not to allocate sufficient resources to achieve tolerable risk. This process should take place annually during the budget development process for the stockpile management organisation.

12 Risk communication (LEVEL 1)

Risk communication is an interactive process of exchange of information and opinion on risk among risk assessors, risk managers, and other stakeholders, which should include representatives from the local civilian community that may be impacted by the risk.

Risk communication is an integral and ongoing part of the risk management process, and ideally all stakeholder groups should be involved from the start. Risk communication makes stakeholders aware of the results of the risk assessment, the logic behind the risk analysis process and the remedial measures taken to ensure a level of tolerable risk.

The identification of particular interest groups and their representatives should comprise a part of an overall risk communication strategy. This identification should take into account gender differences in regards to access to information and movement patterns (e.g., areas predominantly occupied by women only, such as points of water or firewood collection, laundry, etc., of which men in the community may not be fully aware). Experience shows that in many cultures women are not welcome to express themselves in mixed public gatherings, so outreach to community women may take place through women-only consultations or women's community organizations. This risk communication strategy should be discussed and agreed upon between risk managers early in the process to ensure two-way communication. This strategy should also cover who should present information to the public, and the manner in which it should be done. Managers should plan for differences in access to means of communication, taking into account gender-differences in literacy, the presence of linguistic minorities, and culturally appropriate spokespersons for each group (e.g., a female presenter may be more accepted by women in the community). The risk communication strategy should aim to improve the perceptions of safety for the personnel within the ammunition depot and also the local community.

13 Techniques of risk estimation

The technique used to estimate risk should be easily explainable, even if the formulae used are complex. There is sometimes scepticism towards risk assessments, and it may therefore be worth the effort to develop explanations that are easily understood. This does not mean the selection of methods that are simple but inaccurate. It means that the time needed to develop clear understandable analysis and explanation is well worth the effort. If it cannot be explained and justified using accepted explosive engineering or science, it may not be accepted by consensus. If it does not command consensus it may not stand up in court.

13.1 Tests (LEVEL 3)

Where there is insufficient data readily available it may be desirable to conduct a physical test, at full or reduced scale, to gain specific data where the events have been rare or inadequately recorded. In terms of undesirable or unplanned explosive events in ammunition storage areas such tests are very expensive, rarely conducted and are usually conducted on a bi-lateral basis. Luckily, the results of previous tests[33] have been made available, and they form the basis of the recommended quantity and separation distances used in a range of international 'best practices'.[34]

13.2 Separation and quantity distances (LEVEL 1)

The use of Quantity Distances (QD) to develop appropriate separation distances between potential explosion sites (PES) and areas exposed to the effects of such an explosion (exposed sites (ES)) is standard practice for many conventional ammunition stockpile management organisations. IATG 02.20 *Quantity and separation distances* provides more detailed information on the application of this technique, and the appropriate distances to be used. The IATG Implementation Support Toolkit provides an Explosives Limits Licence[35] tool that uses the scaled distance formulae from IATG 01.80 to aid the explosives safety practitioner in applying QD.

The models used for the evaluation of quantity distance criteria provide results that err on the side of safety, as this provides confidence that the effects of an explosion are not underestimated. As the outcome of accidental explosions in explosive storage areas depends on many factors, not all of which are easily modelled accurately, there are limitations in the practicality of applying quantity distance criteria in all circumstances. Although the use of quantity distance criteria is a reasonably simple process, the appropriate protection level can only be formulated for broad categories of PES and ES. Building design, state of repair, topography etc. will vary in different scenarios and hence QD criteria only provide accurate estimations for the building types for which data is available.

It is not always possible to provide the separation distances called for by QD, in which case an Explosion Consequence Analysis (ECA) should be considered.

13.3 Explosion consequence analysis (LEVEL 2)

Explosion Consequence Analysis (ECA) can be defined as *a structured process, utilising explosives science and explosives engineering, to provide scientific evidence of the potential risk to individuals and property from blast effects and fragmentation in the event of an undesirable explosive event*.

The ECA can be a core component of the risk analysis process during the development of a Quantitative Risk Assessment. The initial component of an ECA should be compiled using the appropriate scientific formula(e) from IATG 01.80 *Formulae for ammunition management*. The IATG Implementation Support Tool provides an Explosion Consequence Analysis[36] tool that calculates the blast overpressure element for the analysis. Other tools, such as the Gurney equations for Fragment Velocity[37] and Explosion Danger Area Calculator[38] might also be used to support the analysis.

The objectives of an ECA should be to:

a) consider a realistic explosion threat scenario;

b) estimate the explosion effects on nearby personnel and structures; and

[33] Including full-scale tests in Australia over the last 40 years on behalf of a range of governments working together.

[34] NATO AASPT-1, UK MSER etc.

[35] www.un.org/disarmament/un-saferguard/explosives-limit-license/

[36] www.un.org/disarmament/un-saferguard/explosion-consequence-analysis/

[37] www.un.org/disarmament/un-saferguard/gurney/

[38] /www.un.org/disarmament/un-saferguard/explosion-danger-area/

c) highlight particularly vulnerable risk areas that may require special protection requirements.

An example of a simple ECA methodology that could be used is at Annex E. A fuller ECA should also consider the following additional external hazards and contributions to initiation frequency:

a) lightning strikes. Where lightning protection in accordance with IATG 05.40 *Safety standards for electrical installations* is not provided;

b) flooding. Where the explosives facility is within a known flood plain;

c) aircraft crash. Where the explosives facility is close to commercial air routes or if in an area of high use by light aircraft;

d) nearby hazardous installations. Where the explosive facility is close to, or co-located with, for example, petroleum depots or ammunition disposal sites;

e) malicious destruction. The threat from sabotage or terrorist attack; and/or

f) consequential initiation. Where the potential explosion sites (PES) are within inappropriate separation distances and an explosion in one causes the initiation of explosives in nearby PES.

The IATG software includes an 'automated' ECA which just requires the input of basic readily available data.[39] Details of the IATG software are at Annex F.

13.4 Explosive Safety Cases (LEVEL 2)

For the construction of temporary ammunition storage sites (see IATG 04.10) when full compliance with Outside Quantity Distances and Inside Quantity Distances is not possible, an Explosive Safety Case (ESC) shall be compiled. This is done to ensure that the explosive risk carried is as low as possible, does not jeopardise operational capability and that health and safety requirements, and duty of care responsibilities, are properly considered.

There will be instances, particularly in post conflict environments, where a multitude of stakeholders are involved in ammunition stockpile management advisory or operational functions for humanitarian purposes. It is highly desirable that in such circumstances all stakeholders should use a common format for explosive safety cases, which integrates requirements from across the IATG. Such a format is at Annex G.

Explosive Safety Cases shall only be accomplished by individuals whom are appropriately qualified and experienced in ammunition safety management.

14 Uncertainty in risk estimation

Uncertainties are inevitable in risk estimation when predicting the consequences of explosive events due to the range of variables involved. Assumptions during the process should always be clearly stated, as should data sources. It may also be possible to include error margins and confidence levels, although this will require access to a range of statistical data that may well be unavailable. It is possible that uncertainties in the probability of events (see the example at Clause 8.2.3) may be of a factor of two or three; in some cases, even a factor of 10. In mathematical terms, this would be undesirable during, for example, a financial budgeting process, but in risk estimation it may be acceptable.

[39] More complex systems have been designed by countries. These include AMMORISK (Norway and Switzerland), AUSRISK (Australia), NOHARM (USA), RISKWING (UK), SAFER (USA). States should consider trying to obtain these systems on a bi-lateral support basis.

To explain, many nations accept that an $IR_{fatality}$ to workers from an industrial process should be in the region of 1×10^{-5} to 1×10^{-6}, and therefore if an $IR_{fatality}$ was estimated for an undesirable explosive event to be 1×10^{-3} then this would clearly not be tolerable risk, as it is two to three orders of magnitude away from the societal risk levels acceptable in those particular nations.

Risk estimation is a powerful tool in ensuring the safety of conventional ammunition stockpiles, but it should be used judiciously and by individuals who understand the hazards and have the technical experience to evaluate when it produces unlikely results. It is not a precise technique and the results will only be approximate, but in the field of explosive engineering, it is a proven technique that has significantly improved explosive safety when it has been applied.

15 Cost benefit analysis (LEVEL 2)

15.1 Expected monetary values (LEVEL 2)

One technique of cost benefit analysis that can be used to estimate the costs of remediation measures versus the financial costs of an undesired explosive event within an ammunition storage area is that of Expected Monetary Value (EMV).[40] This is a technique that is extensively used by actuaries in the insurance sector.

Table 9 illustrates the indicative financial costs of remediation following an undesired explosion within an ammunition depot. It considers three scenarios:

a) a minor fire resulting in: 1) damage to ammunition stocks; and 2) limited infrastructure damage;

b) a major fire leading to minor explosions resulting in: 1) destruction of ammunition stocks; 2) destruction of the explosive storehouse; 3) limited damage elsewhere in the depot; 4) limited UXO contamination within the ammunition depot; 5) minor injuries to the civilian population; and 6) minor damage to civilian property outside the ammunition depot; and

c) a major fire leading to major explosions resulting in: 1) destruction of the explosive storehouse; 2) destruction of surrounding explosive storehouses; 3) destruction of a significant proportion of the ammunition stocks within the ammunition depot; 4) significant UXO contamination outside the perimeter of the explosives area; 5) fatalities and injuries to the civilian population; and 6) destruction and damage to civilian property outside the ammunition depot.

Due to the wide variance in economic costs in different regions of the world, it is not possible to allocate finite financial costs, but it is possible to indicate the order of magnitude of the costs, shown in Table 9 as 'x'.

Financial Cost Area	Costs of Event ($x)		
	Minor Fire (No Explosion)	**Major Fire** (Minor Explosion)	**Major Fire** (Mass Explosion)[41]
EOD Clearance Costs	x	xx	xxxxx
Repair Costs (Ammunition Depot)	xx	xxxx	xxxxx
Repair Costs (Civilian Buildings)		x	xxxx
Reconstruction Costs (Ammunition Depot)	xx	xxxx	xxxxx
Reconstruction Costs (Civilian Buildings)			xxx
Injury Compensation Costs		x	xxxx
Replacement Ammunition Costs	xxx	xxxx	xxxxx
Staff Training Costs (New Staff)		xx	xxxx

[40] Concept source for the use of EMV. Keeley R. *The Economics of Landmine Clearance*. www.dissertation.de. 2006.

[41] Assuming propagation from one explosive storehouse to the next.

Financial Cost Area	Costs of Event ($x)		
	Minor Fire (No Explosion)	**Major Fire** (Minor Explosion)	**Major Fire** (Mass Explosion)[41]
Total Costs	**8 x**	**18 x**	**35 x**

Table 9: Indicative EMV orders of magnitude for explosive events

Table 10 illustrates the indicative financial costs of possible risk reduction measures that should be adopted to reduce the probability of an undesired explosion within an ammunition depot.

Due to the wide variance in economic costs in different regions of the world, it is again not possible to allocate finite financial costs, but it is possible to indicate the order of magnitude of the costs, shown in Table 10 as 'y'.

Financial Cost Area	Risk Reduction Costs against Event ($y)		
	Minor Fire (No Explosion)	**Major Fire** (Minor Explosion)	**Major Fire** (Mass Explosion)[42]
Robust Explosive Storehouse (ESH) Buildings[43]		**yyy**	**yyyyy**
Barricades[44]		**yy**	**yy**
ESH and Barricades Annual Maintenance	**y**	**y**	**y**
Effective Fire Fighting Equipment	**y**	**yy**	**yy**
Vegetation Clearance Costs	**y**	**y**	**y**
Effective Staff Training	**y**	**yy**	**yyy**
Effective Ammunition Depot Procedures	**y**	**y**	**y**
Effective Contraband Measures	**y**	**y**	**y**
Total Costs	**6 y**	**13 y**	**16 y**

Table 10: Indicative EMV orders of magnitude for risk reduction costs

EMV uses a payoff matrix to estimate the annual financial costs of either taking remedial action or not taking remedial action. The EMV is calculated thus:

$$\textbf{\textit{EMV (\$) = (Remedial Costs Taken or Not Taken x } P_{Event}\textbf{) + (Remedial Costs Taken or Not Taken x } P_{Non\text{-}Event}\textbf{)}}$$

An example of the use of EMV indicative figures for a real ammunition depot, where an explosion took place due to fire, is explained at Annex H; this covers the Major Fire / Mass Explosion scenario shown in Tables 9 and 10.

[42] Assuming propagation from one explosive storehouse to the next.
[43] Initial procurement and construction costs.
[44] Initial procurement and construction costs.

Annex A
(normative)
References

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

d) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA. 2020;

e) IATG 01.80 *Formulae for ammunition management*. UNODA. 2020;

f) IATG 02.20 *Quantity and separation distances*. UNODA. 2020;

g) ISO Guide 51 *Safety aspects – Guidelines for their inclusion in standards*. ISO. 2014; and

h) *Selection and use of explosion effects and consequence models for explosives.* (ISBN 07176 1791 2). Health and Safety Executive. UK. 2000. http://books.hse.gov.uk

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[45] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[45] Where copyright permits.

Annex B
(informative)
Bibliography

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

i) *Explosion Hazards and Evaluation*. W E Baker et al. (ISBN 0 444 42094 0). Elsevier. Amsterdam. 1983;

j) IATG 02.30 *Licensing of explosive storage areas*. UNODA. 2021

k) AASTP-3, Edition 1, Change 3, *Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives*. NATO Standardization Organization (NSO). March 1995. (Note: restricted distribution)

l) AASTP-4 Edition1, Change 4, *Explosives Safety Risk Analysis*. NATO Standardization Organization (NSO). September 2016. (Note: Part 2 has restricted distribution);

m) AASTP-5, Edition 1, Version 3, *NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations*. NATO Standardization Organization (NSO). June2016;

n) Technical Paper 14. *Approved Methods and Algorithms for DoD Risk-Based Explosives Siting*. Revision 4. US Department of Defense Explosives Safety Board (DDESB), Alexandria, Virginia, USA. 17 March 2017;

o) Technical Paper 23. *Assessing Explosives Safety Risks, Deviations, and Consequences*. US Department of Defense Explosives Safety Board (DDESB), Alexandria, Virginia, USA. 31 July 2009.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[46] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[46] Where copyright permits.

Annex C
(informative)
General effects of explosions

C.1 General

An explosion is a sudden release of energy caused by a very rapid chemical reaction that turns a solid or liquid into heat and gas. This reaction takes place in less than a millisecond. In the process of turning a solid or liquid into a gas expansion occurs, so in the case of an explosion the expanding gas is produced extremely rapidly and pushes the surrounding air out in front of it, thus creating a pressure wave, known as the Blast Wave.

When an explosion occurs at ground level there are several effects created that cause damage and injury. The extent of these effects will be generally dependent on the power, quality and the quantity of explosive deployed.

The seven basic effects are:

a) thermal radiation;

b) brisance or shattering;

c) primary fragments;

d) blast wave;

e) ground shock;

f) debris (secondary fragments); and

g) confinement effects.

Each of these effects are summarised in the following sections.

C.2 Thermal effects

The thermal effects can be considered to be a 'ball of fire' created as part of the explosive process. It is very local to the seat of the explosion and is very short lived (a few milliseconds).

The thermal effects are particularly hazardous to those very close to the blast (i.e. taking shelter in a hardened structure) as the heat is able to penetrate small openings in a structure. For those in the open the blast wave and fragment effects have a greater range for inflicting damage.

C.3 Brisance

Brisance is the shattering effect, and it is very local to the seat of the explosion and is generally associated with high explosives. The effect of brisance can be severe when an explosive device is placed directly in contact with a structural component. A small air gap between the explosive and the target is effective at mitigating the onset of brisance-induced failures.

C.4 Primary Fragments

These are the fragments of the device or container of the device, which have been shattered by the brisance effect and are propelled at high velocity over great distances. Primary fragments can travel ahead of the blast wave and have the potential to cause injuries at a greater range than the blast wave.

C.5 Blast Wave

The blast wave is a very fast moving high-pressure wave created by the rapidly expanding gas of the explosion, which gradually diminishes with distance. The blast wave is capable of reflecting off surfaces and in the process can magnify itself. This is typically displayed when large devices are detonated in urban environments and the blast is 'funnelled' down narrow streets.

The blast wave has the potential to cause fatalities and serious injuries including lung and organ damage, rupture of the eardrums and the like. It can also cause injury due to whole body translation (or throwing) of individuals.

C.6 Ground Shock

Ground shock is produced by the brisance effect of the explosion shattering the ground local to the seat of the explosion, i.e., creating the crater of the explosion. The shock wave resulting from the crater's creation continues through the ground and is known as ground shock.

The ground shock has the potential to cause damage to underground services (e.g. water, electricity etc) as well as structures below ground. It is not uncommon for floods to occur after a vehicle bomb attack, caused by the rupture of water mains.

C.7 Debris

These are the secondary fragments that have been created by the blast wave imparting pressure onto frangible materials that are unable to withstand this pressure or loose articles. The energy imparted to the fragments created by the blast can be such as to throw them large distances at great speed. Typical frangible materials that form debris are glass, roof slates, timber, metal frames and the like.

Due to the human body's moderate resistance to the effects of the 'blast wave', debris is likely to cause injury at greater distance than the blast wave. Debris can cause fatalities and serious injury.

C.8 Confinement Effects

The detonation of an explosive within a building is more severe than in an open environment. This is because the blast wave is able to undergo multiple reflections (off walls, floors etc.), which leads to an increase in the amplitude and duration of the blast pressure. This increases the severity of damage to both structural elements as well as humans.

For internal explosions within robust rooms, it is possible for even more severe confinement effects to occur. This is a result of the confinement of the extremely hot gases that are produced by detonation. By suppressing the expansion of the gases, very high pressures/forces are applied to the room enclosure. The smaller the room the higher the resulting pressure.

Annex D
(informative)
Example Quantative Risk Assessment methodology (LEVEL 1 and 2)

SECTION A - GENERAL RISK ASSESSMENT SUMMARY SHEET[47]

Complete this sheet once Sections B to D have been used to conduct the Risk Assessment. This sheet then acts as a front page summary and review record.

ASSESSMENT NO:	IATG Example 1	**TASK LOCATION:**	APB 1	**DATE:**	25 August 2019
TASK DESCRIPTION:	Removal of Fuze from 152mm Artillery Shells by remote hydraulic fuze removal tool.				

#[48]	RESIDUAL RISKS IDENTIFIED	ACTION REQUIRED TO RECTIFY (ADDITIONAL TO CURRENT CONTROL MEASURES)
1	Failure of hydraulic pressure system for the remote fuze removal system, resulting in broken hoses.	▪ **Guards for hydraulic pipes.**
2	Static electricity present on individuals working in the APB initiating Electro-Explosive Devices r bare explosive dust.	▪ **Invoke control measures as for risk #5.**
3	Injury due to lifting of packs of 152mm artillery shells, and of individual shells from their packaging.	▪ **Consider installation of mechanical lifting devices.**
8**	Accidental initiation of shell when fuzes removed due to crystallization of TNT explosive filling in screw thread.	▪ **Actions as shown for #6 and #7.**

SECTION B - GENERAL RISK ASSESSMENT SUMMARY SHEET

Use this section to identify Hazards and Sub-hazards. Detail the hazards identified here in Section C of the assessment.

[47] The risk assessment has been completed for a 4 person team removing the fuzes from artillery shells in an ammunition process building.
[48] From Section C.

HAZARDS	MECHANICAL		ELECTRICAL		ACCESS AND ENVIRONMENT		HANDLING LIFTING AND TRANSPORT		EXPLOSIVES AND DANGEROUS SUBSTANCES		NOISE AND BLAST		RADIATION AND ENVIRONMENT	
SUB HAZARDS	Abrasion		Static	2	Slips, Trips etc.		Manual Handling	3	Primary		Launch		RF	
	Cutting		Piezo-Electric		Falling Objects etc.		Mechanical Equipment		Secondary	5	Impact		Radar	
	Shearing		Spark Ignition		Height		Lifting Tackle		Propellants		Static Initiation		Ionising	
	Stabbing		Connections		Trenching		Heavy Objects		Pyrotechnics		Blast Wave	6	Non-Ionising	
	Impact				Confined Space		Transport Explosives	4	WP		Fragmentation	7	Laser Cl 1	
	Crushing				Exposed Areas		Transport Dangerous Goods		Chemical		Shock Transfer		Laser Cl 2	
	Pressure System	1			Noise				Lachrymatory				Laser Cl 3A	
	Machine Tools				Vibration				Toxic				Laser Cl 3B	
	Cavitation				Humidity				Corrosive				Laser Cl4	
	Grit				Temperature				Irritant					
					Weather				Paints and Solvents					
									Dusts					
									Fumes					

Now use Section C to expand on the Hazards identified, evaluate existing protective measures and "Rate" the Risk.

GENERAL RISK ASSESSMENT SUMMARY SHEET - SECTION C

Use this Section to record the hazards identified in Section B in more detail and evaluate current control measures, if any. Then using Section D as a guide, assess the risk and give it a rating.

Record the ratings in this Section and identify the Residual Risks.

ASSESSMENT NO:	IATG Example 1	**TASK LOCATION:**	APB 1	**DATE:**	25 August 2019
TASK DESCRIPTION:	Removal of Fuze from 152mm Artillery Shells by remote hydraulic fuze removal tool.				

#[49]	FURTHER DETAILS OF HAZARD FROM SECTION B	CURRENT CONTROL MEASURES	RISK RATE	RESIDUAL RISK
1	Failure of hydraulic pressure system for the remote fuze removal system, resulting in broken hoses.	▪ Effective initial and refresher staff training. ▪ Supervision by ammunition qualified staff. ▪ Regular maintenance of hydraulic systems.	**120**	▪Very High ▪Action immediately
2	Static electricity present on individuals working in the APB initiating Electro-Explosive Devices r bare explosive dust.	▪ Ensure use of static discharge system on access to APB. ▪ Use of static discharge leads on staff wrists.	**45**	▪High ▪Action as soon as possible
3	Injury due to lifting of packs of 152mm artillery shells, and of individual shells from their packaging.	▪ Ensure staff trained in manual lifting techniques.	**60**	▪High ▪Action as soon as possible
4	Explosion during movement of explosives from explosive storehouses (ESH) to ammunition process building.	▪ In accordance with IATG 08.10	**0.3**	▪Acceptable ▪Accept risk and keep under review
5	Exposure of bare explosive to atmosphere when fuze removed.	▪ Category C operating conditions in place. ▪ Shells are immediately plugged after fuze removal.	**0**	▪Acceptable ▪Accept risk and keep under review

[49] From Section B.

#[49]	FURTHER DETAILS OF HAZARD FROM SECTION B	CURRENT CONTROL MEASURES	RISK RATE	RESIDUAL RISK
6	Accidental initiation of shell when fuze removed due to crystallization of TNT explosive filling in screw thread.	▪ Use of remote hydraulic fuze removal system. ▪ Screw thread of shells wiped with acetone to ensure no explosive can be trapped when plugs fitted. ▪ Man limit of 4 staff imposed within APB. Work ceases if these limits are reached.	**0**	▪Acceptable ▪Accept risk and keep under review
7	Fragmentation from shell body in the event of 6 above.	▪ Use of remote hydraulic fuze removal system. ▪ Remote fuze removal system behind armoured screens. ▪ Man limit of 4 staff imposed within APB. Work ceases if these limits are reached.	**0**	▪Acceptable ▪Accept risk and keep under review
8**[50]	Accidental initiation of shell when fuze removed due to crystallization of TNT explosive filling in screw thread.	▪ NIL	150	▪Very High ▪Action immediately

Now complete the Risk Assessment Summary Sheet, Section A, transferring the Residual Risks and identifying appropriate corrective action.

[50] This has been included to show the difference in risk if NO control measures are taken.

GENERAL RISK ASSESSMENT - RISK RATING TABLES - SECTION D

Use this section to identify Hazards and Sub-hazards. Detail the hazards identified here in Section C of the assessment

Use this Section to assess Risks and calculate a Rating for each Risk. The ratings should then be annotated as applicable in Section C.

ASSESSMENT NO:	IATG Example 1	**TASK LOCATION:**	APB 1	**DATE:**	25 August 2019
TASK DESCRIPTION:	Removal of Fuze from 152mm Artillery Shells by remote hydraulic fuze removal tool.				

HAZARD # FROM SECTION C	PROBABILITY OF EXPOSURE 'E'	FREQUENCY OF EXPOSURE 'F'	MAXIMUM LOSS 'L'	PERSONS AT RISK 'N'	RISK RATING E x F x L x N	SCORING TABLES							
						'E'		'F'		'L'		'N'	
1	15	4	2	1	**120**	**Impossible**	0.0	**Infrequent**	0.1	**Fatality**	15.0	**1 - 2 Persons**	1
2	15	2.5	0	1	**45**	**Almost Impossible**	0.1	**Annually**	0.2	**Permanent Serious Injury**	8.0	**3 - 7 Persons**	2
3	15	4	1	1	**60**			**Monthly**	1.0			**8 - 15 Persons**	4
4	2	0.1	15	1	**0.3**	**Highly Unlikely**	0.5	**Weekly**	1.5	**Temporary Serious Injury**	4.0	**16 - 50 Persons**	8
5	15	4	0	1	**0**			**Daily**	2.5			**> 50 Persons**	12
6	2	0.1	0	1	**0**	**Unlikely**	1.0	**Hourly**	4.0	**Break major bone or major illness**	2.0		
7	2	0.1	0	1	**0**	**Possible**	2.0	**Constantly**	5.0				
8**	2	5	15	1	**150**	**Even Chance**	5.0						
						Probable	8.0			**Lacerations or mild ill health**	1.0		
						Very Likely	10.0						
						Certain	15.0			**Scratch or Bruising**	0.5		

RISK RATING	RISK	ACTION TIMETABLE	RISK RATING	RISK	ACTION TIMETABLE
0 - 0.9	Acceptable	Accept Risk, but keep under review	50 - 100	High	Action as soon as possible
1.0 - 4.9	Very Low	Consider action and set timetable for completion	100 - 200	Very High	Action immediately
5.0 - 9.9	Low	Consider action and set timetable for completion	200 - 300	Extreme	Consider stopping activity - Action immediately
10.0 - 49.9	Significant	Consider action and remedy as soon as possible	300 +	Unacceptable	Stop activity

Take into account existing Control Measures when assessing these values.

Now complete the Summary Sheet at Section C, Section A and ensure the assessment is signed by the appropriate persons.

Annex E
(informative)
Explosion Consequence Analysis methodology (LEVEL 2)

The ECA methodology at Table E.1 below is only one concept and example of how an ECA may be conducted. It is modelled on a single explosive storehouse (ESH), and only considers the consequence to the local civilian population; a more detailed model should also examine the potential loss of operational capability. An ECA for a complete ammunition depot will be a lot more complex, but the same principles used in Table E.1 should apply.

The phases of the ECA are explained using the risk management terminology relationships from Table E.1. Therefore, an ECA is primarily a risk assessment process, as it provides the technical and scientific analysis and evaluation to allow for risk-based decisions to be then made. It is not the role of an ECA to make decisions, although it may contain recommendations.

An ECA should not be required if the requirements of IATG 02.20 *Quantity and separation distances* can be met.

Risk Assessment Process Component	Ser	ECA Activity	Data Source
Risk Analysis (Hazard Identification and Analysis)	1	Determine UN Hazard Division of Ammunition.	▪ IATG 01.50 *UN Explosive Hazard Classification System and Codes*
	2	Determine Net Explosive Quantity (NEQ) of ammunition by Hazard Division in ESH or Temporary Storage Area.	▪
	3	Aggregate to HD 1.1 if applicable.	▪
	4	Determine level of protection of ESH or Temporary Storage Site.	▪ IATG 02.20 *Quantity and separation distances.* (Type of ESH). ▪ IATG 04.20 T*emporary storage.*
	5	Determine Range (m) to nearest public road.	▪ Google Earth. ▪ Site Plans or maps. ▪ Laser range finder. ▪ Tape measure. ▪ Pacing.
	6	Determine Range (m) to nearest inhabited building (civilian house).	
	7	Determine Range (m) to nearest vulnerable building (hospital).	
	8	Determine Range (m) to any Secondary Hazards.	
	9	Determine condition of ammunition and likelihood for spontaneous ignition of propellant.	▪ Historical. ▪ Surveillance results.
Risk Analysis (Risk Estimation)	10	Determine physical effects (reflected overpressure and reflected impulse) at each range to Serials 5 - 8.	▪ IATG 01.80, Clause 6.2. (using IATG Software[51]).
	11	Estimate ranges for thresholds of impact on humans (from *Bowen*).	▪ IATG 01.80, Clause 11.2
	12	Determine number of humans likely to be in open within ranges at Serial 11. **(Human casualties in the open now estimated for blast effects).**	▪
	13	For the NEQ at Serial 2 determine the ranges at which various levels of damage to buildings may be expected.	▪ IATG 01.80, Clause 10.1
	14	Determine the number of buildings within each damage criteria range estimated at Serial 13. **(Damage to buildings from blast now estimated)**	▪
	15	For the NEQ at Serial 2 estimate the range at which Ground Shock is likely to cause damage.	▪ IATG 01.80, Clause 10.3

[51] www.un.org/disarmament/un-saferguard/kingery-bulmash/

Risk Assessment Process Component	Ser	ECA Activity	Data Source
	16	Determine the number of buildings within Ground Shock range. Check that they are not also damaged by blast, to avoid 'double counting'. **(Damage to buildings from Ground Shock now estimated)**	▪
	17	Apply the probability values for secondary blast injury to the Serial 14 results. **(Probability of secondary blast injuries for each building now established.)**	▪ IATG 01.80, Clause 11.3, Table 36
	18	Estimate occupancy levels and exposure probabilities for houses at Serial 16. Then estimate casualty numbers. **(Human casualties in the open now estimated for blast effects).**	▪
	19	Estimate financial values of stocks, costs to rebuild/repair storage infrastructure, repair/rebuild civilian damaged building.	▪
	20	Use Serial 19 data in EMV model to estimate likely financial consequences of an explosive event.	▪ Clause 15.1
Risk and ALARP Evaluation	21	Compare estimated predicted casualties at Serials 12 and 18 to other industrial accident levels. Are the predicted casualties tolerable?	▪
	22	Are the financial consequences at Serial 20 acceptable to the government? If no, then is the MOD prepared to accept lower stock levels. If yes to both, then risk tolerable. If no to both or one, then risk not tolerable.	▪

Annex F
(informative)
Risk management and IATG software (LEVEL 1 and 2)

See IATG Implementation Support Tool Kit:www.un.org/disarmament/ammunition .

The IATG Implementation Support Toolkit includes a Risk Reduction Checklist[52] tool that gives the user a determination of the Risk Reduction Process Level (RRPL) for a stockpile at a single site. If this tool is used to determine a baseline, it can then be used subsequently to determine how the level of risk being accepted by the authorities is being reduced as the storage facility develops over time.

[52] www.un.org/disarmament/un-saferguard/risk-reduction-process-levels

Annex G
(informative)
Explosive Safety Case (ESC) Format (LEVEL 2)

1. Introduction

Include an explanation of the explosive storage area and summarise why full IATG compliance is not possible. This should include location, infrastructure type, total numbers of persons at the site or in the immediate area of the site.

2. Explosion Consequence Analysis (ECA)

Include the ECA in accordance with Annex E to IATG 02.10.

3. Summary of Non-Compliances

List all non-compliance issues referenced against the appropriate IATG and Clause. For example:

The maximum Outside Quantity Distance (OQD) that may be achieved is only 220m. This is 120m less than the recommended OQD as at IATG 04.10, Clause 8.5.2, Table 11.

4. Summary of Hazard Mitigation Measures

List all hazard mitigation measures applied in order to reduce risk. These should be referenced against each non-compliance area.

5. Residual Risks

List the residual risk for each non-compliance issue. For example:

The required storage levels of 35,000kg of HD1.1 means that in the event of an undesired explosive the reflected blast over-pressure at 220m will be 41.8kPa. This is in excess of the 34.5kPa level at which permanent hearing damage is to be expected (249m). There are routinely 40 persons working within the 220m to 249m zone who would be inversely affected by suffering permanent hearing damage.

6. Probability of Event

The ESC compiler should try to determine the probability (likelihood) of an event at the site. This may be based on past historical data within the country and the security environment at the time the ESC is complied. Alternatively, estimate can be made on past global explosive events at ammunition storage areas, (data in IATG 02.10, Clause 8.2.1.1).

7. Acceptance of Risk

(IATG 02.10, Clause 11, IATG 04.10, Clause 5,2)

The ESC and the residual risk identified shall be formally acknowledged by the risk owner. Include here the full details of the risk owner.

The wording of the 'risk acceptance letter' is extremely important and a draft should be provided by the compiler of the ESC as an Annex to the ESC. Due to the large number of possible scenarios and variables, it is not possible to provide an example draft of such a letter.

Name of ESC Compiler:		**Signature of ESC Compiler:**	
Qualifications of ESC Compiler:		**Date of ESC:**	
Organization of ECA Compiler:			
Contact Details of ECA Compiler:			

Annexes

A. Safety Map (indicating areas of risk).
B. Site Plan.
C. Draft Explosive Limits Licence (from IATG 02.30).
D. Draft Acceptance of Risk Letter.

Annex H
(informative)
Expected Monetary Value Estimation (LEVEL 2)

An example of the use of EMV indicative figures for a real ammunition depot, where an explosion took place due to fire, is explained below; this covers the Major Fire / Mass Explosion scenario shown in Tables 5 and 6. This event, that took place in April 2000, resulted in 2 fatalities, 10 injured and the loss of US$ 90m of ammunition stock.

Input data for the EMV analysis is assumed as follows which will provide indicative costs.

a) The probability of an explosive event P_e (Events per Year) at the ammunition depot was 2.78 x 10^{-2} (Clause 8.2.1). This is because of inadequate ammunition stockpile management;

b) The probability of that explosive event being caused by fire = 0.455; [53]

c) The probability of an explosive event P_e (Events per Year) at the ammunition depot, had effective stockpile management processes being in place, is assumed to be two orders of magnitude less, i.e. 2.78 x 10^{-4};

d) The probability of that explosive event being caused by fire remains at 0.455, as there is no available evidence to suggest that the causes of such events will change this probability;

e) The financial costs in Year 1 to reduce the probability of the event taking place have been estimated at US$ 200,000. This reduces to US$ 50,000 for Year 2 onwards. (This figure obviously needs to be estimated for each case.);

f) The annual financial cost of operating the depot with no actions taken to reduce the probability of an event was US$ 5,000;

g) The declared loss of ammunition stocks, which will require replacement, equates to US$ 90m if remedial action is not taken;

h) The predicted loss of ammunition stocks, which would have required replacement, equates to US$1M had remedial action being taken prior to the event. (As the remedial action protected other stocks in the depot.);

i) The compensation cost in Year 1 for each fatality that occurred is assumed to be US$ 10,000. (This is low, but this is due to the explosion taking place in a lesser developed country.);

j) The compensation cost in Year 1for each injury that occurred is assumed to be US$ 5,000;

k) There are no compensation costs for Year 2 as it assumed that the remedial action is effective, even if there should be an explosive event.

In this example, as remedial action would require a ‘one off’ financial cost of infrastructure improvement to the ammunition depot and technical staff training, two calculations are required: Year 1 and Year 2. These are shown in Tables G.1 and G.2.

[53] From data contained within Explosive Capabilities Limited, *The Threat from Explosive Events in Ammunition Storage Areas.* Annex B. 01 April 2009. This includes fires started due to propellant instability, as well as external and internal fires.

Remedial Actions	Financial Costs (US$)		EMV (US$)
	Incident Scenario Doesn't Occur	**Incident Scenario Does Occur**	
Taken (Storage depot improved and operated in accordance with IATG recommendations) (Stock loss minimised to $ 100,000)	**$ 200,000**	**$ 300,000**	**$ 201,265**
Not Taken Stock loss of $90M and $ 100K compensation costs)	**$ 5,000**	**$ 90,080,000**	**$ 1,144,359**
		EMV Differential	**$ 943,094**

Table G.1: Indicative EMV values (US$) based on the April 2002 explosive event (Year 1)

So, for Year 1 of this incident scenario, there would be a US$ 943,094 EMV benefit if US$ 200,000 was spent on remedial action to reduce the probability of an explosive event caused by fire within the ammunition depot. As the EMV of not taking any action is US$ 1,144,359, then financial investment in training and infrastructure necessary to comply with the IATG guidelines during Year 1 could be justified up to a cash level of US$ 1,155,175[54] solely on the EMV financial benefit.

Assuming that the infrastructure and training remedial actions were taken in Year 1, then the operating costs of the ammunition depot fall significantly for Year 2 onwards, until major maintenance or refurbishment work is required (usually after 20 years). In Table G.2 the probability of an event is two orders of magnitude less than for Table 1, but the stock loss levels remain the same should an event take place.

Remedial Actions	Financial Costs (US$)		EMV (US$)
	Incident Scenario Doesn't Occur	**Incident Scenario Does Occur**	
Taken (Storage depot improved and operated in accordance with IATG recommendations) (Stock loss minimised to $100,000)	**$ 50,000**	**$ 1,000,000**	**$ 50,120**
Not Taken (In Years 1 and 2) Stock loss of $90M and $100K compensation costs)	**$ 5,000**	**$ 90,080,000**	**$ 1,144,359**[55]
		EMV Differential	**$ 1,094,239**

Table G.2: Indicative EMV values (US$) per year based on the April 2002 explosive event (Years 2 - 20)

So, for Years 2 to 20 of this incident scenario, there would be a US$ 1,094,239 EMV benefit per year if US$ 50,000 was spent on continued remedial action to reduce the probability of an explosive event caused by fire within the ammunition depot. As the EMV of not taking any action in Years 1 and 2 is still US$ 1,144,359, then theoretically financial investment in training and infrastructure necessary to comply with the IATG guidelines during Years 2 to 20 could be justified up to a cash level of US$ 1,144,378 solely on the EMV financial benefit.

[54] This figure is achieved by using the spreadsheet contained within the IATG Software. The data entry for the Financial Costs (Incident Scenario Doesn't Occur / Remedial Action taken) is adjusted until the EMV's of Action Taken and Action Not Taken balance.

[55] The probability for this EMV remains at 1.11 x 10^{-2} as no remedial action taken in Years 1 and 2.

This example illustrates the usefulness of the EMV system when comparing the financial requirements necessary to be compliant with the IATG Guidelines against the real financial costs of an explosive event within an ammunition depot. EMV analysis should be done for each generic type of scenario that is likely to result in an explosive event, compared against the financial costs of remedial action necessary to reduce the probability and consequences of such an event to tolerable risk levels (for financial, reduced defence capability, human and political costs).

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 02.20

Third edition
March 2021

Quantity and separation distances

IATG 02.20:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition storage area detonations count among the largest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organised crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalised in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for a 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum of every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organisations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The storage and handling of ammunition and explosives within an ammunition storage area are operations that present inherent risks to persons and property. A national authority shall therefore have a legal responsibility to ensure, during any operation involving storage and/or handling of ammunition and explosives, that the risks associated with those operations are both tolerable and as low as reasonably practicable (ALARP) .

One of the most efficient means of protecting the public from the effects of an explosive event is by the use of separation distances, which ensure that they are always at a tolerably safe distance from the explosives during storage and handling. A point to remember is the greater the separation distance, the greater the protection afforded.

An assessment of the effects of an undesirable explosives event (e.g. blast, thermal fireball, and fragment and structural debris) radii), and predictions as to which specified levels of risk (in terms of injury or damage) has allowed the development of 'best practice' separation distances. Tables of Net Explosive Quantity (NEQ) and associated minimum, recommended distances have been developed by regional organisations. These tables, (which contain appropriate separation distances), are known as Quantity Distance (QD) Tables and, together with other criteria for their use, should form the foundation for the safe storage and licensing[3] of Potential Explosion Sites (PES) as well as for the placement of any Exposed Sites (ES) in a location where they are not hazarded by explosion effects that could emanate from an explosion at any PES. These QD Tables are based on trials and other data, but are susceptible to uncertainty owing to the variability of the nature of explosions and the incompleteness of trials data.[4] QD should therefore be subject to continuing refinement, as further data becomes available. Such information should be shared internationally.

As an additional precaution, users of the recommended QD contained within this IATG need to understand that the use of QD is by necessity a compromise between 'an acceptable level of risk' and 'absolute protection', as it is generally impractical to procure/restrict all the land around explosives locations such that all risk and explosion effects are eliminated. Glass breakage, some structural damage, and fragment impacts, in some cases capable of injury and possibly death, may be expected to occur outside these 'safe' separation distances. Where available, greater separation than those called for by the minimum QD should be applied whenever possible/practicable.

There is an online IATG Implementation Support Toolkit available on the UN SaferGuard website and among the tools is an Explosives Limits Licence creation tool[5].

[3] See IATG 02.30:2020[E] *Licensing of explosive facilities.*

[4] Even though extensive trials have taken place in support of their development.

[5] www.un.org/disarmament/un-saferguard/explosives-limit-license

Quantity and separation distances

1 Scope

This IATG module introduces and explains the concept and development of quantity and separation distances. It also makes recommendations on the appropriate distances to be used to support the safe, effective and efficient storage and handling of conventional ammunition, and provides an acceptable level of protection to surrounding personnel and ES.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40:2020(E) *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'barricade' refers to *a natural ground feature, artificial mound, barricade or wall which, for storage purposes, is capable of preventing direct communication of explosion from one quantity of **explosives** to another although it may be destroyed in the process*.

A barricade *is capable of intercepting high velocity low angle projections from a potential explosion site and preventing initiation of explosives stocks stored nearby. The term 'traverse' is now been phased out and the alternate 'barricade' is now more frequently used. A barricade might be located at a PES or at an ES. If located at the PES, it may be destroyed by an explosion at that PES, but not until it has achieved its aim.*

The terms 'ammunition storage area', 'explosives area' or 'explosive facility refer to *an area used for the handling, processing and storing of ammunition and explosives. Where there is no fence, it is taken as being the area within a radius of 50m from any building or stack containing ammunition and explosives*.

The term 'exposed site' (ES) refers to *a magazine, cell, stack, truck or trailer loaded with ammunition, ammunition process building (APB), inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the potential explosion site (PES) under consideration*.

The term 'heavy walled building' refers to *a building of non-combustible construction used for explosive storage with walls of at least 450 mm reinforced concrete (RC), or 700 mm brick, or equivalent penetration resistance of other materials, with or without a protective roof. The door is normally strengthened if it faces another potential explosion site (PES)*.

The term '*earth-covered magazine (ECM)'*refers to *a magazine, normally built at ground level, with earth-covered roof, sides and rear, and constructed in corrugated steel or reinforced concrete. Formerly called an '*igloo'*.*

The front wall may/may not be protected by a barricade. When present, a front barricade can provide significant protection to an ECM's contents from an explosion at an adjacent explosive location and potentially mitigate the effects of an explosion inside the ECM.

The term 'inhabited building' refers to *a building or structure occupied in whole or in part by people (usually civilian).* The term is used synonymously with *occupied building*.

The term inhabited building distance (IBD) refers to '*the minimum permissible distance between potential explosive sites (PES) and non-associated exposed sites (ES) that requires a high degree of protection from an explosion*.

The IBD is a form of Outside Quantity Distance (OQD).

The term 'inside quantity distance' (IQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) inside the explosives area*.

The term 'inter-magazine distance' (IMD) refers to *the minimum permissible distance between a building or stack containing explosives to other such buildings or stacks, which will prevent the immediate propagation of explosions or fire from one to the other by missile, flame or blast*.

The IMD is a form of Inside Quantity Distance (IQD).

Subsequent reactions (fire or detonation) may still occur at adjacent explosive locations that meet IMD, as a result of burning debris, high angle fragment impacts, building collapse, etc.

The term 'magazine' refers to *any building, structure, or container approved for the storage of explosive materials. (c.f. explosive storehouse (ESH)*'.

The term 'marshalling yard' refers to *groups of railway sidings in which freight trains are formed/reformed, or areas where road convoys are assembled*.

The term 'outside quantity distance' (OQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) outside the explosives area*.

The term 'potential explosion site' (PES) refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an explosion of its content*.

The term 'process building distance' (PBD) refers to *the minimum permissible distance from a building or stack containing explosives to an ammunition process building, or from an ammunition process building to another ammunition process building, which will provide a reasonable degree of immunity for the operatives within the ammunition process building(s), and a high degree of protection against immediate or subsequent propagation of explosions*.
The PBD is a form of Inside Quantity Distance (IQD).

The term 'public traffic route' (PTR) refers to *a road used for general public traffic; a railway outside the explosives area that is used for public passenger traffic; a waterway, such as a river having tidal water and a canal, used by passenger vessels*.

A PTR is an ES.

The term 'public traffic route distance' (PTRD) refers to *the minimum permissible distance between a potential explosion site (PES) and public traffic routes, which is such that the ignition or explosion of explosives at the PES will not cause intolerable danger to the occupants of vehicles at an exposed site (ES*).

The PTRD is a form of Outside Quantity Distance (OQD).

The term 'quantity distance' (QD) refers to *the minimum permissible distance required between a potential explosion site (PES) and an exposed site (ES)*.

The term 'separation distance' refers to *a generic term for the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES).*

Separation distances may or may not involve the use of the quantity distance system. They can be developed through the use of an explosion consequence analysis.

The term 'transit area' refers to *areas where consignments of explosives undergoing movements are assembled/dismantled for transhipment between modes of transport that operate within an explosives facility and those that operate outside the area.*

The term 'vulnerable building' refers to *an exposed site (ES) deemed to be vulnerable by nature of its construction or function and therefore sited at greater than normal OQD*.

Examples are multi-story buildings with a large expanse of exposed glass facing the PES, hospitals, places of high concentrations of people such as schools and churches, and warehouse type structures that use curtain-wall construction techniques.

The term 'vulnerable building distance' (VBD) refers to *the minimum permissible distance between a potential explosion site (PES) and a vulnerable building.*

The VBD is a form of Outside Quantity Distance (OQD).

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Separation distances

A separation distance is the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) where the risks due to an explosive event have been determined as tolerable by the appropriate national authority. Separation distances may not necessarily involve the use of the quantity distance system (Clause 5). They can be developed through the use of explosion consequence analysis (see IATG 02.10 *Introduction to risk management principles and processes*). Notwithstanding, the use of the quantity distance system is considered to be 'best practice' by many States and will therefore form the basis of the guidance within this IATG module.

Quantity distances do not, however, exclude the risk to the public from projections, broken glass, displaced tiles etc., or the risk of some minor injury to occupants. Glazing is an important factor in building occupant protection and protective features are relatively easy to provide.[6]

5 Background to quantity distances

Many States use rules based upon the explosives, their quantity, and the distance from the explosive to where people and, in some cases, critical facilities/equipment are at risk. These rules are known as Quantity-Distance (Q-D) criteria and are based on the approach derived from the *Hopkinson-*

[6] Analysis of glazing hazards is a specialist component of an explosion consequence analysis. See IATG 02.10 *Introduction to risk management principles and processes* and the *UK Glazing Hazard Guide 1997.*

Cranz Scaling Law,[7] [8] which is further amended by a range of coefficients. It is the basis of much of the work on the estimation of appropriate quantity and separation distances.

The *Hopkinson-Cranz Scaling Law* is also referred to as the *Cube Root Scaling Law*:

$(R_1/R_2) = (W_1/W_2)^{1/3}$ $R = ZW^{1/3}$	R = Range (m) Z = Constant of Proportionality (dependent on acceptable blast overpressure). **The coefficient 'Q' is used for QD work.** W = Explosive Weight (kg) **The coefficient NEQ is used for QD work.**

Table 1: Hopkinson-Cranz Scaling Law

Examples of the coefficient 'Q' used in explosive storage safety[9] for above ground storage are shown in Table 2, which are based on regional[10] 'best practice':

Q	QD	Purpose	Remarks
3,6 (IMD) **8.0 (PBD)**	Inside Quantity Distance (IQD)	Used to predict minimum separation distances that should be observed between PES and ES that contain explosives (which are in effect also PES), and between PES and ammunition process buildings (APB). .	▪ Minimum permissible distances further apply if R is below a certain level, which differs for each 'Z' function.
14.8	Public Traffic Route Distance (PTRD)	Used to predict minimum separation distances between a PES and a public traffic route with civilian access.	
22.2	Inhabited Building Distance (IBD)	Used to predict minimum separation distances between a PES and a building inhabited by civilians.	
44.4	Vulnerable Building Distance (VBD)	Used to predict minimum separation distances between a PES and a vulnerable building.	

Table 2: Examples of Coefficient 'Q'

The particular QD coefficients 'Q' shown at Table 2 are based on trials and other data, but are susceptible to uncertainty owing to the variability of the nature of explosions and the incompleteness of the trials data. Because of this, QD should be subject to continuing refinement, as further data becomes available.

The use of QD requires compliance with the UN explosive classification system as all of the available previous work in the area of QD has used the UN system of hazard divisions.[11]

A less complex system of the use of QD is that of the former Warsaw Pact that utilised the QD shown in Table 3.

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[7] Hopkinson B, UK Ordnance Board Minutes 13565, 1915.

[8] Cranz C, *Lehrbuch der Ballistik*, Springer-Verlag, Berlin, 1916.

[9] These are the default 'Q' settings in the IATG Software, although the software does allow the user to input alternative 'Q' values.

[10] OSCE and NATO regions.

[11] See IATG 01.50: *UN explosive classification system and codes.*

Q	QD	Purpose	Comment
4.5	Human Defeat Distance (Blast)	Used to predict separation distances for blast effects from a PES to individuals.	
14.0	Human Defeat Distance (Fragmentation)	Used to predict separation distances for fragmentation effects from a PES to individuals.	Similar to the Public Traffic Route Distance (PTRD) at Table 2.

Table 3: Examples of Coefficient 'Q'

6 Types of quantity distances

There are two major types of quantity distance, the inside quantity distance (IQD) and the outside quantity distance (OQD). These in turn have sub-types, summarised at Table 4.

QD Type	Applicability	QD Sub-Types
Inside Quantity Distance (IQD)	Only usually inside the designated explosives area.	(Ammunition) Process Building Distance (PBD)
		Inter-Magazine Distance (IMD)
Outside Quantity Distances (OQD)	Only outside the designated explosives area[12].	Public Traffic Route Distance (PTRD)
		Inhabited Building Distance (IBD)
		Vulnerable Building Distance (VBD)

Table 4: Types of QD

6.1 Inside quantity distances (IQD) (LEVEL 1)

IQD are the minimum distances that should be observed between PES and ES that contain explosives (which are in effect also PES), and between PES and ammunition process buildings (APB).

6.1.1. Process building distances (PBD)

PBD provide a high degree of protection against immediate or subsequent propagation of an explosion in the APB. PBD are generally intended for situations where personnel are regularly employed in the preparation or processing of explosives.

PBD are the minimum distances that should be observed either between PES and APBs, or between APBs. They are intended to give a reasonable degree of immunity to personnel within a hardened and barricaded APB from the effects of a nearby explosion. Light structured APBs are likely to be damaged if not completely destroyed, and as such offer minimal protection to personnel inside them.

6.1.2. Inter-magazine distances (IMD)

IMD are the minimum distances to be observed between individual PES and ES that contain explosives (which are in effect also PES) and are designed to provide specified degrees of protection

[12] See Clause 3 *Terms and definitions and* IATG 01.40 Glossary of *terms, definitions and appreciations*: **Explosives area** means an area used for the handling, processing and storing of ammunition and explosives. Where there is no fence, it is taken as being the area within a radius of 50m from any building or stack containing explosives.

to explosives at an ES. Primarily, these distances are intended to prevent direct propagation at each ES for each Hazard Division (HD). An explosion at a PES may lead indirectly to explosions at a nearby PES due to secondary fires, but this situation is more likely at the lowest degree of protection, detailed below.

6.2 Outside quantity distances (OQD) (LEVEL 1)

OQD are minimum distances to be observed between PES and non-explosives area related ES such as public roads, railways, civil airport facilities, inhabited buildings and other buildings/areas, whether they be inside or outside the explosives area, which are used by the general public and/or government personnel. In certain circumstances, such as when there is low density traffic on a road, minimum fragment distances are applied.

6.2.1. Public traffic route distance (PTRD)

PTRD should be the distances to be observed between PES and routes used by the general public, which are generically referred to as Public Traffic Routes. These include:

a) roads;

b) railways;

c) waterways, including rivers, canals and lakes;

d) runways, taxi ways and aircraft parking areas ; and

e) public rights of way (e.g. footpaths).

The distance required is based on the amount of usage of the route by vehicles, people, etc., also known as traffic density. Examples of usage rates for each density level that should be considered are shown in the footnotes at Annex D. Three alternative QD should therefore be used, dependent on the average public usage of the route, as shown in Table 5:

Density	Criteria (per day)	Appropriate QD
High Density Usage	Roads - 5000 or more vehicles Railways - 5000 or more rail passengers Waterways – 1800 or more users Public Rights of Way or Recreational Facilities – 900 or more users	100% of IBD
Medium Density Usage (the PTRD)	Roads - 1000 or more but less than 5000 vehicles Railways – 1000 or more but less than 5000 passengers Waterways – 400 or more but less than 1800 users Public Rights of Way or Recreational Facilities – 200 or more but less than 900 users	67% of IBD
Low Density Usage	Roads - Less than 1000 vehicles Railways – Less than 1000 passengers Waterways – Less than 400 users Public Rights of Way or Recreational Facilities – Less than 200 users	50% of IBD

Table 5: Types of QD for PTR

The numbers of people exposed to the hazard and their relative times of exposure should be determined by the average of the traffic or people counted, as appropriate, over a number of 24 hour periods.

Similar QD to those suggested for public rights of way should be applied to playing fields, golf courses and similar recreational facilities. These should be subject to the same minimum QD requirements.

6.2.2. Inhabited building distance (IBD)

IBD should be the minimum distances to be observed between PES and buildings or sites where members of the general public, or personnel not involved in explosives-related operations, either work, live or congregate. Planners should be aware that some public gathering sites, such as periodic, seasonal, or itinerant markets, may not exist on a permanent or daily basis.

The distances are intended to prevent serious structural damage to traditional types of inhabited buildings or caravans, and any consequential death or serious injury to their occupants. Persons in the open would not suffer direct injury from the effects of blast and radiant heat at these distances.

Fragments and debris may cause some injuries. The extent of injuries will depend upon the PES structure and the NEQ and fragmentation characteristics of the ammunition and explosives involved. At this distance, the fragment threat is defined as one hazardous fragment of 80 joules/56m^2. The fragment threat will decrease as the distance from the PES increases. The distances do not, however, exclude the risk to the public from projections falling from structures, broken glass, displaced tiles etc., or the risk of some minor injury to occupants. Glazing is an important factor in building occupant protection and protective features are relatively easy to provide.

IBD are normally subject to fixed minimum distances to give protection against fragments and debris emanating from a PES.

6.2.3. Vulnerable building distance (VBD)

Where an inhabited building is of vulnerable construction (e.g. glass facade) or is a large facility of special importance (e.g. a school), larger distances (normally $44.4Q^{1/3}$) shall be applied from PES containing HD 1.1 to afford a higher degree of protection. Examples are given in the quantity distance matrices that follow.

7 Rules for use of quantity distances (above ground storage)[13] (LEVEL 1)

7.1 Guidance

In order that the QD system is most effectively implemented users should comply fully with the requirements of this clause.

7.2 Measurement of distances

QD shall be accurately measured from the nearest point of the PES, or hard-standing of an open stack PES, to the nearest point of the ES or hard-standing of an open stack ES. Distances are measured along a straight line without regard for barricades or earth cover.

7.3 Unitisation

Where the total Net Explosive Quantity (NEQ) in a PES (including an ammunition process building (APB)) is separated into stacks such that the maximum credible event is limited to the quantity in any one stack (referred to as unit risk or unitisation), distances may be measured from the outside of the wall adjacent to the controlling stack concerned to the nearest outside wall of the ES. If the separation to prevent practically instantaneous propagation is provided by one or more substantial dividing walls within a PES, then the QD may be measured from these walls instead of from the

[13] More specific rules for underground storage, storage in ports and transit areas follow later in this IATG. These rules at Clause 7 shall also apply, where appropriate and unless superseded by guidance that follows later.

outside walls. Details on the construction of these types of walls, which are rarely used, may be found in UFC 3-340-02 (see Annex B).

The use of unitisation may also allow for reduced QD to be applied. Specialist ammunition technical advice should be obtained in these circumstances as it is a highly complex issue. Similar advice should also be sought should purpose built compartmentalised buildings be available for ammunition and explosive storage.

7.4 Intervening structures

In general, because of its very complicated nature, the effect of intervening buildings and structures, other than barricades, should be ignored when applying QD. In an exceptional case, such as a high building that has the same effect as a barricade, the situation should be specially assessed by qualified technical staff.

7.5 Net Explosive Quantity (NEQ)

Unless it has been determined by trials that the effective NEQ is significantly different from the actual NEQ, the total NEQ of explosives in a single PES should be used for the computation of QD. When HDs have to be mixed in a storage location then the aggregation rules at Table 6 shall apply.[14] HD 1.4, 1.5, and 1.6 are addressed in 10.2 below.

Serial	Hazard Divisions			Storage Requirement
	1.1	1.2	1.3	
1	YES	NO	NO	▪ Use HD 1.1 Quantity Distance.
2	YES	YES	NO	▪ Aggregate the HD 1.1 and 1.2 NEQ. ▪ Evaluate aggregate as HD 1.1 then as HD 1.2 and use the greater Quantity Distance.
3	YES	YES	YES	▪ Aggregate the HD 1.1, 1.2 and 1.3 NEQ. ▪ Evaluate aggregate as HD 1.1 then as HD 1.2 and use the greater Quantity Distance.
4	YES	NO	YES	▪ Aggregate the HD 1.1 and 1.3 NEQ. ▪ Use HD 1.1 Quantity Distance for the aggregated NEQ total.
5	NO	YES	NO	▪ Use HD 1.2 Quantity Distance.
6	NO	YES	YES	▪ Assess QD for the NEQ of each HD. ▪ Use the greatest Quantity Distance.
7	NO	NO	YES	▪ Use HD 1.3 Quantity Distance.

Table 6: Aggregation rules

The NEQ does not include substances such as white phosphorus, chemical agents, smoke, or incendiary compositions unless these substances contribute significantly to the dominant HD concerned. Any other energetic materials such as liquid fuels should be aggregated with the explosive NEQ unless it has been determined by testing that they do not contribute to the overall hazard.

7.6 Determination of quantity distances or permissible quantities

The location of PES with respect to each other and to other ES is based on the total NEQ in the individual PES unless this total NEQ is subdivided such that an incident involving any one of the smaller concentrations cannot produce a practically instantaneous explosion in adjacent stacks.

[14] This includes individual storage locations.

The QD required between each of two or more nearby storage sites or ammunition process buildings that contain explosives of one HD only are determined by considering each as a PES. The NEQ permitted in the storage sites or ammunition process buildings is limited to the least amount allowed by the appropriate table for the distances separating the storage sites or ammunition process buildings concerned. The QD required from each of two or more nearby storage sites to contain given quantities of explosives of different HDs at different times should be determined as follows:

a) consider each building or stack, in turn, as a PES;

b) refer to the table of each HD that can be stored in the building or stack considered as a PES;

c) determine the QD for each HD as the minimum to be required from the building or stack; and

d) record the QD in terms of each HD in each instance as those to be required from the building or stack. Alternatively, calculate the permitted NEQ of each HD based upon the available distances.

7.7 Rounding of quantity distance

The values of QD in the QD Tables that follow have been rounded up in accordance with Table 7, below. It is permitted to determine a QD using the distance function formulae at the foot of the appropriate column in the QD Table. A calculated distance, rounded up to the nearest metre, may be used in place of any value in the QD Tables. If an NEQ is back calculated from a distance, using the appropriate QD formula, the answer should be rounded down to the nearest kg.

Range of Value of QD (kg)	Rounded to the Nearest (m)
2 to <100	1
>100 to <500	5
>500 to <1,000	10
> 1,000	20

Table 7: Rounding of QD

8 Rationale for selected quantity distances

The rationale for the QD coefficients selected and used in the QD Tables within this IATG is based on trials, experimentation, modelling and analysis of real explosive events.[15] The primary threat to structures is blast impulse energy, which is a function of overpressure and event duration. For a small NEQ, with little duration, the threat to structures is significantly less than from a very large NEQ event (in the thousands of kg), which would have a very long duration, and consequently a very high impulse. The QD factors were initially developed for these very large NEQ events and then scaled down to apply for smaller quantities. Therefore, for the storage of smaller NEQ quantities the use the explosion consequence analysis (ECA) methodology may be more appropriate (see IATG 02.10 *Introduction to risk management principles and processes*).[16] The expected effects, and impact on facilities and personnel, over a range of QD coefficients for explosives have been estimated for Hazard Division 1.1. These are summarised in Table 8 for above ground storage, and will differ for explosives in HD 1.2 and 1.3 (see later):

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[15] Conducted by NATO Nations for the development of NATO AASTPs.

[16] NATO AASTP-1 does not contain criteria for HD 1.1 NEQ < 500kg. Consequently, the criteria contained in Annexes D and E for HD 1.1 NEQ $\leq$ 50kg and for HD 1.1 NEQ > 50kg has therefore been extrapolated (as a temporary measure) from Tables V3.E3.T1 and V3.E3.T3 of US DoDM 6055.09, *Ammunition and Explosives Safety Standards* and NATO AASTP-1. Until NATO has further developed AASTP-1 to include QD for < 500kg, these particular recommended QD should be used with **extreme caution**. The NATO developed criteria is expected in 2021, and this IATG will then be further amended as necessary once NATO has released the data.

QD[17]	QD Type / Examples	Effects and Impact	
		Structures	**Personnel**
$D_Q = 44.4Q^{1/3}$	Vulnerable Building Distance (VBD) (Purple Line) ▪ Hospitals. ▪ Schools. ▪ Multi-story offices. ▪ Apartments. ▪ Oil Refineries.	▪ Un-strengthened normal structures are likely to suffer only superficial damage. ▪ Certain types of vulnerable structures may collapse and cause injuries or death by crushing and falling debris. ▪ When large panes of glass or other non-load bearing frangible materials, e.g. external cladding panels, are exposed so as to face a PES, 50% or more of these may be detached from the structure or broken by the blast.	▪ Injuries and fatalities are very unlikely as a direct result of blast effects. ▪ Injuries that do occur will be caused principally by the impact on passers-by of falling, broken or detached panel or window materials. ▪ The risk of injury will often be reduced by minimising personnel exposure by, for example, placing gardens around the foot of buildings. ▪ Peak side-on overpressure is 2.0 – 3.0 KPa.
$D_Q = 22.2Q^{1/3}$	Inhabited Building Distance (IBD) (Yellow Line) ▪ Civilian houses. ▪ Major military admin area. ▪ Major road and rail routes.	▪ Un-strengthened buildings will suffer minor damage, particularly to parts such as windows, door frames and chimneys. ▪ Partial collapse may occur in buildings where structural integrity relies either on critical elements or the continuity of the structure.	▪ Injuries and fatalities are very unlikely as a direct result of the blast effects. ▪ Injuries that do occur will be caused principally by glass breakage and flying/falling debris. ▪ Peak side-on overpressure is 5KPa.
$D_Q = 14.8Q^{1/3}$	Public Traffic Route Distance (PTRD) (Green Line) ▪ Medium or minor roads and rail routes. ▪ Sports fields. ▪ Minimum distance at which public may be placed at risk ▪ Administrative buildings related to the explosives activity with < 20 people	▪ Un-strengthened buildings will suffer average damage costing in the range of 10% of total replacement cost to repair.	▪ Personnel under cover are afforded a high degree of protection from death or serious injury. ▪ Such injuries as do occur will be mainly caused by glass breakage and building debris. ▪ Personnel in the open are not likely to be seriously injured by blast but some injuries are likely to be caused by fragments and debris depending on the structure of the PES, the NEQ involved and fragmentation characteristics. ▪ Peak side-on overpressure is 9KPa.
$D_Q = 11.1Q^{1/3}$	▪ (Blue Line) Low density roads, railways and public rights of way.	This is the acceptable level of protection for low-density areas. ▪ Un-strengthened buildings will suffer average damage up to 20% of replacement cost.	▪ Personnel in the open are not likely to suffer any injuries from blast or any significant injuries from debris. ▪ Peak side-on overpressure is 11KPa.

[17] Where D_Q = Distance (m), and Q = NEQ (kg)

QD[17]	QD Type / Examples	Effects and Impact	
		Structures	Personnel
$D_Q = 9.6Q^{1/3}$	Military at Risk ▪ Military sports fields. ▪ Military training areas. ▪ Military aircraft.	▪ Buildings that are un-strengthened can be expected to suffer damage to main structural members that will require repair. ▪ Repairs may cost more than 20% of the replacement cost of the building. ▪ Strengthening of buildings to prevent damage and secondary hazards is feasible and not prohibitively expensive. ▪ Cars may suffer some damage to metal portions of the roof and body by blast. Windows may be broken; however, the glass should not cause serious injury to the occupants. ▪ Aircraft will suffer some damage to appendages and sheet metal skin. ▪ Cargo type ships will suffer minor damage from blast to deck houses and electronic gear.	▪ Personnel may suffer temporary hearing loss; however, permanent ear damage is not likely. There are likely to be some injuries caused by fragments, debris, or translation of the individual(s) involved. ▪ Peak side-on overpressure is 16KPa.
$D_Q = 8.0Q^{1/3}$	(Ammunition) Process Building Distance (PBD) ▪ Ammunition process buildings (APB). ▪ Minor communication links.	▪ Buildings, which are un-strengthened, can be expected to suffer damage that is likely to cost above 30% of the total replacement cost to repair. ▪ There is some possibility of delayed communication of the explosion as a result of fires or equipment failure at the ES. Direct propagation of the explosion is not likely. ▪ Cargo ships will suffer damage to decks and superstructure. In particular, doors and bulkheads on the weather deck are likely to be buckled by the overpressure. ▪ Aircraft are expected to sustain considerable structural damage.	▪ Serious injuries to personnel, which may result in death, are likely to occur due to fragments, debris, firebrands or other objects. ▪ Peak side-on overpressure is 21 KPa.
$D_Q = 3.6Q^{1/3}$	Inter-Magazine Distances (IMD) ▪ Explosive storehouses (ESH).	▪ Un-strengthened buildings will suffer structural damage approaching total demolition. ▪ Aircraft will be damaged, by both blast and fragments, to the extent that they will be beyond economical repair. ▪ If aircraft are loaded with explosives, delayed explosions are likely to result from subsequent fires. ▪ A high degree of protection against direct propagation of an explosion is to be expected, provided direct attack by high velocity fragments is prevented, e.g. by a receptor barricade. ▪ Explosions may subsequently occur in adjacent PES from fire spread by lobbed debris or blast damage to an ES.	▪ Severe injuries or death to occupants of the ES are to be expected from direct blast, fragment impact, building collapse, or translation. ▪ Peak side-on overpressure is 70KPa. ▪ At 105 KPa there is a 50% chance personnel will suffer ear drum damage. ▪ At 130 KPa there is a 50% chance of death due to lung damage.

QD[17]	QD Type / Examples	Effects and Impact	
		Structures	Personnel
$D_Q = 2.4Q^{1/3}$	Inter-Magazine Distances (IMD) ▪ ESH (ECM).	▪ Un-strengthened buildings will suffer complete demolition.	▪ Severe injuries or death to occupants of the ES are to be expected from direct blast, fragment blast, building collapse, or translation. ▪ Peak side-on overpressure is 180KPa.

Table 8: Effects and impact of QD for HD 1.1

There are a range of factors that are used to determine the QD for a particular HD from a PES, which are:

a) the NEQ at the PES and the type, sensitiveness and packaging of the explosives at the ES;

b) the type, use, method of construction and orientation of both the PES and the ES;

c) the presence of effective barricades ;

d) the degree of protection required at the PES and ES;

e) the adequacy of evacuation arrangements for ammunition depot staff and the local population; and

f) the HD Storage sub-Division (SsD). Storage sub-divisions (SsD) are explained below in table 9 and at IATG 5.20 Types of Buildings for Explosives Storage (articles 5.2 and 5.3).

The provision of stronger and more robust ESH allows for the use of smaller QD for a given degree of protection or achieves a higher standard of protection at a given distance, especially in the case of an ES near a PES containing explosives of HD 1.1. Yet some stronger and more robust ESH may also increase OQDs as their heavier structure can produce large, long-range fragments in the event of an explosion within.

9 Symbols

For above ground storage a range of standard symbols should be used to represent the various types of PES and ES during the use of QD methodology. Annex C contains the common symbols that are used within this IATG and the supporting IATG software.

10 Hazard division quantity distance matrices (LEVEL 1)

10.1 HD 1.1, HD 1.2 and HD 1.3

Quantity distance matrices, which contain the appropriate QD factor that should be used between differing PES and ES, are at the Annexes shown in Table 9:

Hazard Division (SsD)	Definition	Annex
Above ground storage		
1.1	Ammunition that has a mass explosion hazard.	▪ Annex D
1.2.1	Ammunition that has a projection hazard but not a mass explosion hazard. (More hazardous items of HD 1.2, which give large fragments over an extended range). HD 1.2 items with HE NEQ of above 0.136kg.	▪ Annex F
1.2.2	Ammunition that has a projection hazard but not a mass explosion hazard. (The less hazardous items of HD 1.2, which give smaller fragments of limited range). HD 1.2 items with HE NEQ of equal to or below 0.136kg.	▪ Annex G

Hazard Division (SsD)	Definition	Annex
1.2.3	Ammunition that exhibit at most an explosion reaction during sympathetic reaction testing and a burning reaction in bullet impact or heating tests. (This is a 'new' SsD and is derived from NATO AASTP-3, Edition 1, Change 3. *Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives.* August 2009).	▪ Not yet available
1.3.1	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. (The more hazardous items with mass fire hazard and considerable thermal radiation).	▪ Annex J
1.3.2	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. (The less hazardous items that burn sporadically).	▪ Annex K
Underground storage		
1.1	Ammunition that has a mass explosion hazard.	▪ Annex M
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.	▪ Annex M
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. (This is treated as if it is HD 1.1 because of the overall degree of confinement in underground storage).	▪ Annex M
Ports		
1.1	Ammunition that has a mass explosion hazard.	▪ Annex P
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.	▪ Annex P
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.	▪ Annex P

Table 9: QD matrices by Annex

The matrices contain a 'D' reference, which refers to the QD column in the HD QD tables (see Clause 11).

For inter-magazine distances (IMD) the matrix also indicates the level of protection afforded to the ammunition stocks at the ES should there be an explosive event within a PES containing HD 1.1 or HD 1.2 ammunition. This level of protection is indicated in Table 10:

Protection Level	Explanation
Virtually complete protection (1.1)	▪ Gives virtually complete protection against practically instantaneous propagation of an explosion by ground shock, blast, flame and high velocity projections. ▪ There are unlikely to be fires or subsequent explosions caused by these effects or by lobbed munitions. ▪ The stocks are likely to remain serviceable; however, ground shock may cause indirect damage and even explosions among especially vulnerable types of explosives, or in conditions of saturated soil. ▪ This level of protection is primarily used when both the PES and the ES are earth-covered structures.
Virtually complete protection (1.2)	▪ Gives virtually complete protection against all explosion effects from the PES. ▪ Ammunition and explosives will remain serviceable at ES.

Protection Level	Explanation
High degree of protection (1.1)	▪ Gives a high degree of protection against practically instantaneous propagation of an explosion by ground shock, blast, flame and high velocity projections. ▪ There may be occasional fires or subsequent explosions caused by these effects or by lobbed munitions. ▪ Heavy cased items (e.g. aircraft bombs and robust shell) are likely to remain serviceable although they may be covered by building or barricade debris. ▪ However, there is a significant increase in the probability that other stocks of explosives will be lost through subsequent propagation from lobbed explosive items or the spread of burning debris. This is particularly so where flammable material, such as wooden packages or dunnage, is present at the ES.
High degree of protection (1.2)	• Gives a high degree of protection against most explosion effects from the PES. • Ammunition and explosives are likely to remain serviceable.
Limited degree of protection (1.1)	• Gives only a limited degree of protection against practically instantaneous propagation of an explosion by ground shock, blast, flame and high velocity projections. • There are likely to be fires or subsequent explosions caused by these effects or by lobbed munitions. • Heavy cased munitions are likely to be damaged and rendered unserviceable and are likely to be completely buried by debris. • There is a high probability that stocks of explosives will be lost through subsequent propagation from lobbed munitions or the spread of burning debris. This is particularly so where flammable materials, such as wooden packages or dunnage, are present at the ES.
Limited degree of protection (1.2)	• Gives limited degree of protection against some explosion effects from the PES. • Ammunition and explosives are unlikely to remain serviceable.

Table 10: Protection levels from IMD

10.2 HD 1.4, HD 1.5 and HD 1.6

Distances from a PES containing ammunition and explosives of HD 1.4 are not a function of NEQ. Separation distances should be based on the fire risks and fire-fighting capability available. The separation distance for a PES of open stacks or light buildings to any type of ES should be greater than 10m. For more robust buildings the separation distance should be that required for emergency access.

Ammunition and explosives of HD 1.5 contain insensitive explosive substances, which are so insensitive that there is very little likelihood of initiation or transition from burning to detonation when stored in isolation. Nevertheless, in order to allow for storage flexibility, they should be considered to be HD 1.1 for the purposes of QD estimation.

Ammunition of HD 1.6 contains extremely insensitive substances. National efforts to develop HD 1.6 munitions began in the 1970s, and due to the difficulty in developing such munitions, this effort is still ongoing. Detailed storage advice may be found in the NATO publication AASTP-1, whilst UN Test Series 7 will determine if ammunition and explosives may be classified as HD 1.6.

11 Hazard division quantity distance tables (LEVEL 1)

Quantity distance tables, which contain the appropriate QD, (pre-calculated for a range of NEQ and minimum permissible distances), that should be used between differing PES and ES, are at the Annexes shown in Table 11:

Hazard Division	Definition	Annex
Above ground storage		
1.1	Ammunition that has a mass explosion hazard.	▪ Annex E
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.	▪ Annex H
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.	▪ Annex L
Underground storage		
1.1	Ammunition that has a mass explosion hazard.	▪ Annexes N and M ▪ Also see Clause 13.
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.	
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.	
Ports		
1.1	Ammunition that has a mass explosion hazard.	▪ Annex Q ▪ Also see Clause 14.
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.	
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.	

Table 11: QD Tables by Annex

12 Marshalling yards and transit areas (LEVEL 2)

Quantity distances for marshalling yards and transit areas should be applied as shown in Table 12:

Type		QD
Class	**Definition**	
A	Facility is used for **more than** One Day per Week. OR Facility is used for HD 1.1	▪ The appropriate IBD shall be used.
B	Facility is used for **less than** One Day per Week No HD 1.1 is moved through the facility.	▪ The appropriate PTRD is to be used.

Table 12: QD for marshalling areas and transit areas

13 Underground storage (LEVEL 2)

13.1 General

The development of appropriate quantity distances for underground storage is much more complex than for above ground storage as more technical factors (geology, channelling of blast, impact of ground shock, etc.) must be considered. Unlike above ground storage, the effects of an undesirable explosion are not omni-directional in their effects on the general public and property.

QD for this type of storage should be developed by appropriately qualified personnel in accordance with NATO AASTP-1 Part 3 *Underground explosives storage*. Aspects of the NATO publication, which is international best practice, are included in this IATG for information and basic guidance only. This information should only be used as a basic staff check to gain an overview of the safety aspects of current underground storage within a State in order to identify if current QD are appropriate.

Information on the design of underground storage facilities may be found in NATO AASTP-1 Part 3 *Underground explosives storage*.

There are two types of underground storage:

a) chambers. These are specially constructed within the rock, and are connected to the outside, and to each other, by tunnels; and

b) natural rock caverns. These are occasionally used, but as the geology, size and shape all impact on their performance in terms of explosion mitigation they are not covered further in this IATG. Each location should be assessed by an explosion consequence analysis developed by an appropriate qualified specialist before explosive limits can be determined.

13.2 Effects from underground explosions

13.2.1. Confinement

Underground storage usually means that the level of confinement in the event of an explosion is much greater than for above ground storage. The volumetric loading density (kg/m^3) within the underground storage therefore introduces a new factor when determining appropriate quantity distances.

13.2.2. Blast

An explosion underground will result in a directional blast wave that will sweep through all tunnels and chambers connected to the initial chamber. The initial pressure will increase with the explosive volumetric loading density within the chamber, being proportional to the cube root of the loading density. Where a tunnel reaches the surface, the underground blast wave will give rise to a blast wave in the air broadly similar to that of a surface explosion, although strong directional effects can be expected. There is also a possibility of propagation by hot gases or flame, which could flow from pre-existing crevices between the chambers. Quasi-static action of the explosion gases may also open up incipient cracks and crevices extending between the two chambers, providing a potential route for propagation of the explosion by the hot gases. The prediction of explosion effects in underground storage is more complex than for above ground storage and should be supported by modelling. Blast effects should be predicted from tunnel adits and from surface craters if rock cover is insufficient.

13.3 Ground shock

The high gas pressure from an explosion will be transferred to the chamber floor, walls and roof, resulting in a ground shock wave. The shock wave velocity will be greater than a shock wave in air due to the higher density of the rock.

Spalling of the rock face or walls of another nearby chamber, possibly causing a reaction in any explosives present there, may also result.

It is possible that ground shock and the sustained high pressure within the initial chamber may, depending on the cover thickness, cause a breach of the rock/earth cover of the chamber. This may cause ejection of the rock, etc., forming the cover, and release of the high-pressure gases from the chamber. This will give rise to an additional blast wave in the air, similar to that from a surface explosion.

Table M.1 provides equations for estimations of ground shock effects suitable for a basic staff check. More detailed calculations should be used when planning new storage or if the basic staff check suggests that current separation distances are unsuitable (see NATO AASTP-1 Part 3 *Underground explosives storage*, Clause 3.3.4.3).

13.4 Fragments and debris

Primary fragments and debris will be carried along all tunnels connected to the chamber by the blast flow; they will also be projected in a relatively narrow angle directly away from the tunnel entrance. Some debris will be projected to great distances along the centre line away from the tunnel entrance in a manner similar to the projection of a shell from a gun barrel. Earth barricades or robust head walls should be used to 'catch' this fragmentation, the advantage being a significantly reduced QD emanating from the tunnel opening.

Within the tunnel complex, changes of tunnel direction can be designed to provide 'debris traps' that will trap debris that cannot follow the blast wave around the change of direction. Multiple 'debris traps' will eventually significantly reduce the threat (and IBD) resulting from fragments and debris when the blast wave reaches the tunnel entrance.

13.5 Types of quantity distances (underground storage)

The OQD and IQD for underground storage are slightly different than those for above ground storage. They are summarised at Table 13.

QD Type	QD Sub-Types	Applicability
Inside Quantity Distance (IQD)	Ammunition Process Building Distance (APBD)	Distance to APB inside the underground system. This may also be referred to as the Explosives Workshop Distance (EWD).
	Chamber Interval (CID)	Distance between underground storage chambers.
Outside Quantity Distances (OQD)	Above Ground Magazine Distance (AGMD)	Distance to a non-ECM type ESH outside the underground system.
	Earth Covered Magazine Distance (ECMD)	Distance to an ECM type ESH outside the underground system.
	Ammunition Process Building Distance (APBD)	Distance to APB outside the underground system. This may also be referred to as the Explosives Workshop Distance (EWD).
	Public Traffic Route Distance (PTRD)	Distance from underground storage to routes and buildings outside the explosives area.
	Inhabited Building Distance (IBD)	
	Vulnerable Building Distance (VBD)	

Table 13: Types of QD (underground storage)

13.6 Applicability of quantity distances (underground storage)

Explosives of HD 1.2 are expected to respond underground in an intermittent manner without causing a mass explosion with its significant blast and ground shock effects. Quantity distances should therefore not be applied to explosives of HD 1.2.

Explosives of HD 1.4 stored underground do not require quantity distances.

Explosives of HD 1.5 stored underground should be considered to be as if they are in HD 1.1.

Therefore, only explosives of HD 1.1 and HD 1.3 require quantity distances for underground storage. It is important that mixing rules are adjusted to consider explosives of HD 1.3 as HD 1.1 when stored underground.[18]

13.7 Measuring quantity distances (underground storage)

13.7.1. Inside quantity distances

The chamber interval distance (CID) shall be the shortest distance between the natural walls of two adjacent chambers. Any chamber linings shall be ignored.

13.7.2. Outside quantity distances

For blast and debris effects from the tunnel entrance (adit), the OQD shall be measured from the centre of the tunnel entrance to the nearest point of the ES. An extended centre line along the length of the tunnel shall be used as a reference line for any directional effects. Properly constructed barricades will stop fragments and debris coming out the tunnel, thereby providing a significant reduction in fragment-related IBD.

For blast and debris effects from any surface crater formation the OQD shall be measured from the nearest wall of the chamber to the nearest point of the ES, taking account of relevant levels.

13.8 Determining quantity distances (underground storage)

The methodology for determining quantity distances for underground storage is different to that used for above ground storage due to the more unusual effects. Each of the following should be considered, in any order, before a final QD is established, which will be the greatest distance identified:

a) blast effects within underground storage;

b) blast effects from tunnel entrance (adit);

c) blast effects from any surface crater formed;

d) ground shock effects;

e) flame and hot gases;

f) debris effects from tunnel entrance; and

g) debris effects from any surface crater formed.

Underground storage sites that are connected to each other by tunnels should be considered as one single storage site unless adequate precautions are taken to prevent the propagation of an explosion from one chamber to another. Technical judgement should be used.

Table 14 provides guidance on the appropriate QD tables or methodology to be used. The number of variables involved means that QD table guidance cannot be provided for ground shock effects or blast effects from the tunnel entrance. These should be determined using the explosion consequence analysis (ECA) methodology at IATG 02.10 *Introduction to risk management principles and processes*, supported by the information at Annexes M and N:

Effects	IQD		OQD	
	CID	APBD	IBD	PTRD
Blast effects within underground storage	Annex M Table N.1			

[18] Mixing rules are contained in IATG 01.50 *UN explosive classification system and codes,* Clause 7.1.

Effects	IQD		OQD	
	CID	APBD	IBD	PTRD
Blast effects from tunnel entrance		ECA	ECA	ECA
Blast effects from surface crater		Annex M		
Ground shock effects (simple estimation)	Annex M	Annex M	Annex M	Annex M
Debris effects from tunnel entrance		ECA	ECA	ECA
Debris effects from surface crater		Annex M Using Table N.2 or Table N.3		

Table 14: Guidance on Tables for QD estimation (underground storage)

14 Ports (LEVEL 2)

14.1 General

The guidelines that follow should be applied for cargo vessels, whether military or commercial, transporting or storing explosives whilst anchored, moored or berthed within a port. They are not designed to cover the normal ammunition and explosive loads for warships, which are a national responsibility.

An explosive event on a vessel afloat will result in some different effects from an explosive event on land. Explosives stored below the waterline of the vessel, for example, will have some of their explosive effects (e.g. blast, thermal output, etc.) attenuated by water, whilst others will be increased (e.g. ground shock).

14.2 Aggregation of NEQ

The close proximity of ships' compartments and the potential closeness to a shore transfer area means that it is possible that an accidental explosion could involve all of the ship's cargo of explosives. Therefore the whole cargo, whether on the vessel or in the process of transfer, shall be aggregated in accordance with Clause 7.5, Table 6.

It may be possible to arrange for an explosive cargo to be stored on a vessel in such a way that the risk of propagation of an explosion from one stowage location to another is reduced and/or mitigated. In this case the separation distance and traversing shall be robust enough to intercept high velocity fragments to prevent them from initiating a simultaneous explosion. Guidance on the appropriate protection level is at Annex P.

14.3 Prohibited activities during refuelling

Vessels carrying explosives shall not refuel or transfer fuel unless the hatches to the explosive storage compartments are firmly secured. There shall be no handling of explosives during refuelling operations.

14.4 Measuring quantity distances (ports)

14.4.1. Measurements

All measurements are to be taken from the nearest point of the compartment storing explosives in a berthed or anchored vessel to the nearest ES.

14.4.2. Swinging circles

When estimating the appropriate QD allowances must be made for the movement of the vessel if it is anchored at a single buoy. The radius of the swinging circle, and effects of the tides, should be accounted for; anchor chain lengths are usually in the order of 40m for larger vessels

14.4.3. Multiple vessels

If more than one vessel carrying explosives is to be berthed or anchored, each should be considered to be a separate PES if appropriate separation distances can be achieved. If appropriate separation distance cannot be achieved, then both vessels should be considered as a single PES, with measurements to the ES taken accordingly from the nearest vessel to the ES.

14.5 Estimating quantity distances (ports)

14.5.1. Protection levels

The quantity distances recommended may only allow for a high degree of protection, as it is considered very unlikely that any vessel can provide a complete level of protection similar to that provided by an earth covered building.

14.5.2. Recommended quantity distances

Quantity distance tables containing the appropriate QD, (pre-calculated for a range of NEQ and safe distances), that should be used between vessels and differing ES are at Annex Q.

15 IATG software[19] and adjustment of quantity distances (LEVEL 2)

The IATG software is pre-loaded with the QD coefficients for above ground storage recommended within the annexes to this IATG. Nevertheless, the software allows users to enter their own QD coefficients. If coefficients are entered that are lower than those recommended within this IATG, then they should be supported by a full explosion consequence analysis in accordance with IATG 02.10 *Introduction to risk management processes and principles.*

[19] www.un.org/disarmament/un-saferguard/explosives-limit-license

Annex A
(normative)
References

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

a) IATG 01.40 Glossary of *terms, definitions and appreciations*. UNODA. 2020;

b) IATG 01.50 *UN explosive classification system and codes*. UNODA. 2020;

c) IATG 01.80 *Formulae for ammunition management.* UNODA. 2020;

d) IATG 02.10 *Introduction to risk management principles and processes*. UNODA. 2020; and

e) IATG 02.30 *Licensing of explosive facilities*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[20] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[20] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[21]

f) AASTP-1, Edition B, Version 1,. *NATO Guidelines for the Storage of Military Ammunition and Explosives. (Part 1 General Principles and Guidelines for all Explosives Storage and Quantity Distance Tables for Above Ground Storage)*. NATO Standardization Office (NSO). December 2015;

g) AASTP-1, Edition B, Version 1,. *NATO Guidelines for the Storage of Military Ammunition and Explosives. (Part 3 Underground Explosives Storage)*. NATO Standardization Office (NSO). December 2015;

h) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020:

i) *Usage Manual for Missile and Artillery Armaments, Part 1, Use of Missile and Artillery Armaments by Troops*,[22] *Chapter 4.* USSR MOD. 1989;

j) DoDM 6055.09, *Ammunition and Explosives Safety Standards*. (Incorporating Change 1 (12 March 2012)). US Department of Defense. 29 February 2008; and

k) UFC-3-340-02, *Structures to Resist the Effects of Accidental Explosions*. US Department of Defense. 05 December 2008; Change 2, 01 September 2014. https://www.ddesb.pentagon.mil/documents/?pg=subcont-internationalissuances

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[23] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[21] Data from many of these publications has been used to develop this IATG.

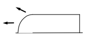
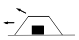
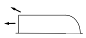
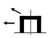
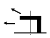
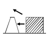
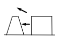
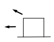
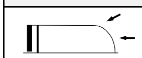
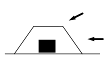
[22] Appendix 1 to Order of the Chief Commander of the Ground Forces No 5 1988.

[23] Where copyright permits.

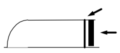
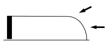
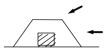
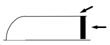
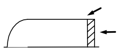
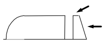
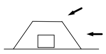
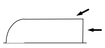
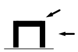
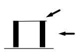
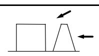
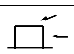
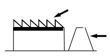
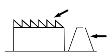
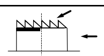
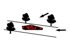
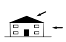
Annex C
(normative)
Symbols for QD concept (LEVEL 2)

The following symbols shall be used during the use of the QD concept within the IATG guidelines and supporting software. These are commonly used already by many States[24] and their use simplifies explanatory QD matrices and tables.

The symbols are purely diagrammatic and do not necessarily mean that the explosive storehouses should have similar shapes and proportions. The orientation shown is intended to indicate the direction of principle concern for blast, flame, radiant heat and projections, (shown by the arrows). When using the QD system every direction must be considered in turn. At a PES, there are relatively few significant variations, but at an ES it is necessary to distinguish among different types of construction, to include the presence of a barricade, and among different functions of buildings. For these reasons, a given building may require one symbol when it is being considered as a PES and a different symbol when it is considered as an ES. Further information on the directional effects of ECMs follows the Table C1.

Symbol	Type of Structure / Area	Description	Directional Effects
Potential Explosion Site (PES)			
	Earth covered magazine (ECM)	Building with earth on the roof and against three walls.	Front of magazine faces away from ES
	Earth covered magazine (ECM)	Building with earth on the roof and against three walls.	Side of magazine perpendicular to the direction of the ES.
	Earth covered magazine (ECM)	Building with earth on the roof and against three walls.	Front of magazine faces towards the ES.
	Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). Protective Roof of 150mm RC.	Any direction to the ES
	Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). Protective Roof of 150mm RC.	Door or other large opening faces towards the ES.
	Semi-Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). No Protective Roof.	Any direction to ES.
	Medium Building, Barricaded	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Barricaded side to ES.
	Medium Building	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Any direction to ES.
	Light Building or Open Stack, Barricaded	Light building or open stack of ammunition with an effective barricade	Barricaded side to ES
	Light Building or Open Stack	Light building or open stack of ammunition.	Any direction to ES.
Exposed Site (ES)			
	Standard NATO ECM	Building with earth on the roof and against three walls. 7BAR Door.	Door facing away from PES.
	Standard NATO ECM	Building with earth on the roof and against three walls. 7BAR Headwall and Door.	Door facing perpendicular to the direction of the PES.

[24] They form the basis of the QD system within NATO AASTP-1, which is also used by many non-NATO States around the world.

Symbol	Type of Structure / Area	Description	Directional Effects
	Standard NATO ECM	Building with earth on the roof and against three walls. 7BAR Headwall and Door.	Door facing towards a PES.
	NATO Standard ECM	Building with earth on the roof and against three walls. 3BAR Headwall and Door.	Door facing away from PES.
	NATO Standard ECM	Building with earth on the roof and against three walls. 3BAR Headwall and Door.	Door facing perpendicular to a PES.
	NATO Standard ECM	Building with earth on the roof and against three walls. 3BAR Headwall and Door.	Door facing towards a PES.
	Undefined ECM	Building with earth on the roof and against three walls. Headwall and door resistant to high velocity projections.	Door facing towards a PES.
	Undefined ECM	Building with earth on the roof and against three walls and weaker than above magazines. Barricade in front of door and headwall that may or may not be resistant to low velocity fragments.	Door facing towards a PES.
	Undefined ECM	Building with earth on the roof and against three walls. Headwall and door may or may not be resistant to low velocity projections.	Door facing away from PES.
	Undefined ECM	Building with earth on the roof and against three walls. Headwall and door may or may not be resistant to low velocity projections.	Door facing perpendicular to PES.
	Undefined ECM	Building with earth on the roof and against three walls. Headwall and door may or may not be resistant to low velocity projections.	Door facing towards a PES.
	Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). Protective Roof of 150mm RC.	Any direction to PES.
	Semi-Reinforced ESH	Walls of nominal 450mm Reinforced Concrete (RC) (or 680mm Brick). No Protective Roof.	Any direction to PES.
	Medium Building, Barricaded	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Barricaded side to PES.
	Medium Building	Walls of minimum 215mm brick, or equivalent. Protective roof of 150mm RC.	Any direction to PES.
	Light Building or Open Stack, Barricaded	Light Building or Open stack of ammunition with an effective r barricade.	Barricaded side to PES.
	Light Building or Open Stack	Light Building or Open stack of ammunition with no protection.	Any direction to PES.
	Ammunition Process Building (APB), Barricaded	Protective roof.	Barricaded side to PES.
	Ammunition Process Building (APB), Barricaded	No protective roof.	Barricaded side to PES.
	Ammunition Process Building (APB)	No protective roof or barricade.	Any direction to PES.
	Public Traffic Route (PTR)	Road, Railway, Waterway or Right of Way. Usage density will be shown in QD Matrix.	Any direction to PES.
	Inhabited Building	Civilian Buildings or Places of Assembly.	Any direction to PES.

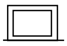
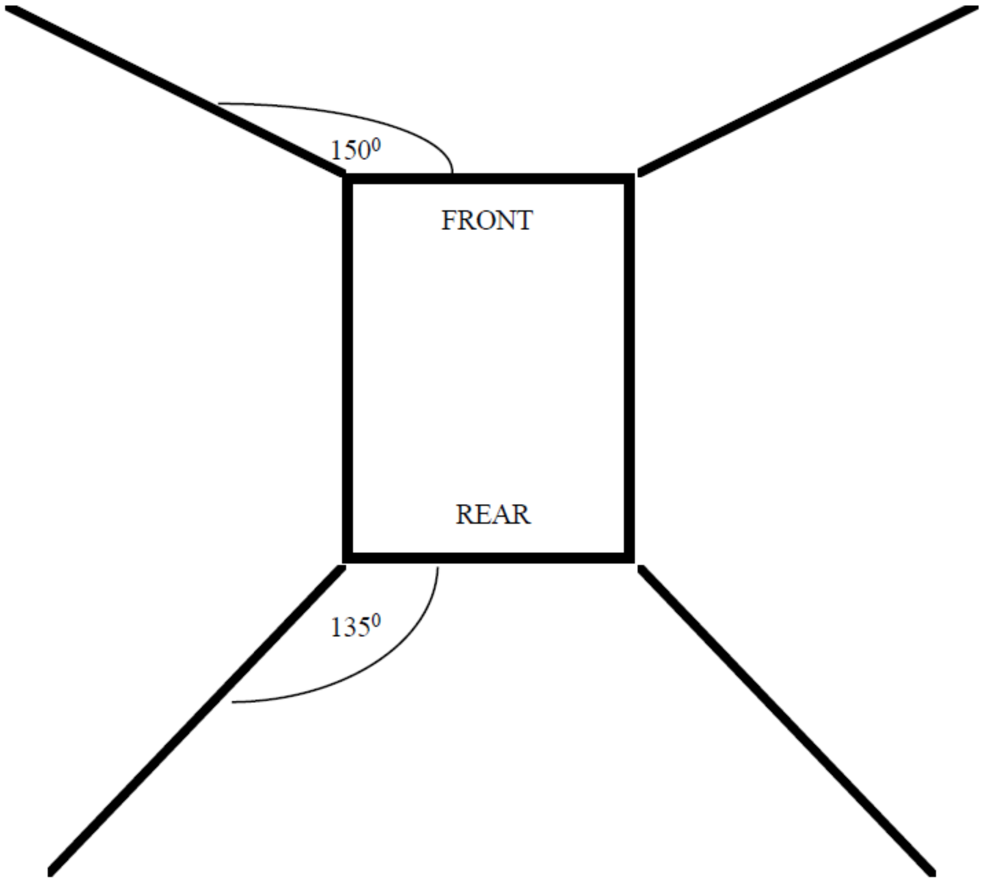
Symbol	Type of Structure / Area	Description	Directional Effects
	Vulnerable Building	Hospitals, Glass facade Buildings etc.	Any direction to PES.

Table C.1: QD Symbology

Directional effects from ECMs with HD 1.1

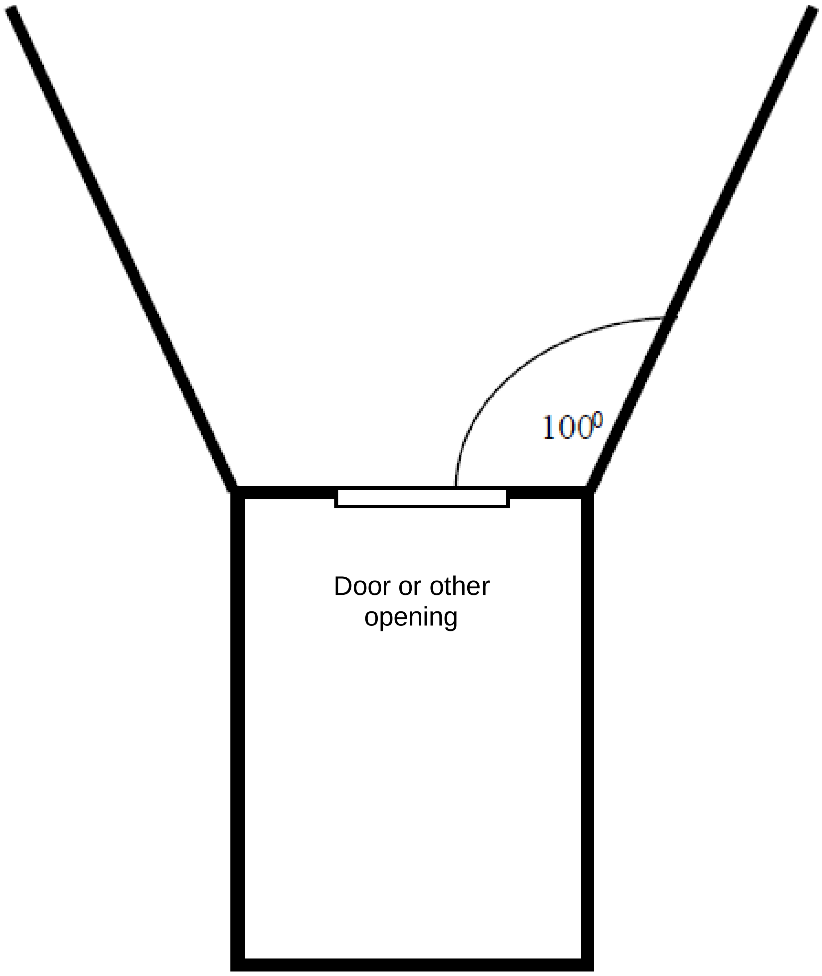
The directional effects for HD 1.1 or HD 1.3 from buildings which meet the design criteria for ECMs are considered to occur:

a. Through the front in the area bounded by lines drawn at 150º to the front face of the PES from its front corners.
b. Through the rear in the area bounded by lines drawn at 135º to the rear face of the PES from its rear corners
c. All area around a PES not included in a. or b. above are considered to be to the side of the PES. In those cases where an ES lies on the line separating rear/side of a PES, the greater QD should be observed.



Directional effects from ECMs with HD 1.2

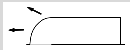
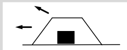
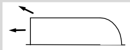
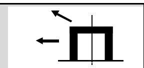
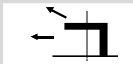
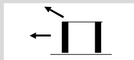
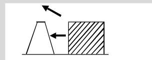
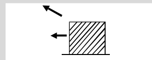
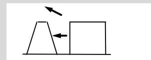
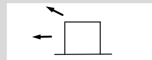
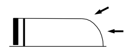
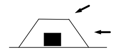
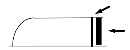
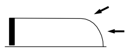
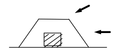
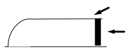
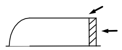
The directional effects for HD 1.2 from buildings which meet the design criteria for ECMs or HD 1.2 containment buildings are considered to occur through the front in the area bounded by lines drawn at 100º to the front face of the PES from its corners.

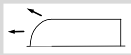
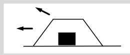
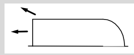
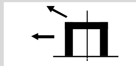
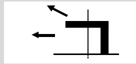
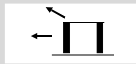
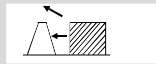
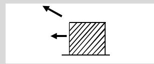
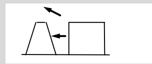
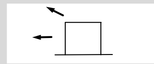
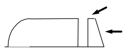
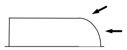
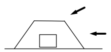
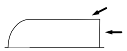


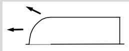
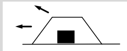
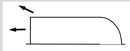
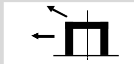
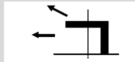
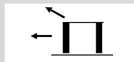
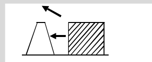
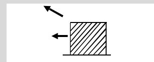
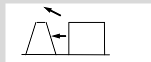
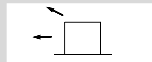
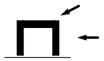
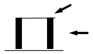
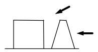
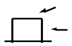
Annex D
(normative)

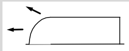
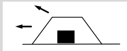
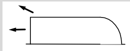
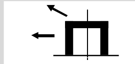
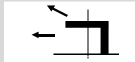
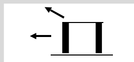
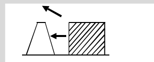
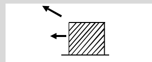
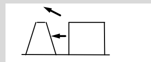
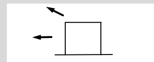
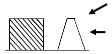
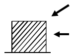
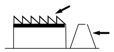
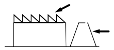
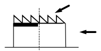
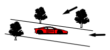
Hazard division 1.1 QD matrix (above ground storage) (LEVEL 1)

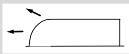
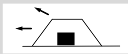
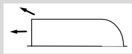
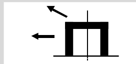
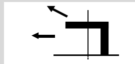
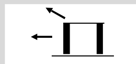
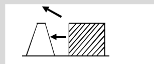
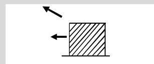
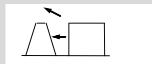
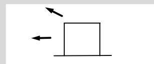
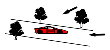
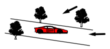
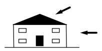
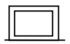
D.1 NEQ (>50kg)

PES ⇒ ES ⇓										
	**D3** Virtually Complete Protection	**D3** Virtually Complete Protection	**D4** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** Virtually Complete Protection
	**D3** Virtually Complete Protection	**D3** Virtually Complete Protection	**D5** Virtually Complete Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection
	**D4** Virtually Complete Protection	**D5** Virtually Complete Protection **or D4** High Degree of Protection	**D8** High Degree of Protection	**D8** High Degree of Protection **or D12** Virtually Complete Protection	**D8** High Degree of Protection **or D12** Virtually Complete Protection	**D8** High Degree of Protection **or D12** Virtually Complete Protection	**D8** High Degree of Protection	**D8** High Degree of Protection	**D8** High Degree of Protection	**D8** High Degree of Protection
	**D3** Virtually Complete Protection	**D3** Virtually Complete Protection	**D4** Virtually Complete Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection
	**D3** Virtually Complete Protection	**D3** Virtually Complete Protection	**D5** Virtually Complete Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection
	**D6** Virtually Complete Protection	**D6** Virtually Complete Protection	**D8** High Degree of Protection	**D9** High Degree of Protection **or D12** Virtually Complete Protection	**D9** High Degree of Protection **or D12** Virtually Complete Protection	**D9** High Degree of Protection **or D12** Virtually Complete Protection	**D8** High Degree of Protection	**D8** High Degree of Protection	**D8** High Degree of Protection	**D8** High Degree of Protection
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spa **or D7** High Degree of Protection	**D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D9** High Degree of Protection	**D9** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D9** High Degree of Protection	**D9** High Degree of Protection

PES ⇒ ES ⇓										
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection	**D9** High Degree of Protection	**D9** High Degree of Protection	**D9** High Degree of Protection	**D9** High Degree of Protection	**D9** High Degree of Protection	**D9** High Degree of Protection	**D9** High Degree of Protection
	**D4** Virtually Complete Protection No primary explosives No items vulnerable to spall **or D5** Virtually complete protection No primary explosives	**D4** Virtually Complete Protection No primary explosives No items vulnerable to spall **or D5** Virtually complete protection No primary explosives	**D4** High Degree of Protection No primary explosives No items vulnerable to spall Effect of lobbed ammunition **or D6** Virtually Complete Protection Effect of lobbed ammunition	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection
	**D6** Virtually Complete Protection **or D4** High Degree of Protection **No primary explosives** **No items vulnerable to spall**	**D6** Virtually Complete Protection **or D4** High Degree of Protection **No primary explosives** **No items vulnerable to spall**	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D9** Limited Degree of Protection	**D9** Limited Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D9** Limited Degree of Protection	**D9** Limited Degree of Protection

PES ⇒ **ES ⇓**										
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D5** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D5** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** Limited Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection **D1/D2** High Degree of Protection Open bomb bay storage	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection **D1/D2** High Degree of Protection Open bomb bay storage
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection **or D12** High Degree of Protection	**D9** Limited Degree of Protection **or D12**	**D9** Limited Degree of Protection **or D12**	**D9** Limited Degree of Protection **or D12**	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection **or D12**	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection **D1/D2** High Degree of Protection Open bomb bay storage	**D9** Limited Degree of Protection **or D12**

PES ⇒ ES ⇓										
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection
	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection **or D12** High Degree of Protection	**D9** Limited Degree of Protection **or D12**	**D9** Limited Degree of Protection **or D12**	**D9** Limited Degree of Protection **or D12**	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection **or D12**	**D4** High Degree of Protection No primary explosives No items vulnerable to spall **or D7** High Degree of Protection	**D9** Limited Degree of Protection **or D12**
	**D9** Less than 10 personnel **D10** Limited Degree of Personnel Protection	**D9** Less than 10 personnel **D10** Limited Degree of Personnel Protection	**D9** Less than 10 personnel **D10** Limited Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection
	**D10** (≥270m) Limited Degree of Personnel Protection	**D10** (≥270m) Limited Degree of Personnel Protection	**D10** (≥270m) Limited Degree of Personnel Protection	**D10** (≥270m) Limited Degree of Personnel Protection	**D10** (≥270m) Limited Degree of Personnel Protection	**D10** (≥270m) Limited Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection
	**D10** (≥270m) Limited Degree of Personnel Protection	**D10** (≥270m) Limited Degree of Personnel Protection	**D13** (≥270m) Limited Degree of Personnel Protection	**D13** Limited Degree of Personnel Protection	**D13** Limited Degree of Personnel Protection	**D13** Limited Degree of Personnel Protection	**D9** (≥270m) Less than 10 personnel **D10** (≥270m) High Degree of Personnel Protection	**D13** High Degree of Personnel Protection	**D9** Less than 10 personnel **D10** High Degree of Personnel Protection	**D13** High Degree of Personnel Protection
 PTR Low Density. No QD for very low density PRT and Roads.	**0.5 x D12 or 0.5 x D14** Reduced QD for standard ECM	**0.5 x D12 or 0.5 x D15** Reduced QD for standard ECM	**0.5 x D12**	**0.5 x D12**	**0.5 x D12**	**0.5 x D12**	**0.5 x D12**	**0.5 x D12**	**0.5 x D12**	**0.5 x D12**

PES ⇒ **ES ⇓**										
 PTR Medium Density	**D11** (≥270m) **or** **D16** Reduced QD for standard ECM	**D11** (≥270m) **or** **D17** Reduced QD for standard ECM	**D11** (≥270m)	**D11** (≥270m)	**D11** (≥270m)	**D11** (≥270m)	**D11** (≥180m)	**D11** (≥270m)	**D11** (≥180m)	**D11** (≥270m)
 PTR High Density	**D13** (≥400m) **or** **D14** Reduced QD for standard ECM	**D13** (≥400m) **or** **D15** Reduced QD for standard ECM	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥270m)	**D13** (≥400m)	**D13** (≥270m)	**D13** (≥400m)
 IBD	**D13** (≥400m) **or** **D14** Reduced QD for standard ECM	**D13** (≥400m) **or** **D15** Reduced QD for standard ECM	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)
 VBD	**2 x D12** **or** **2 x D14** Reduced QD for standard ECM	**2 x D12** **or** **2 x D15** Reduced QD for standard ECM	**2 x D12**	**2 x D12**	**2 x D12**	**2 x D12**	**2 x D12**	**2 x D12**	**2 x D12**	**2 x D12**
Office <20 Support staff working in explosives area	**D11** (≥270m) **or** **D16** Reduced QD for standard ECM	**D11** (≥270m) **or** **D17** Reduced QD for standard ECM	**D11** (≥270m)	**D11** (≥270m)	**D11** (≥270m)	**D11** (≥270m)	**D11** (≥180m)	**D11** (≥270m)	**D11** (≥180m)	**D11** (≥270m)
Office >20 Support staff working in explosives area	**D13** (≥400m) **or** **D14** Reduced QD for standard ECM	**D13** (≥400m) **or** **D15** Reduced QD for standard ECM	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥270m)	**D13** (≥400m)	**D13** (≥270m)	**D13** (≥400m)

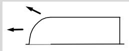
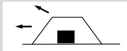
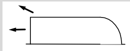
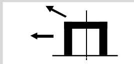
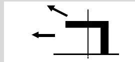
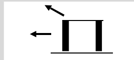
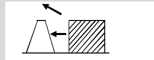
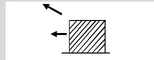
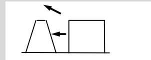
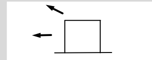
PES ⇒ **ES ⇓**										
Overhead Power Grid Super Network Normal Network Minor Network	**D13 or D14** Reduced QD for standard ECM **D11 or D16** Reduced QD for standard ECM **D10** Reduced QD for standard ECM	**D13 or D15** Reduced QD for standard ECM **D11 or D17** Reduced QD for standard ECM **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**	**D13** **D11** **D10**
POL Facilities Protected or Underground	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)	**0.5 x D7** (≥25m)
Unprotected, Above Ground and Vital	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)	**D13** (≥400m)
Unprotected, Above Ground Minor facilities	**D13**	**D13**	**D13**	**D13**	**D13**	**D13**	**D13**	**D13**	**D13**	**D13**
Small Quantity < 100 litres of petroleum, oils and lubricants held as immediate reserves for operational purposes.	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**

Table D.1: QD Matrix for HD 1.1 (Above Ground Storage) (>50kg)

Annex E
(normative)

Hazard division 1.1 QD tables (above ground storage) (LEVEL 1)

E.1 NEQ (>50kg)

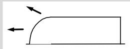
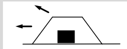
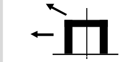
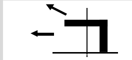
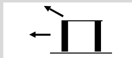
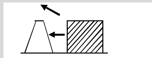
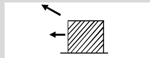
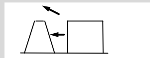
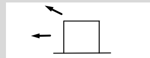
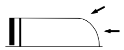
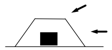
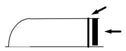
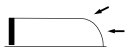
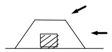
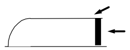
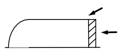
NEQ (kg)	Quantity Distances (metres)																
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17
>50	3		5	7	9	15	20	29	39	64	147	85	220	220	220	220	220
75	3		5	7	9	15	20	29	39	64	147	95	220	258	258	258	258
100	3		5	7	9	15	20	29	39	64	160	105	240	294	294	240	240
200	3		5	7	9	15	20	29	39	64	180	130	270	376	376	270	270
300	3		5	7	9	15	20	29	39	64	180	150	270	400	400	270	270
400	3		5	7	9	15	20	29	39	64	180	165	270	400	400	270	270
500	3		5	7	9	15	20	29	39	64	180	180	270	400	400	270	270
600	3		5	7	10	16	21	31	41	68	180	190	270	400	400	270	270
700	4		5	8	10	16	22	32	43	72	180	200	270	400	400	270	270
800	4		5	8	11	17	23	34	45	75	180	210	270	400	400	270	270
900	4		5	8	11	18	24	35	47	78	180	215	270	400	400	270	270
1,000	4		5	8	11	18	24	36	48	80	180	225	270	400	400	270	270
1,200	4		6	9	12	20	26	39	52	86	180	240	270	400	400	270	270
1,400	4		6	9	13	21	27	41	54	90	180	250	270	400	400	270	270
1,600	5		6	10	13	22	29	43	57	94	180	260	270	400	400	270	270
1,800	5		7	10	14	22	30	44	59	98	180	270	270	400	400	270	270
2,000	5		7	11	14	23	31	46	61	105	180	280	270	400	400	270	270
2,500	5		7	11	15	25	33	49	66	110	185	305	280	400	400	270	270

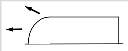
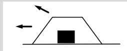
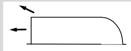
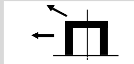
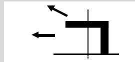
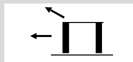
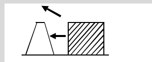
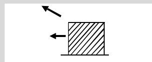
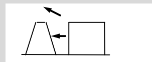
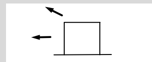
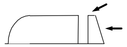
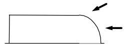
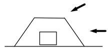
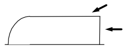
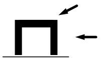
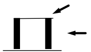
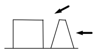
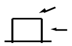
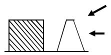
NEQ (kg)	Quantity Distances (metres)																
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17
3,000	6		8	12	16	26	35	52	70	120	205	325	305	400	400	270	270
3,500	6		8	13	17	28	37	55	73	125	220	340	330	400	400	270	270
4,000	6		8	13	18	29	39	58	77	130	235	355	350	400	400	270	270
5,000	6		9	14	19	31	42	62	83	140	255	380	380	400	400	270	270
6,000	7		10	15	20	33	44	66	88	150	270	405	405	400	400	270	270
7,000	7		10	16	22	35	46	69	92	155	285	425	425	400	400	270	270
8,000	7		10	16	22	36	48	72	96	160	300	445	445	400	400	270	270
9,000	8		11	17	23	38	50	75	100	170	310	465	465	400	400	270	270
10,000	8		11	18	24	39	52	78	105	175	320	480	480	400	400	270	270
12,000	9		12	19	26	42	55	83	110	185	340	510	510	400	415	270	275
14,000	9		13	20	27	44	58	87	120	195	360	540	540	400	435	270	290
16,000	10		13	21	28	46	61	91	125	205	375	560	560	400	455	270	305
18,000	10		14	21	29	48	63	95	130	210	390	590	590	400	475	270	315
20,000	10		14	22	30	49	66	98	135	220	405	610	610	400	490	270	330
25,000	11		15	24	33	53	71	110	145	235	435	650	650	410	530	275	355
30,000	11		16	25	35	56	75	115	150	250	460	690	690	435	560	290	375
35,000		15	17	27	36	59	79	120	160	265	485	730	730	460	580	305	395
40,000		16	18	28	38	62	82	125	165	275	510	760	760	500	620	320	415
50,000		17	19	30	41	67	89	135	180	295	550	820	820	515	663	343	442
60,000		18	20	32	44	71	94	145	190	315	580	870	870	548	705	364	470
70,000		19	21	33	46	75	99	150	200	330	610	920	920	577	742	383	495
80,000		19	22	35	48	78	105	160	210	345	640	960	960	603	776	401	517
90,000		20	23	36	50	81	110	165	220	360	670	1000	1000	627	807	417	538
100,000		21	24	38	52	84	115	170	225	375	690	1040	1040	650	835	432	557
120,000		22	25	40	55	89	120	180	240	395	730	1100	1100	690	887	459	592

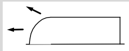
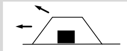
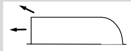
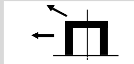
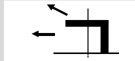
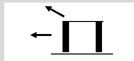
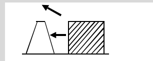
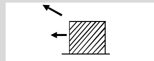
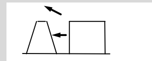
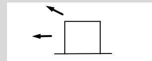
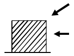
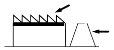
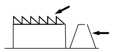
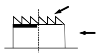
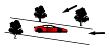
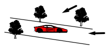
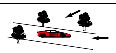
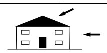
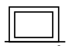
NEQ (kg)	Quantity Distances (metres)																
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17
140,000			26	42	58	94	125	190	250	420	770	1160	1160	727	935	483	623
160,000			28	44	60	98	135	200	265	435	810	1220	1220	760	977	505	651
180,000			29	46	63	105	140	205	275	455	840	1260	1260	790	1016	525	678
200,000			30	47	65	110	145	215	285	470	870	1300	1300	819	1053	544	702
250,000			32	51	70	115	155	230	305	510	940	1400	1400	882	1134	586	756
CAUTION Check the Q root.	$0.35Q^{1/3}$	$0.44Q^{1/3}$	$0.5Q^{1/3}$	$0.8Q^{1/3}$	$1.1Q^{1/3}$	$1.8Q^{1/3}$	$2.4Q^{1/3}$	$3.6Q^{1/3}$	$4.8Q^{1/3}$	$8.0Q^{1/3}$	$1.0Q^{2/3}$ for Q<2500 $3.6Q^{1/2}$ for Q>2500 $14.8Q^{1/3}$ for Q>4500	$22.2Q^{1/3}$	$1.5Q^{2/3}$ for Q<2500 $5.5Q^{1/2}$ for Q>2500 $22.2Q^{1/3}$ for Q>4500	$14.0Q^{1/3}$	$18.0Q^{1/3}$	$9.3Q^{1/3}$	$12.0Q^{1/3}$

Table E.1: QD Table for HD 1.1 (Above Ground Storage) (>50kg)

Annex F
(normative)
Hazard division 1.2.1 QD matrix (above ground storage) (LEVEL 1)

PES ⇒ ES ⇓										
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection

PES ⇒ ES ⇓										
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D6** Limited Degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection	**D6** High Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D6** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D6** Limited degree of Protection	**D6** Limited degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D6** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D6** Limited degree of Protection	**D6** Limited degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D6** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D6** Limited degree of Protection	**D6** Limited degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection	**D6** Limited Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**No QD** High Degree of Protection	**No QD** High Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection

PES ⇒ ES ⇓										
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** High Degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**No QD** High Degree of Protection	**No QD** High Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection
	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons
	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D4** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D4** High/Limited Degree of Protection for Persons	**D4** Limited Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons	**D4** High Degree of Protection for Persons rapidly evacuated
	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D6** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D6** Limited Degree of Protection for Persons	**D6** Limited Degree of Protection for Persons	**D6** High Degree of Protection for Persons	**D6** High Degree of Protection for Persons	**D6** High Degree of Protection for Persons	**D6** High Degree of Protection for Persons
 PTR Low Density. No QD for very low density PRT and Roads.	**No QD**	**No QD**	**0.5 x D2**	**No QD**	**0.5 x D2**	**0.5 x D2**	**0.5 x D2**	**0.5 x D2**	**0.5 x D2**	**0.5 x D2**
 PTR Medium Density	**No QD**	**No QD**	**D6**	**No QD**	**D6**	**D6**	**D6**	**D6**	**D6**	**D6**
 PTR High Density	**60m**	**60m**	**D2**	**60m**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
 IBD	**60m**	**60m**	**D2**	**60m**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
 VBD	**60m**	**60m**	**D2**	**60m**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**

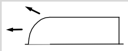
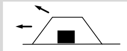
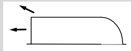
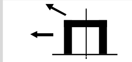
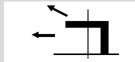
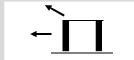
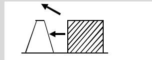
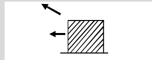
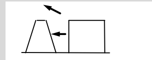
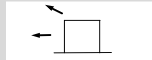
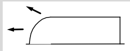
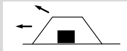
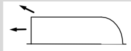
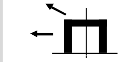
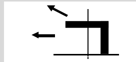
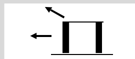
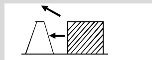
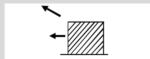
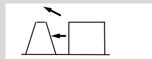
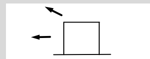
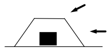
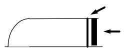
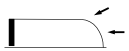
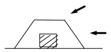
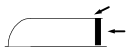
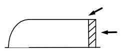
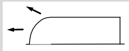
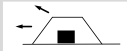
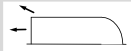
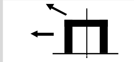
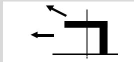
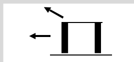
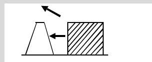
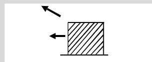
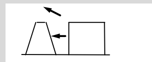
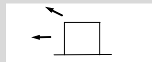
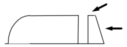
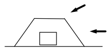
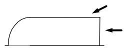
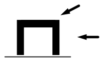
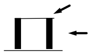
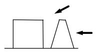
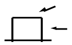
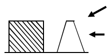
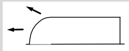
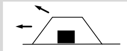
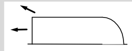
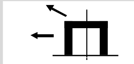
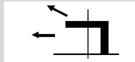
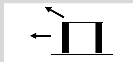
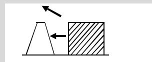
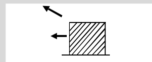
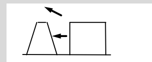
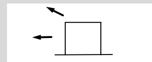
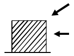
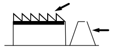
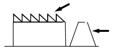
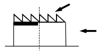
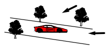
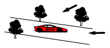
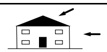
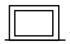
PES ⇒ ES ⇓										
Office <20 Support staff working in explosives area	**40m**	**40m**	**D6**	**40m**	**D6**	**D6**	**D6**	**D6**	**D6**	**D6**
Office >20 Support staff working in explosives area	**60m**	**60m**	**D2**	**60m**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
Overhead Power Grid Super Network	**60m**	**60m**	**D2**	**60m**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
Normal Network	**30m**	**30m**	**D6**	**30m**	**D6**	**D6**	**D6**	**D6**	**D6**	**D6**
Minor Network	**No QD**	**No QD**	**D4**	**No QD**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
POL Facilities Protected or Underground	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**
Unprotected, Above Ground and Vital	**60m**	**60m**	**D2**	**60m**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
Unprotected, Above Ground	**30m**	**30m**	**D6**	**30m**	**D6**	**D6**	**D6**	**D6**	**D6**	**D6**
Small Quantities. < 100 litres of petroleum, oils and lubricants held as immediate reserves for operational purposes.	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**

Table F.1: QD Matrix for HD 1.2.1 (Above Ground Storage)

Annex G
(normative)
Hazard division 1.2.2 QD matrix (above ground storage) (LEVEL 1)

PES ⇒ ES ⇓										
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection

PES ⇒ ES ⇓										
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** High Degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**No QD** High Degree of Protection	**No QD** High Degree of Protection	**D5** High Degree of Protection	**D5** High Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** Limited degree of Protection	**D5** Limited degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** Limited degree of Protection	**D5** Limited degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** Limited degree of Protection	**D5** Limited degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** Limited degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**No QD** High Degree of Protection	**No QD** High Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection

PES ⇒ ES ⇓										
	**No QD** Virtually Complete Protection	**No QD** Virtually Complete Protection	**D5** High Degree of Protection	**No QD** These combinations of structures will always provide virtually complete protection	**D5** High Degree of Protection	**D5** High Degree of Protection	**No QD** High Degree of Protection	**No QD** High Degree of Protection	**D5** Limited Degree of Protection	**D5** Limited Degree of Protection
	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D3** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D3** High Degree of Protection for Persons	**D3** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D3** High Degree of Protection for Persons	**D3** High Degree of Protection for Persons
	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D3** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D3** Limited Degree of Protection for Persons	**D3** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D3** Limited Degree of Protection for Persons	**D3** Limited Degree of Protection for Persons
	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D5** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D5** Limited Degree of Protection for Persons	**D5** Limited Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**No QD** High Degree of Protection for Persons	**D5** Limited Degree of Protection for Persons	**D5** Limited Degree of Protection for Persons
 PTR Low Density No QD for very low density PRT and Roads.	**No QD**	**No QD**	**0.5 x D1**	**No QD**	**0.5 x D1**	**0.5 x D1**	**No QD**	**No QD**	**0.5 x D1**	**0.5 x D1**
 PTR Medium Density	**20m**	**20m**	**D5**	**20m**	**D5**	**D5**	**D5**	**D5**	**D5**	**D5**
 PTR (High Density)	**30m**	**30m**	**D1**	**30m**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
 IBD	**30m**	**30m**	**D1**	**30m**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
 VBD	**30m**	**30m**	**D1**	**30m**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
Office <20 Support staff working in explosives area	**20m**	**20m**	**D5**	**20m**	**D5**	**D5**	**D5**	**D5**	**D5**	**D5**

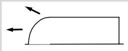
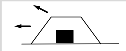
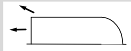
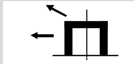
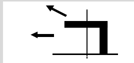
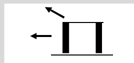
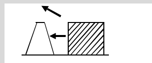
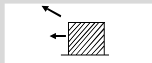
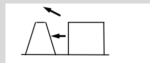
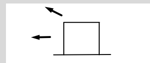
PES ⇒ ES ⇓										
Office >20 Support staff working in explosives area	**30m**	**30m**	**D1**	**30m**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
Overhead Power Grid Super Network	**30m**	**30m**	**D1**	**30m**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
Normal Network	**15m**	**15m**	**D5**	**15m**	**D5**	**D5**	**D5**	**D5**	**D5**	**D5**
Minor Network	**No QD**	**No QD**	**D3**	**No QD**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
POL Facilities Protected or Underground	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**
Unprotected, Above Ground and Vital	**30m**	**30m**	**D1**	**30m**	**D1**	**D1**	**D1**	**D1**	**D1**	**D1**
Unprotected, Above Ground	**15m**	**15m**	**D5**	**15m**	**D5**	**D5**	**D5**	**D5**	**D5**	**D5**
Small Quantities < 100 litres of petroleum, oils and lubricants held as immediate reserves for operational purposes.	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**	**No QD**

Table G.1: QD Matrix for HD 1.2.2 (Above Ground Storage)

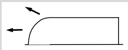
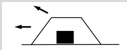
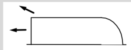
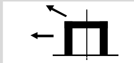
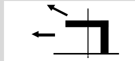
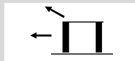
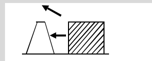
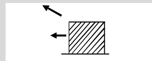
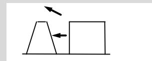
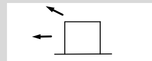
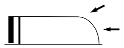
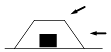
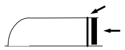
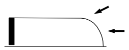
Annex H
(normative)
Hazard division 1.2 QD tables (above ground storage) (LEVEL 1)

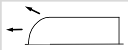
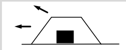
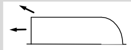
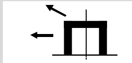
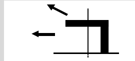
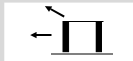
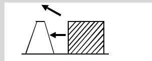
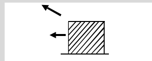
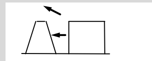
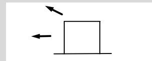
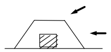
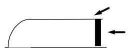
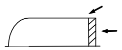
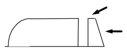
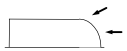
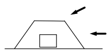
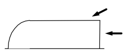
NEQ (kg)	Quantity Distances (m)					
	D1	D2	D3	D4	D5	D6
10	30	60	20	20	30	60
20	36	60	20	20	30	60
50	44	88	20	32	30	60
70	47	110	20	39	32	73
80	49	120	20	42	33	78
90	50	125	20	45	34	83
100	51	130	20	47	35	87
120	53	140	20	51	36	94
140	55	150	20	54	37	100
160	57	160	21	57	39	105
180	59	165	22	59	40	110
200	60	170	22	61	41	115
250	64	185	24	66	43	125
300	66	195	24	70	45	130
350	69	200	25	72	47	135
400	71	210	26	75	48	140
500	75	220	27	80	51	150
600	78	230	29	83	53	155
700	81	240	30	86	55	160
800	83	245	30	89	56	165
900	86	255	31	91	58	170
1,000	88	260	32	93	59	175
1,200	91	270	33	96	61	180
1,400	94	275	34	99	63	185
1,600	97	285	35	105	65	190
1,800	100	290	36	105	67	195
2,000	105	295	37	110	69	200
2,500	110	305	39	115	72	205
3,000	115	315	40	115	75	210
3,500	115	320	42	120	77	215
4,000	120	330	43	120	80	220
4,500	120	335	44	120	81	225
5,000	125	340	45	125	83	230
6,000	130	350	46	125	86	235
7,000	135	355	48	130	88	240
8,000	135	360	49	130	91	245
9,000	140	365	50	135	93	245

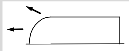
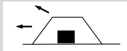
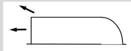
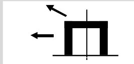
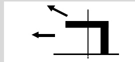
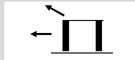
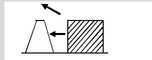
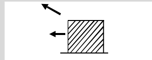
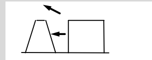
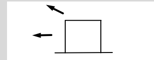
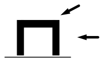
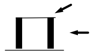
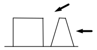
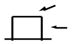
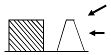
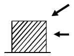
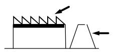
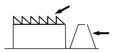
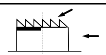
NEQ (kg)	Quantity Distances (m)					
	D1	D2	D3	D4	D5	D6
10,000	145	370	51	135	95	250
12,000	150	380	53	140	98	255
14,000	150	390	54	140	105	260
16,000	155	395	56	145	105	265
18,000	160	400	57	145	110	270
20,000	160	405	58	145	110	275
25,000	170	415	60	150	115	280
30,000	175	420	62	155	120	285
35,000	180	430	64	155	120	290
40,000	185	435	66	160	125	295
45,000	185	440	67	160	125	295
50,000	190	445	68	160	130	300
60,000	195	450	70	165	130	305
70,000	200	455	72	165	135	305
80,000	205	465	74	170	140	310
90,000	210	470	75	170	140	315
100,000	215	470	76	170	145	315
120,000	220	480	79	175	150	320
140,000	225	485	80	175	150	325
160,000	230	490	82	180	155	330
180,000	235	495	84	180	155	335
200,000	235	500	85	180	160	335
250,000	245	510	88	185	165	340
500,000	270	540	97	195	185	360
CAUTION Check the Q root.	**$D1 = 28.127-2.364*LN(NEQ)+1.577*((LN(NEQ))^2)$**	**$D 2 = -167.648+70.345*LN(NEQ)-1.303*((LN(NEQ))^2)$**	**0.36*D1**	**0.36*D2**	**0.67*D1**	**0.67*D2**

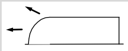
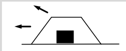
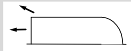
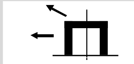
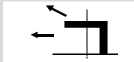
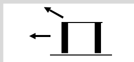
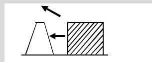
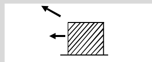
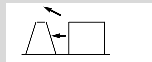
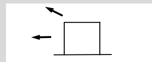
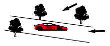
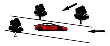
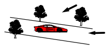
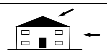
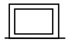
Table H.1: QD Table for HD 1.2 (Above Ground Storage)

Annex J
(normative)
Hazard division 1.3.1 QD matrix (above ground storage) (LEVEL 1)

PES ⇒ ES ⇓										
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection

PES ⇒ **ES ⇓**										
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection
	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**D1** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**D1** High Degree of Protection	**25m** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection
	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**D1** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**D1** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection
	**25m** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection

PES ⇒ ES ⇓										
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High/Limited degree of protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High degree of protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High/Limited degree of protection	**25m** These combinations of structures will always provide virtually complete protection **10m** High/Limited degree of protection
	**25m** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** High Degree of Protection	**D1** High/Limited Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High/Limited Degree of Protection	**D1** High/Limited Degree of Protection
	**25m** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High/Limited Degree of Protection	**D1** High/Limited Degree of Protection
	**25m** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High Degree of Protection	**D1** High/Limited Degree of Protection	**D1** High/Limited Degree of Protection
	**25m** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1**These combination of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** High/Limited Degree of Protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection
	**25m** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** High/Limited Degree of Protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection	**D1** These combinations of structures will always provide virtually complete protection
	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**

PES ⇒ **ES** ⇓										
 PTR Low Density No QD for very low density PRT and Roads.	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**
 PTR Medium Density	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
 PTR High Density	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
 IBD	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
 VBD	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Office <20 Support staff working in explosives area	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
Office >20 Support staff working in explosives area	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Overhead Power Grid Super Network Normal Network Minor Network	**D4** **D3** **D2**	**D4** **D3** **D2**	**D4** **D3** **D2**	**D4** **D3** **D2** (>15m)	**D4** **D3** **D2** (>15m)	**D4** **D3** **D2** (>15m)	**D4** **D3** **D2** (>15m)	**D4** **D3** **D2** (>15m)	**D4** **D3** **D2** (>15m)	**D4** **D3** **D2** (>15m)

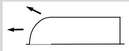
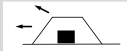
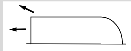
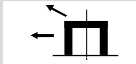
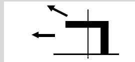
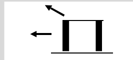
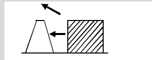
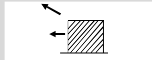
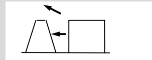
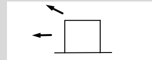
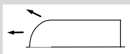
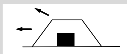
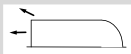
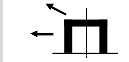
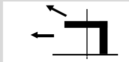
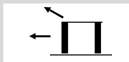
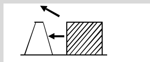
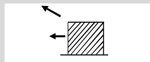
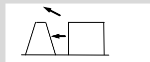
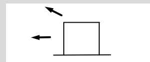
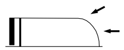
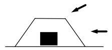
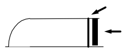
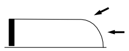
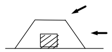
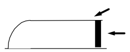
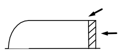
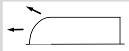
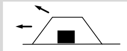
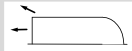
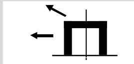
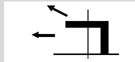
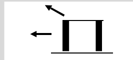
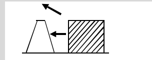
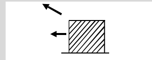
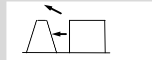
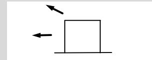
PES ⇒ ES ⇓										
POL Facilities Protected or Underground	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**
Unprotected, Above Ground and Vital	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Unprotected, Above Ground	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
Small Quantities < 100 litres of petroleum, oils and lubricants held as immediate reserves for operational purposes.	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**

Table J.1: QD Matrix for HD 1.3.1 (Above Ground Storage)

Annex K
(normative)
Hazard division 1.3.2 QD matrix (above ground storage) (LEVEL 1)

PES ⇒ ES ⇓										
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m**These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**25m** These combinations of structures will always provide virtually complete protection

PES ⇒ **ES ⇓**										
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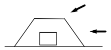
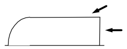
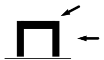
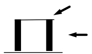
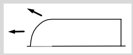
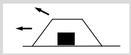
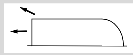
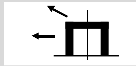
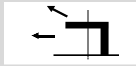
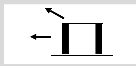
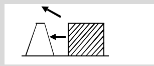
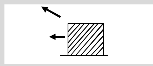
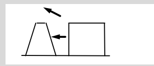
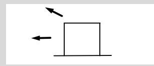
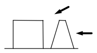
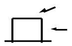
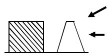
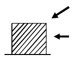
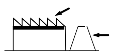
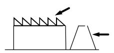
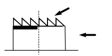
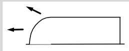
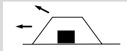
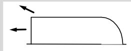
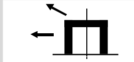
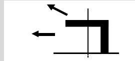
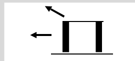
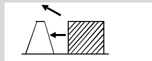
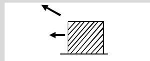
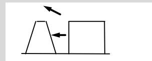
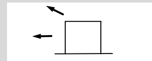
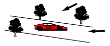
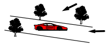
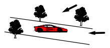
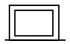
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection
	**No QD** These combinations of structures will always provide virtually complete protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection
	**No QD** These combinations of structures will always provide virtually complete protection	**No QD** These combinations of structures will always provide virtually complete protection	**10m** High/Limited Degree of Protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection	**10m** These combinations of structures will always provide virtually complete protection
	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection

PES ⇒ ES ⇓										
	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection
	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection
	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection
	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** These combinations of structures will always provide virtually complete protection **25m** High/Limited degree of protection	**60m** High/Limited Degree of Protection	**10m** These combinations of structures will always provide virtually complete protection	**60m** High Degree of Protection	**10m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection
	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**
	**60m**	**60m**	**60m**	**60m**	**60m**	**60m**	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection
	**60m**	**60m**	**60m**	**60m**	**25m**	**60m**	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection	**60m** High/Limited Degree of Protection

PES ⇒ **ES ⇓**										
 PTR Low Density No QD for very low density PRT and Roads.	**60m**	**60m**	**60m**	**60m**	**60m**	**60m**	**60m**	**60m**	**60m**	**60m**
 PTR Medium Density	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
 PTR High Density	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
 IBD	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
 VBD	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Office <20 Support staff working in explosives area	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
Office >20 Support staff working in explosives area	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Overhead Power Grid Super Network	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Normal Network	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
Minor Network	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**	**D2**

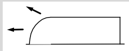
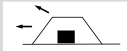
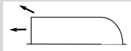
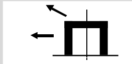
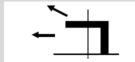
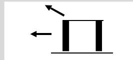
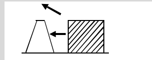
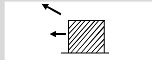
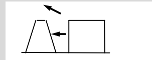
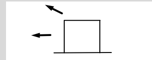
PES ⇒ **ES ⇓**										
POL Facilities	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**	**25m**
Protected or Underground	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**	**D4**
Unprotected, Above Ground and Vital Unprotected, Above Ground	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**	**D3**
Small Quantities < 100 litres of petroleum, oils and lubricants held as immediate reserves for operational purposes.	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**	**10m**

Table K.1: QD Matrix for HD 1.3.2 (Above Ground Storage)

Annex L
(normative)
Hazard division 1.3 QD tables (above ground storage) (LEVEL 1)

NEQ (kg)	Quantity Distances (m)			
	D1	D2	D3	D4
500	25	60	60	60
600	25	60	60	60
700	25	60	60	60
800	25	60	60	60
900	25	60	60	62
1,000	25	60	60	64
1,200	25	60	60	69
1,400	25	60	60	72
1,600	25	60	60	75
1,800	25	60	60	78
2,000	25	60	60	81
2,500	25	60	60	87
3,000	25	60	62	93
3,500	25	60	65	98
4,000	25	60	68	105
5,000	25	60	73	110
6,000	25	60	78	120
7,000	25	62	82	125
8,000	25	64	86	130
9,000	25	67	89	135
10,000	25	68	92	140
12,000	25	74	98	150
14,000	27	78	105	155
16,000	28	81	110	165
18,000	30	84	115	170
20,000	32	87	120	175
25,000	35	94	125	190
30,000	39	100	135	200
35,000	42	105	140	210
40,000	44	110	150	220
50,000	50	120	160	240
60,000	54	130	170	255
70,000	59	135	180	265
80,000	63	140	185	280
90,000	66	145	195	290
100,000	70	150	200	300
120,000	77	160	215	320

NEQ (kg)	Quantity Distances (m)			
	D1	D2	D3	D4
140,000	83	170	225	335
160,000	88	175	235	350
180,000	94	185	245	365
200,000	99	190	250	375
250,000	110	205	270	405
Distance Functions				
	$0.22Q^{1/2}$	$3.2Q^{1/3}$	$4.3Q^{1/3}$	$6.4Q^{1/3}$

Table L.1: QD Table for HD 1.3 (Above Ground Storage)

Annex M
(normative)
Hazard division QD matrix (underground storage) (LEVEL 2)

The number of variables that impact on an explosive event within underground storage means that it is not possible to provide a single matrix relating PES to ES. Instead a range of QD coefficient factors are summarised or explained in Table M.1.

Factor	QD	QD Function / Formula	Remarks
Propagation by Rock Spall (Hard Rock) D_{cd} (Loading Density < 270kg/m^3)	D1[25]	**$0.6Q^{1/3}$**	A minimum of 5m shall be applied.
Major Damage Prevention by Rock Spall (Hard Rock) D_{cd} (Loading Density < 50kg/m^3)	D2	**$1.0Q^{1/3}$**	A minimum of 5m shall be applied.
Major Damage Prevention by Rock Spall (Sandstone) D_{cd}	D3	**$1.4Q^{1/3}$**	A minimum of 5m shall be applied.
Major Damage Prevention by Rock Spall (Limestone) D_{cd}	D4	**$1.7Q^{1/3}$**	A minimum of 5m shall be applied.
Major Damage Prevention by Rock Spall (Hard Rock) D_{cd} (Loading Density > 50kg/m^3)	D5	**$2.0Q^{1/3}$**	A minimum of 5m shall be applied.
Propagation by Flames and Hot Gases through Cracks and Fissures	CID	**$0.3Q^{1/3}$ to $2.0Q^{1/3}$**	The Q factor should be determined by geological survey. Unlikely to propagate if the CID is greater than 2.0 $Q^{1/3}$.
Blast from Tunnel Entrance[26] [27]	IBD PTRD[28]	**$D = 77 \times H_D \times LD^{1/3}$**	Where: H_D = Hydraulic Diameter of Tunnel Mouth $LD^{1/3}$ = Loading Density (kg/m^3)
		$H_D = 4A/C$	Where: A = Cross-sectional Area of Tunnel Entrance (m^2) C = Circumference of Tunnel Entrance (m)
		$LD^{1/3} = \dfrac{NEQ}{(V_{Ch} + V_{Tunnel})}$	V_{Ch}= Chamber Volume (m^3) V_{Tunnel} = Tunnel Volume (m^3)
Blast from Tunnel Entrance [50] [51]	APBD	**$D = 27.4 \times H_D \times LD^{1/3}$**	As above
Blast Effects from Surface Crater	IBD PTRD	**$22.2Q^{1/3}$**	Where the cover thickness is <$0.1Q^{1/3}$.
		$11.1Q^{1/3}$	Where the cover thickness is >$0.1Q^{1/3}$ but <$0.2Q^{1/3}$.
		$5.6Q^{1/3}$	Where the cover thickness is >$0.2Q^{1/3}$ but <$0.3Q^{1/3}$.
		Nil	Where the cover thickness is >$0.3Q^{1/3}$, as the effects will be negligible.
Ground Shock (Sand, Gravel, Wet Clay) *(Where the maximum particle velocity is 60mm/s)*	IBD PTRD	**$0.9\ f_d\ Q^{4/9}$**	Where: f_d = Decoupling Factor from Graph M.1. The PTRD is 2/3 IBD.
Ground Shock (Sandstone, Soft Rock) *(Where the maximum particle velocity is 115mm/s)*		**$4.8\ f_d\ Q^{4/9}$**	

[25] This may be reduced to as low as $0.3Q^{1/3}$ if the acceptor chamber has protective construction to prevent spall and collapse.

[26] The distance in a non-axial direction may be reduced using a multiplication factor (MF), which should be derived from the formula $MF = 1 / (1 + (\theta/56)^2)^{0.76}$, where θ is the angle from the tunnel centre line in degrees.

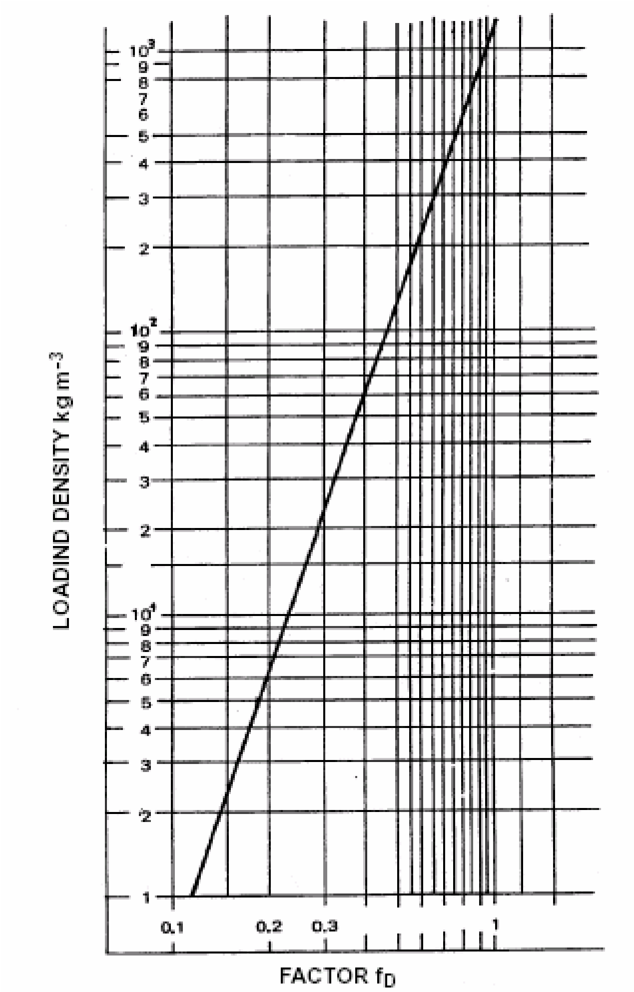
[27] This is a simple approximation. A more accurate methodology is in AASTP-1, Part 3, Clause 3.3.4.1 (b) and (c).

[28] For minor routes 2/3 of the IBD may be used in all cases.

Factor	QD	QD Function / Formula	Remarks
Ground Shock (Sand, Gravel, Wet Clay) *(Where the maximum particle velocity is 60mm/s)*		**$5.4\ f_d\ Q^{4/9}$**	
Debris Effects from Tunnel Entrance[29]	IBD PTRD	**600m**	For an arc of 10^0 either side of the centre line of the tunnel. Ideally all ES should be outside an arc of 30^0 either side of the centre line of the tunnel in order to enhance safety. Fragment/debris IBD can be reduced significantly with the addition of a proper barricade that eliminates line-of-sight out the tunnel entrance. Hence this distance may be reduced. The IBD / PTRD should be at that distance where fragment density is assessed as 'one hazardous fragment (energy greater than 79J) per $56m^2$.
Debris from Failure of Cover (Surface Crater Debris) (Hard Rock) *Limitations:* *NEQ from 1000kg to 2,000,000kg* *ɣ from $1kg/m^3$ to $300kg/m^3$* *$f_C > 0.1m/kg^{1/3}$*	IBD	**$38.7\ Q^{1/3}$ ɣ f_C fα**	If the scaled cover depth ($C/Q^{1/3}$) is greater than 1.2 then debris throw may be neglected. Where: ɣ = Loading Density (NEQ (kg)/Chamber Volume) C = Cover Depth (m) f_C = Scaled Cover Depth $(0.45+(2.15*C/NEQ^{1/3})-(2.11*(C/NEQ^{1/3})^2)$ fα = Overburden Slope Angle See Tables N.2 and N.3 for calculated overburden slope angle.
Debris from Failure of Cover (Surface Crater Debris) (Soft Rock) *(Limitations as above)*	IBD	**$1.15 * 38.7\ Q^{1/3}$ ɣ f_C fα**	See above

Table M.1: QD factors matrix for HD 1.1 (Underground Storage)

[29] This is a simple approximation. A more accurate methodology is in AASTP-1, Part 3, Clause 3.3.4.2.



Graph M.1: Ground shock decoupling factor (Underground Storage)

Annex N
(normative)
Hazard division QD tables (underground storage)[30] (LEVEL 2)

N.1 Chamber interval distance (CID) (HD 1.1)

NEQ (kg)	Chamber Interval Distance (m)				
	D1	D2 (Hard Rock) (<50kg/m^3)	D3 (Sandstone)	D4 (Limestone)	D5 (Hard Rock) (>50kg/m^3)
1,000	6.0	10.0	14	17	20
1,200	6.4	10.6	15	18	21
1,400	6.7	11.2	16	19	22
1,600	7.0	11.7	16	20	23
1,800	7.3	12.2	17	21	24
2,000	7.6	12.6	18	21	25
2,500	8.1	13.6	19	23	27
3,000	8.7	14.4	20	25	29
3,500	9.1	15.2	21	26	30
4,000	9.5	15.9	22	27	32
5,000	10.3	17.1	24	29	34
6,000	10.9	18.2	25	31	36
7,000	11.5	19.1	27	33	38
8,000	12.0	20.0	28	34	40
9,000	12.5	20.8	29	35	42
10,000	12.9	21.5	30	37	43
12,000	13.7	22.9	32	39	46
14,000	14.5	24.1	34	41	48
16,000	15.1	25.2	35	43	50
18,000	15.7	26.2	37	45	52
20,000	16.3	27.1	38	46	54
25,000	17.5	29.2	41	50	58
30,000	18.6	31.1	44	53	62
35,000	19.6	32.7	46	56	65
40,000	20.5	34.2	48	58	68
50,000	22.1	36.8	52	63	74
60,000	23.5	39.1	55	67	78
70,000	24.7	41.2	58	70	82
80,000	25.9	43.1	60	73	86
90,000	26.9	44.8	63	76	90
100,000	28.0	46.4	65	79	93
120,000	30.0	49.3	69	84	99
140,000	31.0	51.9	73	88	104
160,000	33.0	54.3	76	92	109

[30] For crater debris throw.

NEQ (kg)	Chamber Interval Distance (m)				
	D1	D2 (Hard Rock) (<50kg/m^3)	D3 (Sandstone)	D4 (Limestone)	D5 (Hard Rock) (>50kg/m^3)
180,000	34.0	56.5	79	96	113
200,000	35.0	58.5	82	99	117
250,000	38.0	63.0	88	107	126
300,000	40.0	66.9	94	114	134
350,000	42.0	70.5	99	120	141
400,000	44.0	73.7	103	125	147
500,000	48.0	79.4	111	135	159
Distance Functions					
	$0.6Q^{1/3}$	**$1.0Q^{1/3}$**	**$1.4Q^{1/3}$**	**$1.7Q^{1/3}$**	**$2.0Q^{1/3}$**

Table N.1: CID Table for HD 1.1 (Underground Storage)

N.2 Crater debris throw (overburden slope angle - increasing)

α (^{0})	fα
0.0	1.00
2.5	1.05
5.0	1.10
7.5	1.15
10.0	1.20
12.5	1.25
15.0	1.30
17.5	1.35
20.0	1.40
22.5	1.45
> 25.0	1.50

Table N.2: Crater debris throw (overburden slope angle – increasing)

N.3 Crater debris throw (overburden slope angle - decreasing)

α (^{0})	fα
0.0	1.00
2.5	0.94
5.0	0.88
7.5	0.81
10.0	0.75
12.5	0.69
15.0	0.63
17.5	0.56
20.0	0.50
22.5	0.44
25.0	0.38
27.5	0.31
> 30.0	0.25

Table N.3: Crater debris throw (overburden slope angle – decreasing)

Annex P
(normative)
Hazard division QD matrix (ports) (LEVEL 2)

The number of variables that impact on an explosive event within port and vessel storage means that it is not possible to provide a single matrix relating PES to ES. Instead a range of QD coefficient factors are summarised or explained in Table P.1.

Factor	QD	QD Function / Formula	Remarks
Process Buildings (Land)	PBD	**As per Annexes E, G and L as appropriate**	
Inhabited Buildings (Land)	IBD	**$16.7Q^{1/3}$**	If a high density population then $22.2Q^{1/3}$ should be applied.
Vulnerable Buildings (Land)	VBD	**$33.3Q^{1/3}$**	If a vulnerable building falls within this distance an ECA should be completed.
Public Traffic Route Low Density	PTRD	**$16.7Q^{1/3}$**	
Public Traffic Route Medium Density		**$11.1Q^{1/3}$**	
Public Traffic Route High Density		**$8.0Q^{1/3}$**	
Military personnel in open not working with the explosive shipment.		**$11.1Q^{1/3}$**	
Bulk Above Ground Petroleum, Oil and Lubricant (POL) Storage Areas		**$11.1Q^{1/3}$**	
Canteens (<50 persons)		**$11.1Q^{1/3}$**	
Canteens (>50 persons)		**$16.7Q^{1/3}$**	
Passenger Terminals and Ships during Embarking and Disembarking		**$22.2Q^{1/3}$**	When explosives are being loaded or unloaded.
		$16.7Q^{1/3}$	During normal storage.
POL Tanker Vessels		**$16.7Q^{1/3}$**	No unloading or loading operations on either ship.
		$22.2Q^{1/3}$	During concurrent loading or unloading operations.
		$16.7Q^{1/3}$	During single ship unloading or unloading operations.
Bulk Carrier Vessels (Other dangerous Goods)		**$11.1Q^{1/3}$**	
Port Operating Facilities		**$11.1Q^{1/3}$**	
Transit Storage for Dangerous Goods		**$16.7Q^{1/3}$**	
Onboard Barricades	IMD	**$0.8Q^{1/3}$**	This must equate in robustness to the level of protection afforded by an Earth Barricade of 2.4m.
Normal Protection Level (Barricaded)	SD2	**$4.8Q^{1/3}$**	For HD 1.1 Between vessels each carrying explosives only.
Normal Protection Level (Un-barricaded)	SD3	**$8.0Q^{1/3}$**	For HD 1.1 Between vessels each carrying explosives only.
Reduced Protection Level (Barricaded)	SD1	**$3.2Q^{1/3}$**	For HD 1.1 Between vessels each carrying explosives only.
Reduced Protection Level (Un-barricaded)	SD2	**$4.8Q^{1/3}$**	For HD 1.1 Between vessels each carrying explosives only.
Normal Protection Level (Unbarricaded-)	SD4	**$16.0Q^{1/3}$**	For HD 1.1 From manned vessels loading or unloading explosives.
Normal Protection Level (Barricaded)	SD3	**$8.0Q^{1/3}$**	For HD 1.1 From manned vessels, with effective internal barricaded, loading or unloading explosives. From unmanned vessels (i.e. barges) loading or unloading explosives.

Table P.1: QD factors matrix for HD 1.1 (Port Storage)

Annex Q
(normative)
Hazard division QD tables (ports) (LEVEL 2)

Q.1 Quantity distances (HD 1.1) between vessels each carrying explosives.

NEQ (kg)	Quantity Distances to other Vessels (Ships Distance (SD)) (m)			
	SD1	SD2	SD3	SD4
500	60	39	135	135
600	60	41	135	135
700	60	43	135	145
800	60	45	135	150
900	60	47	135	155
1,000	60	48	135	160
1,200	60	52	135	175
1,400	60	54	135	180
1,600	60	57	135	190
1,800	60	59	135	195
2,000	60	61	135	205
2,500	60	66	135	220
3,000	60	70	135	235
3,500	60	73	135	245
4,000	60	77	135	255
5,000	60	83	140	275
6,000	60	88	150	295
7,000	62	92	155	310
8,000	64	96	160	320
9,000	67	100	170	335
10,000	69	105	175	345
12,000	74	110	185	370
14,000	78	120	195	390
16,000	81	125	203	404
18,000	84	130	210	420
20,000	87	135	218	435
25,000	94	145	235	470
30,000	100	150	250	500
35,000	105	160	265	530
40,000	110	165	275	550
50,000	120	180	295	590
60,000	130	190	315	630
70,000	135	200	330	660
80,000	140	210	345	690

NEQ (kg)	Quantity Distances to other Vessels (Ships Distance (SD)) (m)			
	SD1	SD2	SD3	SD4
90,000	145	220	360	720
100,000	150	225	375	750
130,000	160	245	395	790
140,000	170	250	420	840
160,000	175	265	435	870
180,000	185	275	455	910
200,000	190	285	470	940
250,000	205	305	510	1,020
300,000	215	325	540	1,080
350,000	230	340	570	1,140
400,000	240	355	590	1,180
500,000	255	380	640	1,280
1,000,000	320	480	800	1,600
Distance Functions				
	$3.2Q^{1/3}$	**$4.8Q^{1/3}$**	**$8.0Q^{1/3}$**	**$16.0Q^{1/3}$**

Table Q.1: QD Table for HD 1.1 (Ports)

Q.2 Quantity distances (HD 1.2) between vessels each carrying explosives.

For HD 1.2 fixed separation distances should be applied as follows:

a) SsD 1.2.1 - 60m; and

b) SsD 1.2.2 - 30m.

For HD 1.3 a fixed separation distance of 60m should be applied under all conditions.

For HD 1.4 a fixed separation distance of 25m should be applied under all conditions.

Q.3 Quantity and separation distances between manned vessels loading or unloading explosives.

For HD 1.1, SD4 as per Tables P.1 and Q.1.

For HD 1.2 fixed separation distances should be applied as follows:

c) SsD 1.2.1 - 90m; and

d) SsD 1.2.2 - 60m.

For HD 1.3 a fixed separation distance of 60m should be applied under all conditions.

For HD 1.4 a fixed separation distance of 25m should be applied under all conditions.

Q.4 Quantity and separation distances between barricaded manned vessels or un-barricaded unmanned vessels loading or unloading explosives.

For HD 1.1, SD 3 as per Tables P.1 and Q.1.

For HD 1.2 fixed separation distances should be applied as follows:

e) SsD 1.2.1 - 90m; and

f) SsD 1.2.2 - 60m.

For HD 1.3 a fixed separation distance of 60m should be applied under all conditions.

For HD 1.4 a fixed separation distance of 25m should be applied under all conditions.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL
AMMUNITION TECHNICAL
GUIDELINES

IATG
02.30

Third edition
March 2021

Licensing of explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 02.30:2021E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The storage of ammunition and explosives presents inherent risks to nearby persons and property. A national authority shall therefore have a legal responsibility to ensure that during their storage the explosives present risks that are both tolerable and as low as reasonably practicable (the ALARP principle) .

There are a number of factors that determine the risks from explosives to people or facilities. These include: 1) the quantity and type of explosives; 2) the distance between explosives facilities and people or other facilities; 3) the type of explosives storehouses; 4) the type of public installations and 5) the amount and length of time that people and/or facilities are exposed to the risk.

One of the most efficient means of reducing and/or mitigating the risk and thereby contributing towards protecting the public from the effects of an explosive event is by the use of separation distances. These ensure that people and facilities are always at a tolerably safe distance from the explosives during storage and handling.[3] Such distances should be appropriate, recorded and promulgated in the form of an explosives limit licence (ELL) for each individual explosives storehouse (ESH) or facility.

[3] See IATG 02.20 *Quantity and separation distances.*

Licensing of explosives facilities

1 Scope

This IATG module introduces and explains the concept and development of explosives limit licences (ELL) for explosives facilities. It should be used in conjunction with IATG 02.20 *Separation and quantity distances*, which provides guidance on the appropriate safety distances to be used within the ELL.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 Glossary of *terms, definitions and abbreviations,* shall apply.

The term 'exposed site' (ES) refers to *a magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the potential explosion site (PES) under consideration*.

The term 'inside quantity distance' (IQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) inside the explosives area*.

The term 'outside quantity distance' (OQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) outside the explosives area*.

The term 'potential explosion site' (PES) refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content*.

The term 'quantity distance' (QD) refers to *the designated safe distance between a potential explosion site (PES) and an exposed site (ES)*.

The term 'separation distance' refers to *a generic term for the safe distance between a potential explosion site (PES) and an exposed site (ES).*

NOTE 1 Separation distances may or may not involve the use of the quantity distance system. They can be developed through the use of explosion consequence analysis.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Responsibility for licensing of explosives storage and processing facilities

An appropriate national technical authority shall be responsible for the development and operation of a system of licensing of ammunition storage and processing areas. This should be independent of the ammunition storage units but may be delegated to an ammunition inspectorate.[4]

5 Risk management (LEVEL 2)

5.1 General

All facilities used for storing and processing explosives should be licensed as suitable for the intended purpose. For an explosives licence to be issued the appropriate technical authority shall be satisfied that the facility will generate risks to people that are As Low As Reasonably Practicable (ALARP) when operating within the terms of that licence. This should equate to the tolerable risk that has been determined as appropriate to that society.

ALARP should be achieved by demonstrating that explosives facilities are licensed with due regard to the following principles:

a) only an authorised limit (see Clause 7.1) sufficient to meet predicted operational needs over the life of the licence should be considered. Due regard should be made to maintaining flexibility of the available storage, handling and processing assets;

b) whenever reasonably practicable, the authorised limit should be less than the maximum potential limit identified using the system in IATG 02.20 *Separation and quantity distances;*

c) exposure of the civilian population shall be avoided as far as is reasonably practicable;

d) although the cost of appropriate storage facilities with effective separation distances will be a factor, it should not be used as a justification for a stockpile management organisation not to fulfil its 'duty of care' to ensure that the risks are ALARP; and

e) any specific aspects of the licence that may require special management or review processes should be identified and given due consideration.

The prime principle of ALARP should be to think beyond pure licensing regulations as a system of automatic permission and to consider whether the activity could more reasonably and practicably be performed in a safer manner. If safety can be practicably improved beyond the guidance within IATG, then a clear 'duty of care' exists to do so that should be discharged. It should not be enough to rely upon guidance that takes no account of local conditions that might demand or allow a greater level of safety provision. Therefore, for example, it may be permissible within this guidance to place explosives at a reduced QD from people thus increasing their level of risk, but if an alternative location exists, where the activity can be carried out at a greater separation distance, that greater protection to life should be afforded. In this case however, the risks associated with relocating stocks should also be considered in parallel and an overall risk of the storage and transport processes be estimated.

[4] See Table 3 of IATG 03.10 *Inventory management.*

Further guidance on appropriate risk management principles and processes may be found in IATG 02.10 *Introduction to risk management principles and processes.*

5.2 Specific factors

Specific factors that should be considered during the preparation of an ELL for an explosives storehouse (ESH) or ammunition process building (APB) are:

a) there should be no mismatch between a theoretical physical capacity of a PES and the space that the Net Explosive Quantity (NEQ) in the form of the authorised munitions in question will occupy. The intended utilisation of the building must therefore be borne in mind and purely hypothetical circumstances discounted (see Clause 7.1);[5]

b) the ELL for an APB should ensure that the amount of ammunition and explosives present is kept to the reasonably practicable minimum. Accumulations of ammunition and explosives awaiting processing, return to storage or onward transport after processing should be kept to a minimum; and

c) the number of personnel exposed to explosives risks should always be kept to the reasonably practicable minimum. The head of the ammunition storage unit will ensure all personnel non-essential to that activity will be given appropriate protection from risk and be closely controlled by local procedures.

What is reasonably practicable will inevitably be a matter for technical judgement. However, by 'accepting the risk', the appropriate technical authority shall satisfy itself that, in its professional judgement, its decision is supported by thoroughly researched and balanced arguments that can be expected to hold up before searching scrutiny in any potential legal process. The resulting ELL shall therefore indicate or cross reference, in as much detail as possible, the factors and constraints governing the authorised NEQ limits and the matters that must be addressed, supervised and reviewed for effective safety management.

6 Types of explosives limit licence (ELL) (LEVEL 2)

Previous experience has shown that in order to maintain flexibility in storage, whilst maintaining explosives safety standards, it is advantageous to have a small range of different ELL formats. The following types of ELL should be used:

a) 'Standard' ELL. This should be the preference for an ELL unless circumstances require the use of one of the other options (see Annex C for an example that may be used);

b) 'Non-Standard' ELL. This should only be used where there are specific constraints or situations that require regular monitoring (see Annex C for an example that may be used);

[5] For example, a building should not be licensed for an explosives limit of 25,000kg when the physical space can only be occupied by ammunition with an NEQ of 10,000 kg.

c) Authorised Quantity' ELL. This may be used to authorise the storage of 'ready use' ammunition of HD 1.22, HD 1.32 and HD 1.4 within buildings that are not specifically designed for ammunition storage (e.g. a police station, unit guardroom or training store). The licence shall always specify exactly what types of ammunition by nature, hazard division and compatibility group may be stored and in what quantities. It is recommended that a maximum limit of 10kg of HD 1.22 and/or 1.32 and any quantity of HD1.4 should usually be permitted, although up to 25kg of HD 1.22 and/or 1.32 and any quantity of HD1.4 may be authorised if both the technical authority and operational commander agree the need. Where this is not practicable, due to the number of natures or the changing requirements of the facility, it is permissible to state the maximum authorised NEQ by hazard division and include a statement as to the Compatibility Groups allowed in the licence conditions (see Annex D for an example form that may be used); and

d) Demolition Site Ammunition storage ELL. This type of ELL should be used for ESH at locations where the disposal of ammunition and explosives takes place (see Annex E for an example form that may be used[6]).

Whichever ELL is authorised it shall always be supported by the ELL Supplementary Matrix (see Annex F), or an explosion consequence analysis (ECA), which shall always be physically attached to the ELL. This matrix clearly explains how the explosives limits contained in the ELL have been determined. The supporting IATG software contains a copy of the ELL Matrix that will automatically calculate the appropriate explosives limits based on the distances entered.[7]

7 Licensing criteria (LEVEL 2)

7.1 Explosives limits

There are two options for authorising the explosives limits in NEQ at a particular PES regardless of the type of ELL:

a) the Site Potential Limit. This is the potential theoretical NEQ, by HD, which is achievable at a PES after calculating the QDs to the various ES; and

b) the Authorised Limit. This is the actual limit, authorised by the appropriate technical authority, and reflects the maximum quantity of explosives, by HD, that is actually permitted at that PES.

In order to reduce or mitigate explosive risk to a minimum PES should be licensed to an Authorised Limit, unless flexibility in storage is required over the short term. Over the long term a PES could always be re-licensed to a higher authorised limit should it be necessary.

7.2 'Standard' ELL

This form of ELL shall be used as a preference. It shall be the appropriate ELL when the QD between the PES and ES can be achieved in line with the guidance provided in the QD matrices and tables in IATG 02.20 *Quantity and separation distances.*[8]

[6] more guidance can be found in the IMAS and IATG 10.10

[7] These distances and quantity limits are based on the recommended separation and quantity distances contained within IATG 02.20. The software allows the user to change quantity distance coefficients at their own risk.

[8] In exceptional circumstances, and where qualified personnel are readily available, the national technical authority may consider issuing a Standard ELL based on the results of a quantitative risk assessment conducted as part of an ECA.

7.3 'Non-Standard' ELL

A 'non-standard' ELL shall only be used in exceptional circumstances where the QD recommended at IATG 02.20 *Quantity and separation distances* cannot be met, and when an explosion consequence analysis (ECA)[9] has been used to determine the appropriate separation distances.

7.4 'Authorised Quantity' ELL

An 'authorised quantity' ELL shall only be used to allow for the storage of 'ready use' ammunition of HD 1.22, HD 1.32 and HD 1.4 within buildings that are not specifically designed for ammunition storage (e.g. a police station, unit guardroom or training store). It shall always specify exactly what types of ammunition may be stored and in what quantities. It is recommended that a maximum limit of 10kg of HD 1.22 and/or 1.32 and any quantity of HD1.4 should usually be permitted, although up to 25kg of HD 1.22 and/or 1.32 and any quantity of HD1.4 may be authorised if both the technical authority and operational commander agree the need.

7.5 'Ammunition Disposal Site' ELL

This type of ELL should be developed for all ammunition and explosives storage facilities (PES) at sites where ammunition and explosives are disposed of.

8 Management of ELL (LEVEL 2)

8.1 Change of circumstances

The head of the ammunition storage unit shall notify the appropriate national technical authority of any change in circumstances that may compromise the integrity of the ELL (e.g. new civilian houses within the agreed QD, an increase in NEQ within an ESH, etc.).

8.2 Distribution of ELL

The authorised ELL should be distributed as follows:

a) national technical authority – one copy;

b) ammunition storage unit – three copies (of which one for display); and

c) ammunition inspectorate – one copy.

8.3 Display of ELL

A copy of the ELL should be prominently displayed in all buildings and areas that are licensed to store or process ammunition and explosives. Although there is no requirement to display the supplementary pages, such as Annex E or an ECA, they should be treated as an integral part of the ELL itself and may be displayed.

8.4 Validity of ELL

8.4.1. Time validity

Once authorised, an ELL shall have a maximum life of 5 years. Licences should not require renewal or amendment within the 5-year life unless:

[9] Conducted in accordance with the guidance at IATG 02.10 *Risk management principles and processes.*

a) alterations are made to the PES;

b) a review is required by significant changes to national legislation;

c) the ALARP principal can no longer be demonstrated due to change of circumstances (see Clause 8.1); or

d) a change of use or need arises (e.g. a change from storage to processing).

Once authorised, a 'Non-Standard' ELL has a maximum life of 3 years but may be less at the discretion of the national technical authority.

8.4.2. Licence re-validation or renewal

During the year prior to the expiry date, the licence and its original supporting documentation should be reviewed by the appropriate national technical authority and re-validated against the regulations in force at the time of the review. If the justification for the licence is still valid and the risks remain ALARP, a new licence should be issued.

8.4.3. Extension to licence life

In exceptional circumstances the life of an ELL may be extended for a period of up to 12 months by the national technical authority. Such circumstances may occur when it is believed that 12 months will not be sufficient for the formal re-validation and renewal process to be followed.

8.4.4. Licence amendment

There may be occasions when a minor amendment to a licence is required but a new licence is not justified. In these cases, a copy of the letter, e-mail or signal from the national technical authority should be attached to all copies of the licence pending issue of a new licence. To avoid confusion such amendments should normally be limited to a maximum of three.

8.4.5. Letter of Authority

Where a licence cannot be issued in accordance with the ALARP principal then an appropriate 'Letter of Authority', which formally accepts the risk, should be obtained from the appropriate authority (see Clause 11 of IATG 02.10 *Introduction to risk management principals and processes*).

Copies of the Letter of Authority are to be held with all subject licences for its duration.

8.4.6. Completion of ELL

Only personnel specifically trained for the purpose[10] shall complete and authorise the issue of ELL.

8.4.7. Withdrawal / Suspension of explosives limit licences

If for any reason the national technical authority withdraws or suspends an ELL, the activity authorised by that licence shall cease immediately and shall not be resumed until either a new licence is issued or the licence has been reinstated.

[10] For example, Ammunition Managers as defined in IATG 01.90 – *Ammunition Management Personnel Competences*.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA. 2020;

b) IATG 01.50 *UN explosives classification system and codes*. UNODA. 2020;

c) IATG 02.10 *Introduction to risk management principles and processes*. UNODA. 2020;

d) IATG 02.20 *Quantity and separation distances*. UNODA. 2020;

e) IATG 03.10 *Inventory management*. UNODA. 2020;

f) IATG 02.50 *Fire safety*. UNODA. 2020;

g) IATG 05.20 *Types of buildings for explosives storage.* UNODA. 2020;

h) IATG 05.40 *Safety standards for electrical installations*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[11] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmamentammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[11] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[12]

a) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[13] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[12] Data from many of these publications has been used to develop this IATG.

[13] Where copyright permits.

Annex C
(normative)
Example Standard / Non-Standard Explosives Limits Licence (ELL)

Standard / Non-Standard[14] Explosives Limit Licence (ELL)[18]	
	IATG Form 02.30C
PES Number / Designation:	ESH 101

Unit	**Location**	**Authorised as**
123 Ammunition Depot	Crossways, Bluetown	Explosives Storehouse

Maximum Authorised NEQ											
HD 1.1		**HD 1.2.1**		**HD 1.2.2**		**HD 1.3.1**		**HD 1.3.2**		**HD 1.4**	
25,000	**and kg**	~~/or[16]~~ **25,000**	~~and~~ **kg**	/or[16] **25,000**	**and kg**	~~/or[16]~~ **25,000**	~~and~~ **kg**	/or[16] **25,000**	**kg**	**To physical capacity, ~~or~~**	~~Kg~~

Aggregation Rules Apply			
Safeguarded Outside Quantity Distance Authorised:	1,200m	**Units of Space:**	225

Licensed in Accordance With:	IATG 02.20 Quantity Distances as recommended in IATG matrices and QD tables.
Special Conditions and Notes	
Nil	
Acceptance of Risk:	Yes, as ALARP principle applied.
Endorsements:[15]	Nil

Explosives Limit Licence Authorisation					
Signature:	A D Smith	Name:	A D Smith	**Rank:**	Major
Appointment:	Technical Officer	Unit:	Ammunition Inspectorate (North)		

Date ELL Issued:	12 January 2019
Date ELL Expires:	11 January 2024
Attached Documentation:	IATG 02.30F ELL Supplementary Matrix.
Licence Serial Number:	BT/ESH101/0010

[14] Delete as appropriate.

[15] Usually applied by national technical authority.

Annex D
(normative)
Example Authorised Quantity ELL

Authorised Quantity Explosives Limit Licence (ELL)	
	IATG Form 02.30D
Building / Room:	B Company Ammunition Store

Unit	**Location**	**Authorised as**
1 Mechanised Battalion	Cavalry Barracks, Redtown	Explosives Store

Maximum Authorised NEQ

HD 1.1		**HD 1.2.1**		**HD 1.2.2**		**HD 1.3.1**		**HD 1.3.2**		**HD 1.4**
NIL	**kg**	**NIL**	**kg**	**NIL**	**kg**	**NIL**	**Kg**	**18**	**kg**	**To physical capacity, ~~or~~ ~~Kg~~**

Authorised Ammunition Types

HCC	**Ammunition Type**	**Qty**	**NEQ (kg)**	**Fire / Supplementary Symbol**
1.3s	Signal Flares	450	18.0	HD 1.3 Fire risk
1.4S	Round 5.56mm Ball	20,000	Negligible	Nil

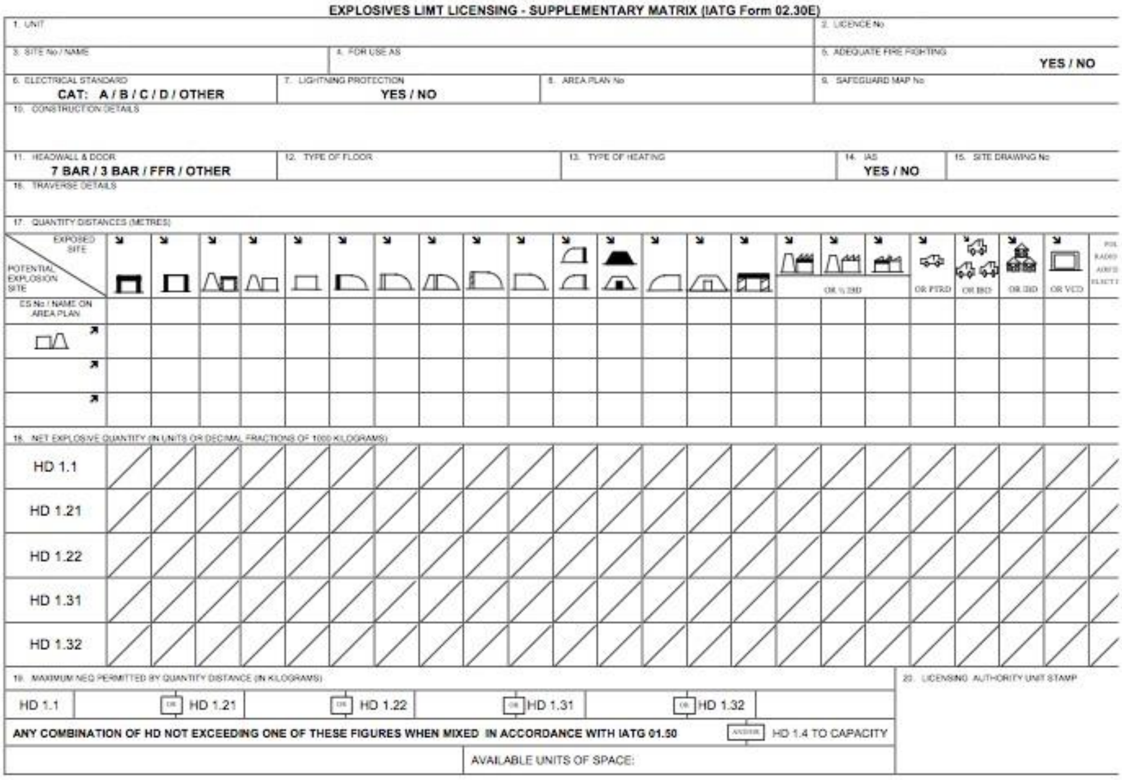
Additional Information / Special Instructions

1. All ammunition must be stored in its authorised packaging.
2. Fraction packages must be sealed and in their authorised packaging.

Explosives Limit Licence Authorisation

Signature:	A D Smith	Name:	A D Smith	**Rank:**	Major
Appointment:	Technical Officer	Unit:	Ammunition Inspectorate (North)		
Date ELL Issued:	12 January 2019				
Date ELL Expires:	11 January 2024				
Licence Serial Number:	1MR/B/001				

Annex E
(normative)
Example ELL Supplementary Matrix[16]



EXPLOSIVES LIMT LICENSING - SUPPLEMENTARY MATRIX (IATG Form 02.30E)

1. UNIT
2. LICENCE No
3. SITE No / NAME
4. FOR USE AS
5. ADEQUATE FIRE FIGHTING — YES / NO
6. ELECTRICAL STANDARD — CAT: A / B / C / D / OTHER
7. LIGHTNING PROTECTION — YES / NO
8. AREA PLAN No
9. SAFEGUARD MAP No
10. CONSTRUCTION DETAILS
11. HEADWALL & DOOR — 7 BAR / 3 BAR / FFR / OTHER
12. TYPE OF FLOOR
13. TYPE OF HEATING
14. IAS — YES / NO
15. SITE DRAWING No
16. TRAVERSE DETAILS
17. QUANTITY DISTANCES (METRES)

EXPOSED SITE / POTENTIAL EXPLOSION SITE

ES No / NAME ON AREA PLAN

OR ½ IBD — OR PTRD — OR IBD — OR IBD — OR VCD

18. NET EXPLOSIVE QUANTITY (IN UNITS OR DECIMAL FRACTIONS OF 1000 KILOGRAMS)

HD 1.1
HD 1.21
HD 1.22
HD 1.31
HD 1.32

19. MAXIMUM NEQ PERMITTED BY QUANTITY DISTANCE (IN KILOGRAMS)

HD 1.1 — OR — HD 1.21 — OR — HD 1.22 — OR — HD 1.31 — OR — HD 1.32

ANY COMBINATION OF HD NOT EXCEEDING ONE OF THESE FIGURES WHEN MIXED IN ACCORDANCE WITH IATG 01.50 — AND/OR — HD 1.4 TO CAPACITY

AVAILABLE UNITS OF SPACE:

20. LICENSING AUTHORITY UNIT STAMP

[16] A larger WORD version may be obtained from the IATG Forms part of the supplementary IATG software. IATG Form 02.30E.

Appendix 1 to Annex E (normative)
Guide to ELL Supplementary Matrix

This guide is for use with the IATG ELL Matrix in order to show the POTENTIAL NEQ of the PES (which may be reduced on the front sheet of the ELL itself for management purposes) and to provide proof of the accuracy of the Authorised NEQs on the front sheet of the Licence, if the full potential NEQ is used. It also provides other relevant detail for which there is no space on the Licence (construction details etc.).

Guidance on completion of the ELL Supplementary Matrix follows. The paragraph numbers relate to the equivalent box on the ELL Matrix:

F.1. Enter Unit in upper case.

F.2. Enter ELL Ser No e.g. BLUETOWN/ESH/001 or REDTOWN/APB/003.

F.3. Enter Site No e.g. ESH 1 or APB 3.

F.4. Enter usage e.g. 'Explosives Storehouse', 'Ammunition Process Building'.

F.5. Highlight 'YES' or 'NO', whichever is applicable. The criteria for 'Adequate' is 2 x fully manned fire engines within 5 minutes**).**

F.6. Select appropriate electrical standard. **(IATG 05.40 *Safety standards for electrical installations)*.**

F.7. Highlight 'YES' or 'NO', whichever is applicable. **(IATG 05.40 *Safety standards for electrical installations)*.**

F.8. Enter No if applicable.

F.9. As for Box 8. **(IATG 02.40 *Safeguarding of explosives storage areas (ESA))*.**

F.10. Enter Details e.g.

  a. Walls: 280mm Cavity Brick

  b. Roof: 150mm RC

  c. Doors: 25mm Metal Faced Wood

F.11. Select appropriate standard for ESH doors. **(IATG 05.20 *Types of building for explosives storage)*.**

F.12. Enter details e.g. Dust Free Concrete.

F.13. As for Box 12 e.g. Hot Water Radiators.

F.14. Intruder Alarm System (IAS). Highlight 'YES' or 'NO', whichever is applicable.

F.15. Enter No if applicable.

F.16. Enter details.

F.17. Enter appropriate symbols for PES.

F.18. The top left half should contain the appropriate quantity distance based on the QD Function (e.g. D5). The bottom right half should contain the appropriate maximum NEQ for that distance. These should be obtained from the appropriate tables within **IATG 02.20 *Quantity and separation distances.***

F.19. The **minimum NEQ from Box 18** should be selected for each HD.

F.20. Licensing Authority Unit Stamp (preferably date stamp), may be signed by Licence signatory.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 02.40

Third edition
March 2021

Safeguarding of explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 02.40:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for ‘through-life management’ approach to ammunition management. The IATG can be applied at the guidelines’ **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The storage, handling and transportation of explosives are operations that present inherent risks to persons and property. A national authority shall therefore have a legal responsibility to ensure that during storage explosives present risks to the general public that are both tolerable and as low as reasonably practicable (ALARP).

One of the most efficient means of protecting the public from the effects of an explosive event is by using separation distances, which ensure that they are always at a tolerably safe distance from the explosives during storage and handling. These separation distances frequently extend beyond the boundary of the explosive facility. Past experience has shown that without a system of safeguarding the land outside the facility boundary the civilian population may build dwellings or commercial installations thereby negating the effective separation distance. If this occurs, there should only be two options available to the ammunition storage facility: 1) the explosive quantity permitted for storage shall be reduced within the facility; or 2) the increased risk to the civilian population shall be formally accepted, even if it is above the tolerable risk level. Either option is undesirable. The alternative options of: 1) moving the civilian population from the area; or 2) moving the ammunition storage area: are political decisions outside the scope of these guidelines.

Therefore, to ensure that explosive facilities are not compromised by civil encroachment of private or public land development within the explosion danger area of the facility a system of safeguarding should be established.

Safeguarding of explosive facilities

1 Scope

This IATG module introduces and explains the concept of safeguarding for explosive facilities. A safeguarding system is designed to prevent encroachment into the explosion danger area by the civilian population and hence ensure that appropriate separation and quantity distances are maintained.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'explosion danger area' refers to *the area surrounding an explosive facility determined by the distances any blast or fragments may be expected to travel due to the detonation of ammunition*.

The term 'exposed site' (ES) refers to *a magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the potential explosion site (PES) under consideration*.

The term 'inhabited building distance' (IBD) refers to *the separation between potential explosive sites (PES) and non-associated exposed sites (ES) requiring a high degree of protection from an accidental explosion*.

NOTE 1 The IBD is a form of Outside Quantity Distance (OQD).

The term 'outside quantity distance' (OQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) outside the explosives area*.

The term 'potential explosion site' (PES) refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content*.

The term 'purple line' refers to *a continuous line drawn on an ammunition storage area map or plan which encompasses the explosives area and defines the minimum permissible distance between a potential explosion site and inhabited buildings which are by definition of vulnerable construction. It is usually at twice the yellow line or normal inhabited building distance determined by blast considerations.*

NOTE 1 The construction of new inhabited buildings of curtain-wall construction or high rise buildings is restricted.

NOTE 2 The area within the Purple Line is known as the Purple Zone.

The term 'quantity distance' (QD) refers to *the designated safe distance between a potential explosion site (PES) and an exposed site (ES)*.

The term 'safeguarding' refers *to a consultative procedure with the appropriate local authority whereby safeguarded areas outside boundary fences are established for each explosives establishment.*

NOTE 1 Explosives Safeguarding maps for each establishment are produced depicting a Yellow Line based on inhabited building distance (IBD) and a Purple Line, usually but not always, based on 2 x IBD.

NOTE 2 Copies are provided to the appropriate local authority. It is the aim to restrict the construction of any inhabited building, caravan site, or public traffic routes within the yellow line and the construction of curtainwall and high rise buildings with large glazed areas, between the yellow and purple lines.

NOTE 3 All new applications for development within safeguarded areas should be notified to the national technical authority by the appropriate local authority in order that any necessary objections may be lodged.

The term 'separation distance' refers to *a generic term for the safe distance between a potential explosion site (PES) and an exposed site (ES).*

NOTE 1 Separation distances may or may not involve the use of the quantity distance system. They can be developed through the use of explosion consequence analysis.

The term 'yellow line' refers to *a continuous line drawn on an ammunition storage area map or plan which encompasses the explosives area and defines the minimum permissible distance between a potential explosion site and inhabited buildings, caravan sites or assembly places.*

Alternatively, it may refer to *a line at the inhabited building distance within which the construction of new inhabited buildings, caravan sights and public traffic routes are restricted.*

NOTE 1 The area within the Yellow Line is known as the Yellow Zone.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Explosives safeguarding system

4.1 Rationale

A system of explosives safeguarding[3] may not be required if the legal owners of the explosives facility also own all the surrounding land out to the appropriate separation distance for vulnerable buildings. In many cases, this is unlikely to be the case, and therefore the State should ensure that it maintains a degree of control over the activities that may take place on that land. Certain activities that result in a low density of civilian presence, such as agriculture, should be permitted. Conversely, the building of civilian dwellings should not be permitted within the inhabited building distance (IBD) or, in the case of inhabited buildings which are by definition of vulnerable construction, within the vulnerable building distance (VBD).

[3] Referred to as safeguarding for the remainder of this guideline.

A formal system of safeguarding that permits the ammunition storage organisation to influence what activities are permitted within the IBD and VBD should be developed and implemented.

4.2 System requirements (LEVEL 2)

The development and implementation of an explosives safeguarding system shall require the following:

a) the development of an appropriate national technical authority, which shall represent the State on behalf of all owners of explosives facilities nationwide. This authority should be actively involved in the implementation of an explosive safeguarding system;

b) the development of appropriate legislation that enables the owners of the explosives facility (usually the State) to influence future development within the IBD and VBD (see Clause 4.3). The legislation may be used to establish the national technical authority (Clause 4.2(a)). The legislation should not allow the owners of the explosive facility to have a statutory right to unilaterally impose restrictions on development, although it may allow an appropriate Minister to impose such restrictions after all consultation has taken place;

c) the development of a consultative process between the national technical authority, local authority responsible for authorising building planning permission and the owners of the explosives facility;

d) the development of an appeals process should planning permission be granted for development within the IBD or VBD despite the safety requirements of the owners of the explosives facility; and

e) the development of appropriate procedures to be followed by all parties prior to any planning permission being granted for development of land within the IBD or VBD.

4.3 System components (LEVEL 2)

Once established a safeguarding system should consist of the following components, which are designed to support effective implementation of the safeguarding system:

a) safeguarding direction order (SDO). This should be signed at the appropriate level determined by legislation and should require that the local planning authority consult with the owners of the explosive facility before any planning permission is granted for development. A copy of an explosives safeguarding map should form part of the SDO; and

b) explosives safeguarding map (ESM). This should contain the information at Table 1.

ESM Requirement	Explanatory Notes
ESM Map Scale	▪ At least 1:10,000, although 1:2,500 is preferable.
Aerial Photography	▪ Aerial photographs may be used as an alternative to maps.
Identification of Yellow Zone[4]	▪ The Yellow Zone should be indicated by a Yellow Line around the explosives facility. ▪ The Yellow Line distance should be at the Inhabited Building Distance (IBD), see IATG 02.20 *Separation and quantity distances.* ▪ If the safeguarding direction order is approved then no inhabited buildings should be developed within the Yellow Zone without the consultation process (Clause 4.2) being followed.

[4] Colours are used to define the zones within IATG. Other identification systems are permitted.

ESM Requirement	Explanatory Notes
Identification of the Purple Zone	▪ The Purple Zone should be indicated by a Purple Line around the explosives facility. ▪ The Purple Line distance should be at the Vulnerable Building Distance (VBD), see IATG 02.20 *Separation and quantity distances..* ▪ If the safeguarding direction order is approved then no vulnerable buildings should be developed within the Purple Zone without the consultation process (Clause 4.2) being followed. ▪ Such buildings would be high rise buildings, or buildings with curtain walls or glass facades. Facilities such as hospitals, schools or culturally significant monuments or buildings might also be considered as vulnerable buildings.
Identification of the Red Zone	▪ The Red Zone is that area owned by the explosives facility.
Potential Explosive Limits	▪ The Yellow and Purple Lines may be developed based on the Potential Explosive Limits of the Potential Explosion Sites (PES) within the explosives facility rather than the Authorised Limits (Clause 7.1, IATG 02.30 *Licensing of explosive facilities)*. This allows for more flexibility in storage within the explosives facility.

Table 1: ESM requirements

An SDO and an ESM should be produced for each PES except those under an Authorised Quantity licence or only licenced to store HD 1.4. Where there is more than one PES on a site, ie in an Ammunition Storage Area (ASA), an overall, consolidated ESM must be produced showing the outermost yellow and purple lines from all PES.

5 Maintenance of the safeguarded area (LEVEL 2)

5.1 General

The safeguarding of explosive facilities is crucial to the continued operational effectiveness of a site. Although a statutory system of consultation may ensure that the majority of intended land developments come to the notice of the owners of the explosive facility, the mechanism may not be fool proof. The reasons for this are essentially fourfold:

a) local authorities may occasionally, through error, omit to inform the owner of the explosive facility about local planning applications;

b) the local authority maps may not be amended quickly enough in order to reflect any changes made to the safeguarded areas brought about by major changes in explosives licences through extensions to explosives facilities;

c) landowners within the safeguarded area may develop land without first seeking planning permission from the local authority; and

d) a national technical authority may not be in place to coordinate activities at sub-clauses a) and b) above.

5.2 Explosive safeguarding map (ESM) review and inspection

Regular reviews and physical inspections of the safeguarded area should be conducted to maintain the integrity of explosives facilities and to identify any actual[5] or potential[6] encroachment into the safeguarded area.

The ESM should be formally reviewed, and the land within the safeguarded area physically inspected, on a quarterly basis to ensure that there has been no unauthorised land development (encroachment).

5.3 Action on potential encroachments

If an actual, or potential, encroachment is discovered, it is essential that its full nature is determined quickly, but with the utmost discretion. When trying to fully identify the infringement, the following rules should be observed:

a) the parent ministry of the explosives facility should be contacted without delay so that a formal consultative process with the relevant government ministry or local planning authority may be instigated;

b) no member of the explosive facility staff should take unilateral action by contacting the local authorities, as this may compromise any future legal processes; and

c) orders to stop work may only be given by the national technical authority or local authority to personnel working on a building or building site.[7]

Immediate action within the explosives facility, such as stock relocation, may be necessary to ensure that any risk to members of the public is tolerable and ALARP. This could affect quantity and separation distances and may not be an option, so suspension of work should be the priority option for the explosives facility to legally pursue.

Explosives facilities should be aware that landowners may legally carry out certain changes on their property without necessarily seeking planning permission from the local authority. All such changes which come to the notice of the explosives facility are to be notified to the appropriate national authority responsible for explosives licensing, who shall determine the appropriate course of action.

[5] For example, new buildings are identified.

[6] For example, building activities have just commenced.

[7] If an immediate order to stop work is not given, not necessarily by the owner of the explosives facility but essentially by the local or legal authority, the work on the building or building site may develop so much that it becomes very difficult to dissuade the landowners legally. As both the owner of the explosives facility and the landowners have to comply with the law of the land, a temporary suspension of work may be imposed by the local authority pending settlement of the dispute either through consultative process or through legal means.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA. 2020;

b) IATG 02.20 *Quantity and separation distances*. UNODA. 2020; and

c) IATG 02.30 *Licensing of explosive facilities*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[8] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[8] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[9]

a) AASTP-1, Edition B Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015; http://nso.nato.int/nso/nsdd/listpromulg.html and

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[10] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[9] Data from many of these publications has been used to develop this IATG.

[10] Where copyright permits.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 02.50

Third edition
March 2021

Fire safety

IATG 02.50:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

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United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The storage and handling of ammunition and explosives are operations that present inherent risks to persons and property. A national authority shall therefore have a legal responsibility to ensure that during storage its ammunition and explosives present risks that are both tolerable and As Low As Reasonably Practicable (ALARP).

Any outbreak of fire in the vicinity of the explosives facility, or worse amongst the ammunition and explosives themselves, presents a significant hazard. In these circumstances, there is a very high and immediate risk to life and property. The situation will undoubtedly require specialist fire assistance from the local civilian authority (if this is available). Hence, much detail is provided in this IATG to enable the staff of explosives facilities to liaise effectively with those local authority staff having a responsibility for preventing and fighting fires.

This IATG module contains the principles and philosophy of firefighting, whilst also providing guidance on generic systems and procedures that should be applied. Definitive local policy cannot be provided in this IATG module on such matters as firefighting systems, numbers and the exact location of first aid firefighting equipment as this can only be determined after a detailed risk assessment. This should be undertaken in very close co-operation with specialist fire staff of the national technical authority and the local civilian authority.

Fire safety, and particularly fire prevention, is very dependent on local conditions, consequently management and supervisors within the explosives facility shall actively support and promote fire safety awareness for all personnel, including contractors and visitors to the unit.

Fire safety

1 Scope

This IATG module introduces and explains the fire safety requirements for explosive facilities.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘fire safety’ refers to *a generic term pertaining to fire prevention, firefighting and other fire related matters*.

The term ‘potential explosion site refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content*.

The term ‘ammunition process building (APB) refers to *a building or area that contains or is intended to contain one or more of the following activities: maintenance, preparation, inspection, breakdown, renovation, test or repair of ammunition and explosives.*

The term ‘process building distance’ (PBD) refers to *the distance from a building or stack containing explosives to aa APB, or from an APB to another APB, which will provide a reasonable degree of immunity for the operatives within the APB(s), and a high degree of protection against immediate or subsequent propagation of explosions.*

NOTE 1 The PBD is a form of Inside Quantity Distance (IQD).

The term ‘inhabited building distance’ (IBD) refers to *the separation between potential explosive sites and non-associated exposed sites requiring a high degree of protection from an accidental explosion*.

NOTE 1 The IBD is a form of Outside Quantity Distance (OQD).

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Principles of firefighting in explosive facilities (LEVEL 1)

4.1 Above-ground explosive facilities

The following principles should be applied to firefighting in above-ground explosive facilities:

a) initial direct firefighting activities should be aimed at preventing the ammunition and explosives from being involved in the fire;

b) for potential explosion sites containing ammunition and explosives of Hazard Division 1.1 (those with a mass explosion hazard), all firefighting activities shall take place from pre-planned and identified positions that are preferably behind hard cover. This should not be less than the appropriate Process Building Distance (PBD) (see Clause 6.1.1 in IATG 02.20 *Separation and quantity distances*);

c) for potential explosion sites containing ammunition and explosives of Hazard Division 1.1, firefighting crews shall be prepared to immediately withdraw to an appropriate pre-planned safe distance. This shall not be less than the appropriate Inhabited Building Distance (IBD) (see Clause 6.2.2 in IATG 02.20 *Separation and quantity distances*);

d) if ammunition and explosives of Hazard Division 1.1 do become involved in the fire all firefighting crews shall immediately move to the pre-planned safe distance (at Clause 5c above), even if it is likely to result in the complete loss of stocks. A close watch should then be kept for any secondary fires that may start as a result of any explosion;

e) following a mass explosion of Hazard Division 1.1 ammunition and explosives as a result of fire, action should be taken to prevent adjoining buildings becoming involved by the application of large quantities of cooling water if practicable;

f) for potential explosion sites containing ammunition and explosives of Hazard Division 1.2 (those with a projection hazard but no mass explosion hazard) all firefighting activities shall take place from pre-planned and identified positions that are preferably behind hard cover. This should not be less than the appropriate Process Building Distance (PBD) (see Clause 6.1.1 in IATG 02.20 *Separation and quantity distances*);

g) for potential explosion sites containing Hazard Division 1.2 ammunition and explosives action should be taken to prevent adjoining buildings becoming involved by the application of large quantities of cooling water if practicable;

h) there is a risk during fires involving ammunition and explosives of Hazard Divisions 1.1 and 1.2 that ammunition may be propelled out of the potential explosion site and either explode on impact or become armed and hence unexploded ordnance (UXO).[3] Fire crews should ensure that these items are not disturbed by misdirected water jets;

i) for potential explosion sites containing ammunition and explosives of Hazard Division 1.3 (those with a mass fire hazard but no mass explosion hazard) all firefighters shall be aware of the risks of rapid increases of radiant, and sometimes perpendicular jetted, heat. Firefighting activities should concentrate on containing the fire and protecting surrounding buildings;

[3] These UXO will require clearance at a later date by a pre-planned explosive ordnance disposal (EOD) operation.

j) for potential explosion sites containing ammunition and explosives of Hazard Division 1.4 (those with no significant hazard) fire crews should make use of available cover when fighting the fire. In these cases it may be possible to approach the fire at a range that allows the use of water spray; and

k) specialist advice shall be obtained on dealing with fires that may involve radiological hazards[4].

4.2 Underground explosive facilities

The following principles should be applied to firefighting in underground explosive facilities:

a) the principles at Clause 5.1 above shall also be followed, but as soon as firefighting proves ineffective all personnel shall be immediately evacuated or withdrawn from the facility;

b) a very rapid response is required to ensure that initial direct firefighting activities may be aimed at preventing the ammunition and explosives from being involved in the fire;

c) self-contained breathing apparatuses (SCBA) shall be available and used under the direction of the senior fire officer (SFO). No personnel shall enter an underground site under fire without SCBA;

d) the SFO shall make all decisions regarding the opening or closing of any ventilation systems;

e) fires involving ammunition containing smoke, incendiary or toxic substances or compositions shall not be fought as they present unacceptable hazards in these circumstances; and

f) water shall not be used to fight fires where metallic powders[5] are present as the application of water will cause an immediate and violent increase in the burning rate, with the possibility of subsequent explosion. Sites containing such powders should be marked with a NO WATER supplementary hazard warning sign.

5 Fire prevention

5.1 Fire safety plan (LEVEL 1)

The Head of the explosives facility should be responsible for the development and implementation of a fire safety plan (FSP). The following should be covered as a minimum:

Activity	Remarks
Raising the alarm	▪ Fire alarm systems.
Tasking emergency services	▪ A system to ensure the rapid response of supplementary local authority fire and rescue services is required, plus the ability to pass information to them en route if necessary.
Evacuation plan for personnel	▪ This should include appropriate safety distances, arrangements for roll calls and identification if persons are unaccounted for.
Pre-fire action plans for potential explosion sites (PES)	▪ Deployment of warning signs, sprinkler systems, drenching systems and first aid firefighting equipment.

[4] Some more advanced ammunition systems contain low level radioactive sources and materials (such as tritium).

[5] For example, aluminium powder being stored in manufacturing facilities prior to mixing with high explosive compounds to increase their power.

Activity	Remarks
Site plan	▪ This shall be updated on a regular basis to reflect current stock levels. ▪ It should include locations of PES, separation distances,[6] location of emergency water supplies, location of energy sources etc. ▪ Copies should be made available to ensure they can be rapidly handed over to the local authority Senior Fire Officer (SFO) or other external emergency services.
Design drawings	▪ Line drawings of the PES should be available for the SFO.
Liaison mechanisms	▪ Arrangements for regular liaison with local authority emergency services and regular joint training and briefings.
Staff training	▪ Training requirements for unit staff.
Media briefing	▪ A pre-agreed media briefing should be available to reassure the local community that appropriate actions are being taken to resolve the situation safely.

Table 1: FSP requirements

6 Fire alarm systems (LEVEL 1)

Fire alarm systems may be mechanical or electrical but should always be:

a) readily accessible at all times;

b) clearly visible in the dark; and

c) positioned so that the alarm can be quickly raised.

Fire alarms should be tested on a regular basis (weekly for electrical systems and monthly for mechanical systems) and the results formally recorded.

7 Fire breaks and vegetation (LEVEL 1)

There is a major fire risk with any uncontrolled growth of vegetation, particularly during dry weather conditions. Therefore, grass, trees and vegetation shall be controlled to ensure that they do not present a hazard to explosives.

7.1 Control of vegetation

The use of a 'three area plan' to reduce the risk of fire from vegetation for explosive storehouses[7] should be considered. Such a plan should have the following conditions:

a) Area 1. No vegetation should be permitted within 1 m of a PES (with the exception of earth-covered buildings). This will provide a basic fire-break;

b) Area 2. Whenever possible, no vegetation over 5 cm in height should be permitted within a further 5 m of a PES (i.e. out to 6 m). No vegetation longer than 5 cm on, or within 5 m of, earth-covered buildings, or on traverses should be permitted within 5 m of a PES. This will allow for the detection of ejected unexploded articles from any explosion; and

[6] See IATG 02.20 *Separation and quantity distances*.

[7] Similar principles should also be applied to field storage.

c) Area 3. Beyond 6m, the length of vegetation should be in accordance with a site locally assessed risk.

7.2 Control of trees and shrubs

Trees and shrubs may be permitted within explosives areas provided that they do not provide a means by which a fire can bridge a firebreak.

Highly flammable trees such as conifers and spruce should to be kept at least 30 m away from explosives facilities. Other types of tree should be kept at 15 m.

Trees should be regularly maintained by a competent person to ensure that they remain healthy, are less susceptible to storm damage and cannot hazard the PES or the contents.

7.3 Cut vegetation

Cut vegetation, such as grass clippings, fallen branches, hay, etc., should be removed from the short grass areas around PES immediately after cutting. If the cuttings are removed to a distance of not less than 50 m from a PES, they may be temporarily stacked to await removal. Cuttings should be removed as soon as possible from the date of cutting to avoid becoming a fire hazard.

Cut vegetation should not be burnt within the explosives facility.

7.4 Agricultural chemicals

Only chemicals and fertilisers whose residue does not produce or cause a significant fire risk may be used to control vegetation in explosives facilities.

8 Fire practices (LEVEL 1)

Fire practices to test arrangements at the unit level should be held at irregular intervals of not less than every two months. The practice shall include fire and evacuation drills for ammunition process buildings.

Regular liaison with the local authority fire and rescue services shall be maintained as their assistance will be required in the event of a major fire. Regular liaison visits and joint exercises should take place on an annual basis so that they are aware of the particular requirements of firefighting within an explosives facility, and that they are familiar with the layout of the explosives facility and the availability of water supplies etc.

Records should be maintained of each fire practice and a post exercise report prepared to identify any deficiencies. These deficiencies, or errors in any drills, should be resolved and a further practice using the new drills carried out asap.

9 Evacuation of personnel (LEVEL 2)

Adequate provision shall be made for the requirements in Table 2:

Requirement	Remarks
Means of escape	▪ Exit doors shall be kept clear and unobstructed.
Fire access	▪ Clear passageways and gangways through ammunition stocks within a PES shall be maintained. Painted lines should be used on the floor to indicate gangways and passageways.

Requirement	Remarks
Emergency lighting	▪ Emergency lighting should be present in above ground explosive facilities. ▪ Emergency lighting shall be present in underground explosive facilities. ▪ Emergency lighting shall operate independently of, and automatically on failure of, the normal lighting system.
Luminous guidelines	▪ Luminous guidelines indicating exit routes should be present on the floor of underground explosive facilities.

Table 2: Evacuation requirements

10 Firefighting preparation

There is a range of preparatory measures and equipment that should be implemented and/or procured to assist in major firefighting operations in the event of a fire.

10.1 Emergency water supplies (LEVEL 2)

Advice should be obtained from an SFO to determine the amount of emergency water supply (EWS) that should be stored within an explosives facility. As guidance, there should be enough water for two hours initial firefighting and the SFO can advise on the pressure requirements for, and flow rates of, the fire appliances that are likely to be required for initial firefighting.

The EWS should be made up of a combination of mains fire hydrants and emergency water tanks.

10.1.1. EWS locations

Mains fire hydrants should be located no more than 70m from the entry to a PES, whilst EWS tanks should be located no more than 100m from the PES. They should both have hard standing available next to them capable of taking the weight of fully laden fire appliances.

10.1.2. Mains fire hydrants

Mains fire hydrants should be capable of providing a minimum static pressure of 4 bar. If this is not possible then a water flow rate of 75 litres per second should be sustainable from one or more fire hydrants for a minimum of 2 hours.

The outlets of fire hydrants should be of a standard design that is compatible with both the explosive facility's and local authority's fire appliances.

If water supplies are metered there is a possibility that the meter may restrict flow rates. If this is the case a meter by-pass system should be fitted.

10.1.3. EWS tanks

The following may be considered as a form of EWS tank:

a) natural supplies. Rivers, lakes or tidal waters may all be utilised as an EWS if within the ranges at Clause 10.1.1 (above);

b) engineered supplies. Reservoirs, canals and man-made ponds fall in this category. Again the ranges at Clause 10.1.1 (above) shall apply; and

c) static tanks. Open topped tanks may be utilised. These may be above surface, partially buried or fully buried. If above surface consideration should be given to providing fragmentation protection. Experience suggests that static tanks should be of minimum capacity of 114,000 litres.

In very cold weather conditions, a system of gaining access to the water through ice (e.g. ice axes) shall be maintained.

10.1.4. Marking of EWS

Mains fire hydrants and EWS should be clearly marked, and signposts indicating their location should also be provided within the explosives facility. A range of signs that may be used is illustrated at Table 3:

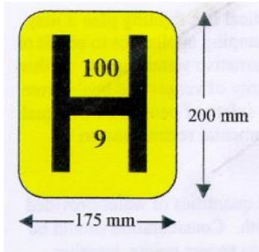
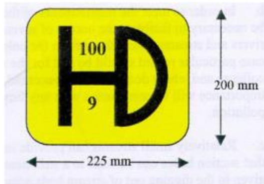
Description	Pictogram
Single Mains Hydrant[8]	
Double Mains Hydrant	
EWS Tank *(90,000 litres)*	
Direction to EWS Tank *(50,000 litres at 200 metres)*	

Table 3: EWS signs

The location of mains fire hydrants and EWS tanks shall be clearly marked on the site plan (see Table 1 to Clause 6.1).

10.1.5. Maintenance of EWS

EWS are to be inspected and tested monthly to ensure that they are in working order and that the water is at an appropriate level. Persistent loss of water in non-drought conditions would indicate a leak that requires identification and repair.

Records of inspections and tests should be maintained. These records should include water flow rates, running pressure and static pressure.

[8] 100 is the Flow Rate in Litres per Second, and 9 is the Static Pressure in Bar.

10.2 Fire signs and symbols (LEVEL 1)

It is essential that external fire crews can rapidly identify the hazards contained within each PES within the explosives facility. Hazard division signs of the 'worst risk' HD should therefore be physically displayed on all PES and on all the approaches to a PES. The hazard division signs should be changed when ammunition and explosives of a particular hazard division are removed from the PES, and replaced with the HD sign of the new 'worst risk' HD (in the order 1.1, 1.2, 1.3, 1.4 or none if no ammunition is within the PES).

Background to the hazard division system is contained in IATG 01.50:2020[E] *UN explosive classification and codes*. Table 1 of Clause 6.1 of IATG 01.50:2020[E] contains the symbols that should be used. These are repeated in Annex C of this this module for convenience.

There is also a range of supplementary fire signs that should be used to provide advice to fire crews. These cover issues such as the use of SCBA and are at Annex C.

10.3 Immediate firefighting appliances (LEVEL 1)

Immediate firefighting appliances (IFFA) shall be made available within and outside PES.[9] The type and quantity of IFFA[10] should be determined by an appropriate SFO. The requirements for the type and quantity of IFFA should also be determined by the building use:

a) explosive storehouses (ESH). Portable fire water and foam extinguishers should be available and capable of extinguishing small fires within the ESH due to electrical faults or accidents. Fire beaters should be available outside the ESH to fight small vegetation fires;

b) ammunition process buildings (APBs). Fixed IFFA installations such as hose reels should be available within APBs. Fire beaters should be available outside the APB to fight small vegetation fires, although the hose reels should have sufficient length to also do this; and

c) transit facilities. The risk at transit facilities is usually one of vehicle fires. Fixed IFFA installations such as hose reels should be available within transit facilities. Portable foam IFFA should be available for electrical fires on vehicles. Fire beaters should also be available outside the transit facility to fight small vegetation fires, although the hose reels should have sufficient length to also do this.

10.4 Major firefighting appliances

In some States the local authority fire and rescue service may be available to support firefighting activities, and they would have the major appliances (such as tenders, mobile pumps and extendable ladders) necessary to fight major fires.

For those explosive facilities where local authority fire and rescue support is unavailable a much larger scale of major firefighting equipment should be held within the explosives area. Staff shall be trained to operate such equipment and should also be trained in how to fight major fires. Professional firefighting personnel should be used to develop the appropriate training packages and to deliver such training. Similarly, their advice shall be sought as to the type and quantity of major firefighting equipment required for each particular explosives facility.

[9] This may not necessarily mean that IFFA are permanently located within explosive storehouses (ESH) as long as they are taken to the ESH on each visit.

[10] ABCE Generic Dry Powder extinguishers are now available that have the versatility to be used on all types of fire. These extinguishers should replace current foam and water extinguishers on a rolling replacement programme.

11 Firefighting

There should be two types of firefighting measures:

a) immediate firefighting by unit personnel. This may involve the use of equipment such as portable extinguishers. It shall only be conducted during the early stages of a fire; and

b) major firefighting. This shall be conducted by trained firefighting personnel and will involve the use of a wide range of equipment such as mobile firefighting appliances and SCBA. It could be undertaken by specially trained unit staff or by local authority fire and rescue services (if available).

11.1 Unit immediate actions (LEVEL 1)

The following immediate actions should be taken by unit staff if a fire is detected before any ammunition and explosives are involved, and it is small enough to be dealt with by unit level fire-fighting equipment:

a) Unless ammunition or explosives are already on fire, immediately attempt to extinguish or control the fire with the immediate firefighting equipment available;

b) sound the fire alarm;

c) evacuate all non-essential personnel in the immediate vicinity of the fire to an appropriate safe distance;

d) immediately call the appropriate fire and rescue service and request their assistance (as time may be a factor if first aid firefighting fails); and

e) prepare personnel for a wider evacuation should immediate firefighting fail to extinguish or control the fire.

Should the immediate firefighting actions fail to control the fire and it begins to spread towards the ammunition and explosives the following immediate action should be taken:

a) all personnel are to be evacuated to an appropriate safe distance based on the separation distance for the potential explosion site involved in the fire;

b) a roll call should be taken to ensure that all unit personnel and visitors are accounted for;

c) the fire and rescue service should be alerted (en route if necessary) that immediate firefighting has failed and that the fire is spreading towards the ammunition and explosives;

d) the fire safety plan (FSP) should be fully instigated.

11.2 Briefing to Senior Fire Officer (LEVEL 1)

The Senior Fire Officer (SFO)[11] will require as much information as possible to allow him/her to develop an action plan on how to most appropriately deal with the incident and how to deploy the firefighting appliances. As well as providing the SFO the site plan and building designs, the following information should be made available as a minimum:

a) the last known location of any individuals unaccounted for;

[11] The SFO may be a specially trained member of the unit, or, more usually, a senior officer of the local fire and rescue service.

b) the hazard division, type and quantity of ammunition and explosives in the potential explosion site on fire;

c) the presence of anything that may constitute a special risk (e.g. depleted uranium);

d) the separation and quantity distances extant for the site;

e) the location of emergency water supplies;

f) information from telemetric sources (e.g. temperature and humidity indicators); and

g) any further information available from eye witnesses.

11.3 Major fires (LEVEL 2)

Major fires shall be fought in accordance with the direction and instructions of the SFO based on the principles at Clauses 5.1 and 5.2. Unit personnel shall follow all instructions from the SFO who shall command all firefighting activities. He/she shall be advised on explosive risks by a senior ammunition trained and qualified officer.

Annex A
(normative)
References

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

a) IATG 01.40 *Terms, glossary and definitions*. UNODA. 2020;

b) IATG 01.50 *UN explosive classification system and codes*. UNODA. 2020; and

c) IATG 02.20 *Separation and quantity distances*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[12] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[12] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[13]

a) AASTP-1, Edition B Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015; and

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[14] used in this guideline and these can be found at www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[13] Data from many of these publications has been used to develop this IATG.

[14] Where copyright permits.

Annex C
(normative)
Fire signs (LEVEL 1)

The following hazard division signs and fire supplementary signs should be used within explosive facilities:

Hazard Division	Description	Pictogram
Hazard division signs		
1.1	Ammunition that has a mass explosion hazard.	
1.2	Ammunition that has a projection hazard but not a mass explosion hazard.	
1.3	Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.	
1.4	Ammunition that presents no significant hazard.	
1.5	Very insensitive substances, which have a mass explosion hazard.	
1.6	Extremely insensitive articles which do not have a mass explosion hazard.	
Fire supplementary signs		

Hazard Division	Description	Pictogram
N/A	Respiratory protection using SCBA required.	
N/A	Personal protective clothing required.	
N/A	Radiological hazard.	
N/A	Water prohibited.	

Table C.1: Fire signs

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 03.10

Third edition
March 2021

Inventory management

IATG 03.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Ammunition is an expensive commodity which could be regarded as an 'insurance' policy for the nation. It is hoped that it will never be needed, but long production lead times and national security commitments mean that it must be procured in advance in order that it is available on demand. This all comes at a cost which means that the inventory management systems should not only be capable of accounting for ammunition in great detail to support explosive safety but should also be designed to ensure that best 'value for money' is obtained from the ammunition.

Ammunition and explosives may deteriorate more rapidly or become damaged unless they are correctly stored, handled and transported, with the resultant effect that they may fail to function as designed and may become dangerous in storage, handling, transport and use. An accurate assessment of a munition's life is of paramount importance in terms of safety, performance and cost.

Effective inventory management is an important component in a national authority's 'Duty of Care' to ensure that only ammunition that is serviceable and safe to use is issued to security agencies for both training and operational use. There is also a 'Duty of Care' to protect the civilian population in the local areas around explosive storage areas with appropriate quantity distances based on accurate net explosives weight of stocks.

The ability to rapidly detect inadvertent inaccuracy in accounting, loss of, theft from or diversion from the national stockpile is also a key control measure of effective stockpile management. Ineffective stock accounting systems significantly increase the risk of proliferation.

Inventory management

1 Scope

This IATG module introduces the concept of inventory management and explains the processes involved that will contribute to an overall safe, secure, effective and efficient conventional ammunition management system.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'accounting' refers to *information management systems and associated operating procedures that are designed to record, numerically monitor, verify, issue and receive ammunition in organisations and stockpiles*.

The term 'batch' refers to *a discrete quantity of ammunition, which is assembled from two, or more lotted components (one of which will be the Primary Governing Component), is as homogeneous as possible and under similar conditions may be expected to give uniform performance*. *Within the batch a number of sub-batches may be found.*

The term 'batch key identity' refers to *a term used to identify a particular batch of ammunition*.

The term 'inventory management' refers to *the systems and processes that identify stockpile requirements, the condition of the stockpile, provide replenishment techniques and report actual and projected inventory status*.

The term 'lot' refers to *a predetermined quantity of ammunition or components which is as homogeneous as possible and under similar conditions may be expected to give uniform performance*. *A lot would normally be manufactured from the same raw materials, using the same production technique and in the same production run.*

The term 'munitions life assessment' refers to *a systems approach to optimising the useful life of ammunition*.

The term 'through life management' refers to *an integrated approach to the process, planning and costing activities across the whole service life of a specific ammunition type.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Aim of an inventory management system

The aim of an inventory management system is to ensure:

a) the safety of personnel during the use, storage, handling, transportation or disposal of conventional ammunition;

b) the efficient use of the conventional ammunition stockpile, which is an expensive national asset;

c) the timely and reliable detection of losses or diversions; and

d) the controlled issue and use of specific or generic conventional ammunition.

5 Inventory management functions (LEVEL 2)

An effective inventory management system should have processes and procedures that cover the following activities:

a) forecast ammunition stockpile levels and future procurement and replenishment requirements;[3]

b) record and numerically monitor stockpile levels by ammunition type, lot number and/or batch number and by exact location (ammunition accounting);

c) monitor the amount of physical storage space available for the safe storage of ammunition;

d) monitor the condition of the ammunition stockpile by each ammunition type, lot number and/or batch number (ammunition condition);[4] [5]

e) ammunition procurement and replenishment;

f) allow ammunition turnover, meaning older and ex-operational stock can be used at training before shelf life expiry or deterioration due to environmental factors make it unsuitable or unsafe for use;

g) establish and record the financial costs of the ammunition stockpile and its maintenance;

h) enable calculation of net explosive quantities to ensure adherence to explosive license limits and associated quantity distances; and

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[3] See IATG 01.30 *Policy development and advice.*

[4] This should be done using a system of surveillance, physical inspection, chemical analysis and in-service proof. See IATG 07.10 *Surveillance and proof* for further details.

[5] An explanation of lotting and batching systems is contained within IATG 03.20 *Lotting and batching*.

i) ensure that compatibility group mixing rules are being followed.

6 Through life management (LEVELS 2 and 3)

6.1 Introduction

Ammunition, due to its inherent hazards, high cost, battle winning capability and technical complexity, has to be managed efficiently and effectively A system of Through Life Management (TLM) should form part of the inventory management process as it enhances explosive safety and prolongs the useful life of the ammunition, hence delivering the optimum return on significant financial investment. It is a philosophy that brings together the behaviour, processes, functional roles and capability enabling lines as well as technical expertise that delivers a safe, secure, effective and efficient methodology for the stockpile management of conventional ammunition.

6.2 Munitions life assessments (LEVEL 2 and 3)

An essential component of TLM is Munitions Life Assessment (MLA), which is a systems approach to optimising the useful life of ammunition. MLA requires an appreciation of how ammunition ages and what environmental factors (due to storage conditions) will influence the ageing process. This is covered in detail in IATG 07.20 *Surveillance and proof.*

TLM not only improves explosive safety but can also deliver substantial cost savings, which are normally accrued towards the end of the useful life of ammunition. This is because sufficient technical data is then available to allow for safe extension of in-service life, thereby delaying the date on which replacement ammunition should be procured. Yet in order to do this, a degree of investment in effective technical inspection capability and inventory management systems is necessary in the early stages.

If a stockpile management organisation can confidently know the actual conditions that ammunition items have experienced throughout their lives, and understand the way that they degrade under such conditions, then the in-service life could be extended, if appropriate, for a particular ammunition item without compromising safety. Even decisions taken about storage conditions during short term operational deployment of ammunition (i.e. protecting the ammunition from extreme environments in terms of heat and cold) can have a major impact on prolonging ammunition in-service life.

6.2.1. MLA requirements and techniques

MLA consists of a range of knowledge requirements and techniques which may be used throughout the life cycle of the ammunition to maximise its useful life. These include:

a) effective and efficient data capture and analysis systems for ammunition technical data;

b) effective protection of ammunition from extreme climatic conditions of heat, cold and humidity;

c) the use of effective surveillance and in-service proof system, as detailed in IATG 07.20 Surveillance and In-Service Proof; and

d) a technical knowledge of how ammunition ages and may therefore fail.

6.2.2. Requirements for MLA (LEVEL 2)

For MLA to provide the most benefit there are the following requirements:

a) ammunition should not be disposed of with residual life available when there is a requirement to maintain a planned operational capability (this requirement should not be used as justification for the maintenance of surplus stocks);

b) replacement of ammunition should be planned so its arrival at the ASA coincides with when the life of existing ammunition has been fully consumed (ensuring that the appropriate safety margins are considered); and

c) excess and unused stocks that have been operationally deployed should be returned to depot storage (after appropriate technical inspection) rather than procuring new stocks.

6.2.3. Benefits of MLA

Although the use of MLA may not result in immediate financial benefit in the terms of life-cycle costs for all the ammunition currently within States' current stockpiles, it will provide other equally important benefits:

a) increased safety in storage, handling, transportation and use through a better understanding of failure modes;

b) consistent performance of ammunition during operations;

c) increased reliability of ammunition during operations;

d) a reduction in logistic and administrative requirements through improved asset tracking;

e) an improvement in the technical surveillance system by using environmental data to better target surveillance requirements;

f) more accurate life-planning of ammunition; and

g) an improvement in behaviour in the care of ammunition and the development of an 'ethos of explosive safety' at all levels.

For legacy ammunition already in an ammunition stockpile MLA should be used to initially determine the current safety of that ammunition if it is not accurately known. A subsequent decision should then be taken to either: 1) specify an in-service life and continue MLA; or 2) to destroy or demilitarize the ammunition. In many cases destruction or demilitarisation may be the only option as it may not even be cost effective to subject ammunition to MLA, even if such a technical capability already exists within an ammunition stockpile management organisation.

6.2.4. Ammunition management policy statements (AMPS) (LEVEL 2)

One means of ensuring that 'value for money' is obtained, as well as supporting safety, is the development of an Ammunition Management Policy Statement (AMPS)[6] for each specific type of ammunition. AMPS may be used to define a policy for the management of an item of ammunition or explosive throughout its service life and should list support information to assist staff with the maintenance and final disposal of the ammunition or explosive. This forms part of the inventory management process.

The contents of an AMPS are at Annex C.

[6] These are sometimes also known as Through Life Management Plans (TLMP). The term AMPS is used in the IATG as it makes it clear that it specifically refers to ammunition, as TLMP may exists for other commodities.

6.3 Improvement of in-service life for ammunition (LEVEL 3)

6.3.1. Benefits

MLA will assist in the identification of options to improve the in-service life of ammunition. Ideally, these measures should be taken prior to the introduction of the particular type of ammunition into service, but in many cases there are already large stockpiles of ammunition for which life improvement measures may need to be taken.

Life improvement measures[7] should be designed to either preserve or conserve the life of the ammunition whilst it is in depot storage, or is operationally deployed. The benefits of life improvement measures include:

a) the life of ammunition can be extended beyond that which would be possible without life improvement measures;

b) if life improvement measures are planned in advance of the introduction into service of an ammunition type then the service life increases may be significant;

c) the introduction of life improvement measures, even at the mid-life stage, for ammunition already in service can still increase service life;

d) the introduction of appropriate life improvement measures may reduce the overall life cycle costs of the ammunition (see Clause 20.1); and

e) the introduction of appropriate life improvement measures will lead to improved confidence in predicting the whole life of the ammunition.

6.3.2. Options

Life improvement measure options may be applied individually or as part of an overall policy designed to reduce the aging effects of the environment on particular ammunition types. These measures are shown in Table 1.

Generic In-Service Life Improvement Measure	Specific In-Service Life Improvement Measure	Explanation
Controlled Storage	▪ Use high quality Explosive Storehouses (ESH) with effective temperature and humidity control.	▪ Explosives degrade when there are conditions of high temperature and humidity. Controlled storage conditions can defer the onset of, and control the rate of, degradation.
	▪ Use a dual-inventory process, whereby a small proportion of a particular lot or batch of ammunition is used for training or operations, with the main stock remaining in controlled storage conditions.	
	▪ Use high quality ammunition packaging.	
Recording	▪ Temperature and humidity records of an ESH are maintained (ideally by use of a data logger).	▪ To be most effective MLA requires complete visibility of the environmental conditions a munition has been subjected to.
	▪ Exposure to environmental conditions outside controlled storage is recorded. (meteorological conditions and period of exposure).	

[7] Sometimes known as 'amelioration'.

Generic In-Service Life Improvement Measure	Specific In-Service Life Improvement Measure	Explanation
	▪ Exposure to operational transport and use conditions (i.e. time spent by a missile vibrating on an armoured vehicle).	
Data Logging	▪ Use of an electronic data logger to record temperature and humidity conditions in each ESH.	▪ If environmental conditions can be accurately recorded, then the percentage of in-service life consumed can be estimated.
Ageing Algorithm	▪ Knowledge of actual conditions when compared against technical surveillance and in-service proof results may allow for the development of ageing algorithms for specific ammunition types.	▪ This requires a quantifiable understanding of the cause-effect link between environment and life-limiting failure.

Table 1: Ammunition in-service life improvement measures

The effectiveness of life improvement measures may not become immediately quantifiable, and the cost benefit will depend to a degree on the type and quantity of ammunition subjected to such improvements. Yet storage under controlled conditions of those ammunition types most susceptible to environmental factors (i.e. propellant, rocket motors and pyrotechnics) should be an effective option.

One of the aims of life improvement measures should be to build models of the ageing characteristics of the explosives in service use, which can be used in future MLA processes. Immediate benefits may not be easily identifiable, but they should become more quantifiable over the longer term. As the effective service life of much ammunition is over 20 years the use of MLA should be considered as a long-term investment.

7 Types of ammunition stockpiles[8] (LEVEL 1)

An effective inventory management system should ensure that the type of ammunition stockpile is clearly defined and that detailed technical information on the quantity, location and condition of the ammunition itself (by specific type) is readily available.

There may be a range of separate ammunition and explosive stockpiles within a country that are under the control of different organisations (such as the police, military (both active and reserve), border guards, ammunition production company holdings etc). Each of these organisational stockpiles should have one or more of the following generic parts:

Type	Comment
Operational ammunition and explosives	▪ The ammunition and explosives necessary to support the routine operations of military, police and other security agencies over an agreed period.
War reserve ammunition and explosives	▪ The ammunition and explosives necessary to support the operations of military, police and other security agencies during external conflict or general war over an agreed period. ▪ 30 days at intensive expenditure rates is often used as the time period.

[8] Also contained within IATG 01.30 *Policy development and advice* and repeated here for convenience.

Type	Comment
Training ammunition and explosives	▪ The ammunition and explosives necessary to support the routine training of military, police and other security agencies. This will usually be an agreed percentage of the war reserve holdings. ▪ 15% would not be unreasonable, dependent on the training activities and frequency.
Experimental ammunition and explosives	▪ This type of ammunition is usually only held by those nations with a research, development and production capability. ▪ These holdings will be minimal but must be included for intellectual accuracy. ▪ They may also pose specific risks which would require their separate storage and accounting
Production ammunition	▪ This type of ammunition is usually only held by those nations with a production capability. ▪ The ammunition and explosives that have been produced and are awaiting sale under the control of the manufacturer. These may be available to the military during general war but would not form part of the war reserve as their availability cannot be guaranteed.
Ammunition and explosives awaiting disposal	▪ The ammunition and explosives that have been identified as unserviceable, unstable or surplus to requirements.

Table 2: Generic types of ammunition stockpiles

The total of all these generic parts should be referred to as the 'national stockpile'. The management of stocks of small arms ammunition in the possession of civilians or retailers should be determined in accordance with MSAIC 03.30 *National controls over the access of civilians to SALW* and not in accordance with this module.

8 Ammunition management system requirements (LEVEL 2)

An ammunition management system should be dependent on the organisational structure, administrative requirements and operational responsibilities of the security forces within a State. Notwithstanding the rights of States to maintain their own organisational structures, a clear chain of command and responsibility shall exist. The ammunition stockpile management system should be made up of the organisations shown in Table 3.

Organisations	Remarks
Ammunition management department	▪ Usually at Ministry of Defence/Interior or Service (Army, Navy, Air Force, Police etc.) level.
Ammunition storage units	▪ Subordinate to the ammunition management organisation. ▪ Usually the major ammunition storage depots.
Ammunition technical inspection units	▪ Subordinate to the ammunition management organisation and co-located with the major ammunition storage depots.
Ammunition training unit	▪ Subordinate to the ammunition management organisation. ▪ Should be co-located with a major ammunition depot.
Ammunition inspectorate	▪ Subordinate to, and reports directly to, the ammunition management organisation. ▪ Independent of other ammunition units. ▪ Consists of ammunition technical staff to ensure the safety and condition of ammunition within user units.
User units	▪ User units fall under the operational chain of command.

Table 3: Ammunition management system components

9 Ammunition management organisation responsibilities (LEVEL 2)

The role of the conventional ammunition management organisation[9] shall include the responsibility to:

a) develop a policy for effective and efficient ammunition storage and accounting;

b) develop effective ammunition storage and accounting units (usually major ammunition depots) and maintain their operational capability;

c) develop a policy for the technical inspection of ammunition when in-service;

d) develop effective ammunition technical inspection units and maintain their operational capability;

e) develop an effective ammunition training unit and maintain its operational capability;

f) develop an effective ammunition inspectorate and maintain its operational capability;

g) co-ordinate with manufacturers in the allocation and promulgation of lot and batch numbers for specific ammunition types (see IATG 03.20 *Lotting and batching*);

h) develop an ammunition descriptive asset code (ADAC) type system, or similar, then allocate and promulgate unique ADAC codes (see Clause 17);

i) develop and maintain ammunition management policy statements (AMPS) or their equivalent;

j) maintain an overview of the frequency and accuracy of ammunition stock checks;

k) develop and implement a system of explosive limits licences (ELL) for ammunition storage and processing facilities (see IATG 02.30 *Licensing of explosive storage areas (ESA));*

l) develop and promulgate a system for the issue and receipt of ammunition between manufacturers, stock holding units and user units;

m) develop and maintain an internal capability to undertake external audits of ammunition accounting and storage units (stockpile safety and accuracy of ammunition accounts);

n) maintain an overview of the usage rates of the conventional ammunition stockpile;

o) maintain an overview of the technical condition of the conventional ammunition stockpile and ensure that appropriate inspection, repair, maintenance or modification processes take place to ensure the safety of the ammunition stockpile;

p) develop and maintain a system for the technical surveillance and in-service proof of ammunition (see IATG 07.10 *Surveillance and proof*);

q) procure new and/or replacement ammunition, when appropriate, to ensure that operational needs can be met (see Clause 20.1); and

r) maintain an overview of technical developments in the wider field of explosive engineering and conventional ammunition.

10 Ammunition storage unit responsibilities (LEVEL 1)

The ammunition storage units (usually the major ammunition depots), which should be subordinate to the ammunition management organisation, shall have the responsibility to:

[9] Which may also act as the National Technical Authority.

a) effectively implement the ammunition accounting system;

b) ensure the security of ammunition stocks;

c) accurately account for ammunition by specific type, quantity lot and/or batch number and exact location within the ammunition stockpile at all times. Records should be maintained for the whole in-service life of the ammunition and 10 years beyond *

d) develop and maintain a system and capability to stock check ammunition by specific type, lot and/or batch number.[10] Records should be maintained for at least ten years;

e) accurately implement the system for the issue and receipt of ammunition between manufacturers, stock holding units and user units. Records should be kept for the whole in service life of the ammunition and 10 years beyond.

f) liaise with the ammunition technical inspection units to ensure the efficiency of in-service ammunition inspection, repair, maintenance and modification processes; and

g) maintain accurate records on the technical condition of ammunition in storage for the whole in service life of the ammunition and 10 years beyond.

11 Ammunition technical inspection unit responsibilities (LEVEL 2)

The ammunition technical inspection units (usually co-located with the major ammunition storage and accounting depots), which should be subordinate to the ammunition management organisation, shall have the responsibility to:

a) safely and effectively inspect (physically), repair, repackage, maintain or modify ammunition when instructed by the ammunition management organisation. (Records should be kept for the whole in service life of the ammunition and 10 years beyond.

b) safely and effectively undertake chemical analysis of explosives and propellants to assure that the ballistic performance of the ammunition is within operational or training limits, and to ensure its chemical stability in storage. (This task may alternatively be undertaken by an appropriate explosives laboratory.);

c) conduct surveillance and in-service proof of ammunition as instructed by the ammunition management organisation (see IATG 07.20 *Surveillance and proof*); and

d) liaise with the ammunition storage units to ensure efficient stock transfer processes.

12 Ammunition training unit responsibilities (LEVEL 2)

The role of the ammunition training unit, which may be subordinate to the ammunition management organisation, should include the responsibility to:

a) develop and provide standardised initial, upgrading and refresher ammunition technical training to ammunition technical staff;

b) develop and provide basic, standardised, ammunition safety in storage training for non-ammunition units; and

c) maintain an overview of technical developments in the wider field of explosive engineering and conventional ammunition.

[10] The frequency of stock checks should be determined by the ammunition management organisation and should not be less than three-monthly. For large stockpiles a continuous 'rolling' stock check may be necessary.

The ammunition training unit may also have the responsibility to:

d) develop and provide standardised Explosive Ordnance Disposal (EOD) training; and

e) research technical developments in the wider field of explosive engineering and conventional ammunition and report, as appropriate, to the ammunition management organisation.

13 Ammunition inspectorate responsibilities (LEVEL 3)

An ammunition inspectorate is normally an independent unit consisting of ammunition technical staff that reports directly to the ammunition management organisation. It may be under the command of a formation (i.e. Army, Corps, Division or Brigade) for operational and administrative purposes, but it shall retain the right of direct reporting to the ammunition management organisation where areas of explosive safety are concerned.

An ammunition inspectorate should have the responsibility to:

a) conduct regular (annual) unit ammunition inspections to ensure the safety in storage at unit level and to assess the technical condition of the ammunition in unit storage; and

b) advise units and formation headquarters on ammunition safety and technical issues.

An ammunition inspectorate may also have the responsibility to:

a) investigate ammunition incidents and accidents (see IATG 11.20 *Ammunition accidents: reporting and investigation*);

b) provide 'expert witness' evidence to judicial enquiries;

c) provide Explosive Ordnance Disposal (EOD) support;

d) provide support to technical intelligence units; and

e) research technical developments in the wider field of explosive engineering and conventional ammunition and inform the ammunition management organisation as appropriate.

14 Ammunition accounting

14.1 Ammunition accounting requirements (LEVELS 1 and 2)

Accurate records should be kept (by specific type, quantity, lot and/or batch number and exact location) for the following stages in the life of the ammunition:

a) on manufacture;

b) on initial testing;

c) during transportation and shipment;

d) on transfer to procurement agency;

e) on transfer to the ammunition management organisation;

f) in depot storage;

g) on transfer to user units;

h) during storage at user units;

i) in case of loss or theft;

j) when used;

k) when returned to ammunition depots;

l) when repaired or modified;

m) when subjected to surveillance or in-service proof;[11] and

n) when disposed of.

14.2 Accounting systems (LEVEL 1)

Either manual or IT-based ammunition accounting systems may be used. Although manual systems are labour intensive and time-consuming compared to IT-systems, and the transmission of information between higher formations and units is slow, they have proven capability and are simple to use when individuals are appropriately trained. Their effectiveness is determined by the administrative instructions for their use and the standing operating procedures used within the ammunition depot. For reasons of accounting accuracy, explosive safety and operational efficiency, parallel systems that can identify specific ammunition by either stockpile location or by lot/batch number are required. Regular reports on inventory levels and condition should be made by the ammunition accounting and storage units to the ammunition management organisation.[12]

Although IT-based ammunition accounts are more efficient and capable, they are expensive to develop, are usually specifically designed for a particular ammunition stockpile management organisation and are just as reliant as the manual systems on the accuracy of the data entered into them. They can be directly linked between the ammunition management organisation and the ammunition accounting and storage units, thereby reducing the requirement for reporting of stock levels as instant visibility is possible.

14.3 International accounting principles and standards (LEVEL 2)

Principles for ammunition accounting may be derived from Generally Accepted Accounting Principles.[13] Although these are a widely accepted set of rules, conventions, standards and procedures for primarily reporting and recording financial information, the requirements for recording transaction activity and stock levels are equally applicable to ammunition as to any other commodity or process. The following accounting principles should be followed for the accounting of ammunition:

a) **objectivity:** ammunition accounts should be based on objective evidence derived from physical stock checks, independent audits and effective operating procedures for transactions;

b) **materiality:** the significance of an accounting issue should be considered when it is reported (i.e. an ineffective component of an accounting method). An issue is considered significant when it would affect the decision of a reasonable individual;

c) **consistency:** the ammunition accounting unit shall use the same accounting principles and methods from year to year; and

d) **prudence**: when choosing between two options, the one should be picked that will be most likely to ensure that a discrepancy, loss or theft is detected.

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[11] See IATG 07.20 *Surveillance and proof*.

[12] Reporting frequency will depend on expected usage rates, and the current condition of the stockpile. It is recommended that reports should be submitted monthly.

[13] GAAP are used by a range of countries. GAAP are being integrated into a range of new International Financial Reporting Standards (IFRS) and International Accounting Standards (IAS). IFRS and IAS are developed and promulgated by the International Accounting Standards Board (IASB) (www.iasb.org), an independent organisation.

14.4 Accuracy of ammunition accounts

No ammunition storage organisation is likely to be able to achieve 100% accuracy in its ammunition accounts. For example, if storage staff issue the right type of ammunition, but of the wrong lot or batch number, there is automatically a discrepancy until the error is identified and rectified during a regular stock check. In this example, the quantity of ammunition in storage would be the same and there has been no criminal intent, but the ammunition account would be inaccurate as 100% visibility of that particular lot or batch number has been lost.

14.5 Stack tally cards (LEVEL 1)

The use of stack tally cards is an effective measure that supports accurate ammunition accounting, assists in stocktaking and deters theft. Each stack of ammunition[14] should have a tally card(s) attached to it that records the following information for that particular stack:

a) grid locator reference;

b) Explosive Storehouse (ESH) number;

c) full description of ammunition (see Annex E);

d) Ammunition Descriptive Asset Codes (ADAC) number (or similar asset code system) (see Clause 17);

e) lot and/or batch number (a separate card should be used for each lot and/or batch number);

f) ammunition condition code (see Clause 18.1);

g) a record of transactions for that stack by quantity, lot/batch number and date; and

h) the issue or receipt voucher reference for each transaction.

i) A record of stockchecks in red.

A specimen example of a stack tally card in use is at Table 4.

Ammunition Stack Tally Card							
							IATG Form 03.10
	ESH	3			**ADAC**	34638-27C	
	Ammunition Type	Shell 155mm HE L15			**Lot/Batch**	GD 0215 217	
	Condition Code	A2			**Remarks**	For Operational use only	
Date	**Issue/Receipt Voucher Number**	**Received**	**Issued**	**Balance**	**Signature**	**Name**	**Grid Locator Reference**
03/02/16	RV 16/0021	1,036	_______	1,036	Insert signature	Verity	B4,B5,B6, C5 to C11
07/04/16	**Stock check**	_______	_______	**1,036**	**Ditto**	**Booth**	**B4,B5,B6, C5 to C11**
09/05/16	IV 16/0154	_______	220	816	Ditto	Verity	B4,B5,B6, C5 to C9
15/06/16	RV 16/0102	96	_______	912	Ditto	Root	B4,B5,B6, C5 to C10
29/06/16	**Stock check**	_______	_______	**912**	**Ditto**	**Booth**	**B4,B5,B6, C5 to C10**

Table 4: Example stack tally card

[14] A stack is the amount of ammunition that is contained within a particular Grid Locator base within an explosive storehouse. This may range from a single ammunition box within a ground level UOS, to a block of many pallets stored vertically over a number of particular ground level UOS.

Stack tally cards should be placed in plastic envelopes or suitable substitutes to prevent deterioration of the forms and to protect them from moisture. When the form is completed, or the last lot or batch of that particular ammunition has been issued, then the stack tally card should be kept by the ammunition depot stocktaking department for 10 years after the ammunition has been issued. This allows future reconciliation of ammunition accounts should a discrepancy occur in the future during stocktaking or audit.

14.6 Stocktaking and audits (LEVEL 1)

Stocktaking is an essential process in supporting the accuracy of ammunition accounts by identifying discrepancies, loss or theft. It means that trained staff, who fully understand the way that ammunition and its packaging is marked, should physically count and record the ammunition in each storage location.

A fundamental principle of effective stocktaking is that staff shall not be provided with a copy of what the ammunition account shows for each storage location. It is only through the reconciliation between the ammunition account and the stocktaking record for each storage location that a proper stock check is conducted.

Stocktaking should take place at least every three months, but for large stockpiles of ammunition a continuous ‘rolling’ stock check may need to be implemented.

15 Stock location in explosive storehouses (LEVEL 2)

15.1 Units of space concept (see also IATG 06.20)

Ammunition stock location can be simplified if a Unit of Space (UOS) concept is adopted. It is generally assumed for planning purposes that the volume of most pallets or unit load containers equate to one cubic metre, with an average weight of 1 tonne. This approach simplifies ammunition storage planning, as the number of UOS within an explosive storehouse may be easily calculated by a simple volume measurement. A small amount of space can be deducted to allow for:

a) the maximum safe stacking height for the ammunition (usually 3 or 4 metres if palletised);

b) aisles wide enough for the type of mechanical handling equipment being used (at least 2m for mechanical handling equipment or 1.2m for hand pallet transporters);

c) a 500mm air gap from the front wall of the ESH to ammunition stacks; and

d) a 500mm air gap between the exterior walls of the ESH and the ammunition stacks.

The remaining floor space is then available for the first layer of pallets. As a UOS must be an integer, the fractions of metres are discounted (which has the benefit of increasing free air space within the ESH and hence improves air circulation). The floor area as an integer multiplied by the safe stacking height as an integer (1, 2, 3 or 4) then equates to the Units of Space, or standard pallets that may be physically stored within the ESH.

A similar approach can be used for un-palletised ammunition, but it is then essential that the exact dimensions of ammunition outer packaging are known.

Table 5 is an illustrative UOS calculation for an ESH.

Dimension	#	Remarks
ESH Width	6m	▪
ESH Length	8m	▪
ESH Height	3.7m	▪
ESH Volume	177.6m^3	▪

Dimension	#	Remarks
MHE Gangway	2m	▪ This reduces the available width.
Available ESH Width	3m	▪ ESH Width minus MHE Gangway and 2 x 0.5m air space at ends of ESH.
Available ESH Length	7m	▪ ESH Length minus 2 x 0.5m air space at ends of ESH.
Available ESH Height	3m	▪ ESH Height minus 100mm air space to floor and 500mm air space to roof. Rounded down to nearest metre for palletisation reasons. Block loose stack height would be 3.1m.
Maximum Theoretical UOS	**63**	▪ One row of 7UOS, three high, = 21 UOS. ▪ MHE Gangway of 2m. ▪ Two rows of 7 UOS, three high = 42 UOS.

Table 5: UOS calculation example

15.2 Grid locator

Ammunition storage within each ESH should be organised in such a way that it can be easily found, as this will improve the issue, receipt and auditing processes. A simple Grid Locator concept may be used as a method of identifying storage locations, which can then be recorded in the ammunition account and on the Stack Tally Cards (see Clause 14.5). A separate record of the location plan, in diagrammatic form, should be kept as a UOS summary as this will identify spare storage space.

Table 6 is an illustrative Grid Locator for the ESH example in Table 5.[15]

Ammunition Depot:				Greentown			
ESH		*21*		Date:		23/11/09	
Grid	**1**	**2**	**3**	**4**	**5**	**6**	**7**
A							
B							
C							
D							
E							
F							
G							
H							
J							
K			X				
L							
M							

Table 6: Grid locator example

A further refinement then allocates the UOS in a single floor grid location by its position in the stack using (a), (b), (c) or (d). Therefore, the third UOS from the floor in grid square K3 would be referred to as K3(c).

[15] Note that the letter 'I' is not used. This avoids confusion with the number '1'.

The use of the UOS concept with a Grid Locator for each ESH will assist in:

a) reducing time taken to locate ammunition for issue, receipt or internal depot transfer;

b) improving the efficient use of available storage space;

c) maintaining the accuracy of the ammunition account; and

d) ensuring that the ESH is not bulk overloaded.

15.3 Planographs

A system similar to the grid system at Clause 15.2 is that of planographs, which also include details of the ammunition, stored within each grid locator. This is explained at Annex B to the *OSCE Handbook of Best Practices on Conventional Ammunition*.[16]

16 Storage space issues (LEVEL 2)

An explosive storehouse should be considered as 'full' when either:

a) all UOS contain ammunition stocks and the Net Explosive Quantity (NEQ) is within the Explosives Limit Licence (see IATG 02.20 *Quantity and separation distances*) for that particular ESH. This condition is known as 'bulked out'; or

b) there are spare UOS available, but the ESH has reached its explosive limit for Hazard Division 1.1, 1.2 or 1.3 ammunition. This condition is known as 'NEQ out'. In this case it may still be permissible to fill the remaining UOS with ammunition of Hazard Division 1.4S if storage space is at a premium.

If storage space permits, it is desirable that a UOS only contains the same specific type of ammunition with the same lot or batch number. Although this is not the most efficient use of storage space, it does make other ammunition management processes a lot easier (i.e. stocktaking, audit etc.), and reduces the risks of discrepancies in the ammunition account.

17 Ammunition descriptive asset codes (LEVEL 2)

There is a very wide range of ammunition types all of which are specific to one or more weapon systems. This means that when referring to the ammunition the exact type must be quoted (i.e. Shell 155mm High Explosive L15A1 or Charge Propelling 155mm L18A2).

The same specific type of ammunition is also often packaged differently dependent on the type of logistic distribution system that it is destined for on operational use (i.e. a Unit Load Container (ULC) contained both HE Shell (Fuzed) and Propelling Charges or a Pallet of HE Shell (Un-fuzed only)).

The level of descriptive detail necessary to ensure that the right specific type of ammunition is being delivered to the user, or that the ammunition depot has counted the right specific type of ammunition during a stock check, means that mistakes are easily made.

[16] *Handbook of Best Practices on Conventional Ammunition*, Annex B. Decision 6/08. OSCE. 2008;

One method of simplifying this process is by the use of a system of Ammunition Descriptive Asset Codes (ADAC),[17] which may be used in place of long descriptive text. An ADAC system uses a five or seven digit numerical code with an optional suffix letter, which is specific for each different type of ammunition and the way that it is packed. This code represents:

a) the user group of the ammunition concerned (i.e. infantry, artillery, tank etc);

b) the generic type of ammunition (i.e. Shell, 155mm);

c) the specific type of ammunition (i.e. Shell HE, 155mm); and

d) the mark or model number (i.e. Shell HE, 155mm, L15A1).

An example of such a system is at Table 7.

<table>
<tr><th>Figure</th><th>Numeral</th><th>Group</th><th colspan="3">ADAC Type</th></tr>
<tr><td rowspan="6">First</td><td>1</td><td>▪ Common Light Ammunition.</td><td rowspan="8">The Generic ADC</td><td rowspan="9">The Specific ADAC</td><td rowspan="10">The Packaged ADAC</td></tr>
<tr><td>2</td><td>▪ Armoured Vehicle Ammunition.</td></tr>
<tr><td>3</td><td>▪ Gunnery and Artillery Ammunition.</td></tr>
<tr><td>4</td><td>▪ Aircraft, Air Delivered and Aviation Support Ammunition.</td></tr>
<tr><td>5</td><td>▪ Mines, Explosives, Clearance, EOD and Engineering Ammunition.</td></tr>
<tr><td>6</td><td>▪ Guided Weapons, Rockets, Torpedoes and Depth Charges.</td></tr>
<tr><td>Second and Third</td><td>11 - 99</td><td>▪ The generic type of ammunition (i.e. Shell, 155mm).</td></tr>
<tr><td>Fourth and Fifth</td><td>11 - 99</td><td>▪ The specific type of ammunition (i.e. Shell HE, 155mm).</td></tr>
<tr><td>Sixth and Seventh</td><td>11 - 99</td><td>▪ The specific mark or model (i.e. Shell HE, 155mm, L15A1).</td><td rowspan="2"></td></tr>
<tr><td>Suffix Letter</td><td>A - Z</td><td>▪ The method of packaging (i.e. Palletised or Unit Load Container).</td><td></td></tr>
</table>

Table 7: Example of ADAC type system

Table 8 illustrates an ADAC system for the range of 155mm Shell using the example ADAC system in Table 7:[18]

Ammunition Type	First Letter	Second and Third Letters	Fourth and Fifth Letters	Sixth and Seventh Letters	Suffix Letter
155mm Shell HE	3	46	38		
Generic ADAC is 34638					
155mm Shell HE L15A1	3	46	38	27	
Specific ADAC is 34638-27					
155mm Shell HE L15A1 (Palletised)	**3**	**46**	**38**	**27**	**C**
Packaged ADAC is 34638-27C					

Table 8: Example ADAC

[17] NATO also uses a 13 digit identification number for its ammunition stocks.

[18] The numbers used in the ADAC example are illustrative only, and do not represent the real ADAC used by any State using a similar system.

18 Condition classification of ammunition (LEVELS 2 and 3) [19]

All ammunition and explosives should be classified[20] as to their condition, which will require a surveillance and in-service proof system.[21] The ammunition condition is used to define the degree of serviceability of the ammunition and the degree of any constraints imposed on its use.

National authorities should ensure that the declared ammunition 'shelf life' is an indication of the performance capability of the ammunition and not necessarily just its safety or stability in storage; only physical inspection and ammunition surveillance can determine this.

National authorities should therefore develop a system that allows the condition of the ammunition to be clearly defined, as it is only in this way that safe storage conditions may be maintained, and subsequent disposal or destruction can be prioritised.

18.1 Ammunition condition groups

The following groupings and codes could be used as a means of classifying the condition of ammunition stocks:

Condition Type Code	Condition Sub-Type Code	Ammunition Status
A		▪ **Serviceable stocks available for use.**
	A1	▪ Available for issue.
	A2	▪ Available for issue, but subject to a minor constraint.
	A3	▪ Available for issue subject to national technical authority approval.
B		▪ **Stocks banned from use pending a technical investigation.**
	B1	▪ Banned for use, but cleared for routine storage and movement.
	B2	▪ Banned for issue and use, and not cleared for movement.
	B3	▪ Awaiting manufacturer's quality assurance reports.
	B4	▪ Shelf life expired.
C		▪ **Stocks unavailable for use pending technical inspection, repair, modification or test**
	C1	▪ Minor processing or repair only required.
	C2	▪ Major processing or repair required.
	C3	▪ Awaiting inspection only ex-unit.
	C4	▪ Manufacturers processing or repair awaited.
	C5	▪ Force regeneration processing required.
D		▪ **Stocks for disposal.**
	D1	▪ Surplus, but serviceable stocks.
	D2	▪ Unserviceable stocks.

Table 9: Ammunition condition classification groups

[19] Also see IATG 06.80 *Inspection of ammunition*.

[20] Best ammunition management practice further recommends that ammunition should also be classified by their Dangerous Goods Classification and UN Serial Number, Hazard Division, Compatibility Group and Hazard Classification Code. (See IATG 01.50 *UN Explosive hazard classification system and codes* for further details.)

[21] See IATG 07.20 *Surveillance and proof* for further details.

When ammunition is subject to inspection and surveillance[22], which is good stockpile management practice, it is inevitable that defects will be found. These defects shall determine which 'Condition Group' the ammunition is placed in, and categorised as:

Defect Type	Ammunition Status
Critical	▪ Defects affecting safety in storage, handling, transportation or use.
Major	▪ Defects that affect the performance of the ammunition and that require remedial action to be taken.
Minor	▪ Defects that do not affect the safety or performance of the ammunition but are of such a nature that the ammunition should not be issued prior to remedial action having been taken.
Insignificant	▪ Any defect that does not fall into any of these categories, but which could conceivably deteriorate into one of them if no remedial action is taken.
Technical	▪ Any defect that requires further technical investigation.

Table 10: Types of ammunition defect

Therefore, it is possible that ammunition classified as B4 (shelf life expired), is not an urgent priority for disposal as further technical investigation may well extend its shelf life, and hence it would be re-classified as A for a further period of time.

[22] The economical surveillance of ammunition and accurate assessment of the quality, within known confidence levels, is achieved by taking a relatively small, random sample from a large bulk quantity.

Annex A
(normative)
References

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

a) *Handbook of Best Practices on Conventional Ammunition*, Annex B. Decision 6/08. OSCE. 2008;

b) International Accounting Standard 2 (IAS2): *Inventories*. IASB. 2005;

c) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA. 2020;

d) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA. 2020;

e) IATG 01.60 *Ammunition faults and performance failures*. UNODA. 2020;

f) IATG 01.70 *Bans and constraints*. UNODA. 2020;

g) IATG 02.20 *Quantity and separation distances*. UNODA. 2020;

h) IATG 03.20 *Lotting and batching*. UNODA. 2020;

i) IATG 07.30 *Inspection of ammunition*. UNODA. 2020;

j) IATG 07.10 *Surveillance and proof*. UNODA. 2020; and

k) Modular small-arms-control implementation compendium (MOSAIC). UN 2018..

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[23] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[23] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) Joint Service Publication 762 *Through Life Munitions Management*. MOD. UK. 2005;

b) Modular small-arms-control implementation compendium (MOSAIC). UN 2018.; and

c) STANAG 4315 *The Scientific Basis for the Whole Life Assessment of Munitions*. NATO Standardization Organization (NSO).

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[24] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[24] Where copyright permits.

Annex C
(informative)
Ammunition management policy statements (AMPS)

AMPS are one means of determining and disseminating policy for the safe, effective and efficient management of an ammunition type throughout its service life. AMPS can contribute to ensuring that the ammunition is correctly and most cost efficiently looked after during its service life, including its final disposal.

This annex provides an example of the layout of an AMPS:

C.1. Ammunition configuration

The paragraph on ammunition configuration is to include details of the designation and manufacturer. Similar details are to be given for components such as fuzes and primers, even if they are the subject of separate policy statements.

C.2. General

C.2.1 General description

The ammunition is to be described briefly and approximate weights and dimensions are to be given.

C.2.2 Planned role and deployment

The planned role of the ammunition is to be explained with its deployment.

C.2.3 Associated equipments

Associated equipments are to be briefly described with, where appropriate, their use.

C.2.4 Deployment and use by other nations

Known or anticipated purchases of equipment by other nations, which may use the ammunition of the same design, (rather than similar ammunition of the same calibre), are to be listed.

C.3. Planned life

C.3.1 In-service date

The In-Service Date (ISD) is to be given.

C.3.2 Design shelf life

The designer's estimate of the minimum shelf life (Design Shelf-Life) for the ammunition is to be given.

C.3.3 Assessed shelf life

The Assessed Shelf-Life as stated by the relevant national technical authority or Cardinal Point Specification (CPS) is to be given.

C.3.4 Shelf-life extensions

Shelf-Life Extensions are to be included as amendments when they occur.

C.3.5 Arrangements for turnover at training

Brief details of the policy for guiding ammunition turnover from operational and war reserve to training are to be given.

C.4. Surveillance

The in-service surveillance and proof strategy is to be stated as advised by the relevant national technical authority.

C.4.1 Service quality requirement

The Service Quality Requirement (SQR) is to be expressed as a percentage.

C.4.2 Functional limiting quality

The Functional Limiting Quality (FLQ) is to be expressed as a percentage.

C.4.3 Operational limiting quality

If determined, the Operational Limiting Quality (OLQ) is to be expressed as a percentage.

C.5. Ammunition maintenance and repair policy

C.5.1 Policy

The maintenance policy is to be stated.

C.5.2 Tools, equipment and materials

The tools, equipment and materials required for maintenance and repair are to be listed and an indication given of the planned deployment, sources of supply and equipment management policy. The information, if lengthy, may be included as an Annex to the AMPS.

C.6 Storage

C.6.1 Net explosive quantity

The total Net Explosive Quantity (NEQ) is to be given for each ammunition nature.

C.6.2 Hazard classification code

The Hazard Classification Code (HCC) is to be given for each ammunition nature.

C.6.3 Temperature limitations

The upper and lower ammunition temperature limits for storage and use and the climatic zones for which the ammunition is cleared are to be given.

C.6.4 Stacking limitations

Any stacking limitations are to be given.

C.6.5 Special storage requirements

Any special storage requirements or limitations to the storage of the ammunition in normal or field storage conditions are to be given.

C.7 Transportability

C.7.1 Special requirements and restrictions on movement

Any special requirements for, or restrictions on, the movement of the ammunition by road, rail, sea and air are to be detailed.

C.7.2 Shipping stowage category

The shipping stowage category of the ammunition is to be given with any restrictions.

C.7.3 Air dropping

The suitability of the ammunition for air dropping is to be given.

C.8 Disposal

C.8.1 Individual rounds and bulk

Alternative methods of disposal for both an ammunition item and bulk stock are to be stated and are to be cross-referenced to ammunition destruction technical procedures.

C.8.2 Demilitarization

Proposed methods for the disposal of bulk quantities under controlled conditions (demilitarization) are to be stated.

C.9 Technical publications

All reference publications are to be listed.

C.10 Packaging

C.10.1 Authorized service packs

The Authorized Service Packs are to be listed.

C.10.3 Expendable/reusable packaging

Packages and packing fitments that are reusable are to be identified.

C.10.4 Commercial packaging

Any non-service or commercial packaging is to be briefly described.

C.11 Staff

All staff implications for the logistic support of the ammunition system, including the maintenance of the system in-service, are to be stated. This is to include surveillance and final disposal.

C.12 Training requirements

C.12.1 Courses

Any special requirements for training ammunition technical staff such as special to the system courses are to be stated.

C.12.2 Training materials

Training materials, including inert cross-sectional instructional rounds, extra clothing or equipment needs are to be listed with their source of supply and deployment.

C.13 Safety

Any safety or health hazards associated with the ammunition, other than the obvious explosives hazards, which are apparent from its normal functioning, are to be stated.

C.14 Security classification

The security classification of the ammunition is to be stated and reference is to be given, if appropriate, to the relevant entries in any national list of classified equipment.

C.15 Management responsibilities

Organisations and agencies that have responsibilities for the ammunition system are to be detailed.

C.16 Additional information

This paragraph is to be used, if necessary, for management information that would be inappropriate to be included in any other section. It may include information on such matters as technical problems that resulted in design changes, or problems that affect storage or use of the ammunition.

Annex D
(informative)
Ammunition Management Policy Statement (AMPS) form example

1 AMMUNITION CONFIGURATIONS

DESIGNATION	ADAC	MANUFACTURER
Shell 155 mm H HE(L-INTR)M107	36012-11 36012-13	USA Iowa Ord Plant Louisiana Ord Plant Italy BPD
COMPONENTS		
Supplementary Charge of 151 g TNT Grade 1.		

2 GENERAL

2.1 **General Description.** A 155 mm HE shell. ADAC 36012-11 is filled TNT, ADAC 36012-13 is filled Comp B (RDX/TNT).

2.2 **Planned Role and Deployment.** Fired by all 155 mm Gun regiments at training in lieu of the more expensive 155 mm L15A2 HE shell.

2.3 **SR(L) Reference.** None.

2.4 **Approval.**

ADAC 36012-11: K/5113.
ADAC 36012-13: DGW(A) 155 mm AMM 0219.

2.5 **Associated Equipments.**

Howitzer 155 mm M109 A2/A3.
Howitzer 155 mm L121 (FH70).
Howitzer 155 mm AS 90.

2.6 **Deployment and Use by Other Nations.**

NATO: BE, CA, DA, FR, GE, GR, IT, NL, NO, PO, SP, TU and US.

2.7 **NATO/Quadripartite Interoperability Agreements.**

See AOP-6 (NATO interoperability in war) for interoperability agreements between BE, CA, DA, FR, GE, IT, NL, NO, PO, TU, UK, and US.

See AOP-14 (NATO interoperability in training) for interoperability agreements between UK and BE, UK and NL, UK and US.

3 PLANNED LIFE

3.1 **ISD.** 1966.	3.2 **QRD.**	3.3 **Design Shelf-Life.** None.
3.4 **Assessed Shelf-Life.** 25 years.		3.5 **Shelf-Life Extensions.** None.
3.6 **Arrangements for Turnover at Training.** Earliest manufactured shell are given priority for issue at training.		

4 SURVEILLANCE

4.1 **SQR.** 97.5%	4.2 **FLQ.** 92%	4.3 **OLQ.** 85%
4.4 **Surveillance Strategy.** Routine surveillance in the 3rd, 8th and 13th year of Service life, then every two years thereafter. Proof frequency as determined by LSA 6.		

5 AMMUNITION MAINTENANCE AND REPAIR POLICY

5.1 **Policy.** No maintenance required, ammunition repaired as and when required.
5.2 **Tools, Equipment and Materials Required for Maintenance and Repair**. No special tools, equipment, or materials required.

6 STORAGE

6.1 **NEQ.** 6.8 kg per round (same filling weight for both ADACs).
6.2 **Hazard Classification Codes.** 1.1D.
6.3 **Temperature Limits.** Approved for use in Climatic Categories A3, C0 and Cl.
6.4 **Stacking Limitations.** Maximum of six pallets high.
6.5 **Special Storage Requirements.** None.

7 TRANSPORTABILITY

7.1 **Special Requirements/Restrictions on Movement.** None.

7.2 **Shipping Stowage Category.**

Under deck - ordinary.
Above deck - secured.

7.3 **Air Drop.** Not approved.

8 DISPOSAL

The following details are provided as management information, and do not constitute authority for disposal action.

Ammunition is to be disposed of by detonation in accordance with A&ER Vol 3 Pam 21 Part 1 Procedure No. 1.

9 TECHNICAL PUBLICATIONS

A&ER Vol 3 Pam 6
Vol 3 Pam 20
Vol 3 Pam 41
Vol 3 Pam 46

TABs.

LUMAT.

RLC Statistics.

JSP 422/Defence Statistics (when published).

10 PACKAGING

10.1 **Authorized Service Packs.** See below.

10.2 **ULS.** ULS 245 (x 20).

10.3 **Expendable/Reusable Packaging.** ULS 245 is reusable, the tensile steel strapping used around the ULS is expendable.

10.4 **Commercial Packaging**. None.

11 MANPOWER

No special manpower requirements.

12 TRAINING REQUIREMENTS

12.1 **Courses.** None.	
12.2 **Training Materials.** None.	

13 SAFETY

No special safety precautions required.

14 ASSOCIATED ORDNANCE BOARD PROCEEDINGS

39449, 41985, 42529, 40242, 42359.

15 SECURITY CLASSIFICATION

UK Restricted.

16 MANAGEMENT RESPONSIBILITIES

16.1 **LSOR Sponsor.** LSOR 6	16.2 **PM.** PM Arty Guns/Ammo	16.3 **ES.** EME 7	16.4 **Ammo Man.** LSA 5
16.5 **Other.** None.			

17 ADDITIONAL INFORMATION

None.

Annex E
(informative)
Ammunition nomenclature - a guide to how to record ammunition

To ensure that an accounting system, whether written or IT based, works, each item has to be called the same name throughout by all operators, thereby allowing the system to be able to recognise it and match it up with similar items on the account.

To enable this function to work correctly every user will have to use the same method of recording the ammunition's details. As an example of where it could go wrong, a UK operator may call a complete small arms ammunition (SAA) item a 'round' (this is the term used when bullet, cartridge case and cap/primer are all present). A US operator would call this a 'cartridge'. Meanwhile, to confuse matters further, the UK operator would call a blank item of SAA a 'cartridge'. As is obvious this would cause huge problems on the system. To avoid this there must be a list of standard terms to be used, and all users must call items of ammunition using these terms. As long as exactly the same terms are used, ammunition management will run smoothly as far as individual ammunition items are concerned.

Another problem is the length of some nomenclatures (complete names) of ammunition items. If the complete name were entered on the accounting system, there would be a lot of words in there that do not match someone else's version completely. The system requires shorter terms in order to successfully match items up. To ensure an accounting system can work correctly there are examples of standard names and abbreviations further on in a table This is a list of British ammunition – it should be altered to reflect how a state identifies its ammunition, and should be in keeping with the types of ammunition that state possesses.

The name of item section on all identifying means is therefore divided into 4 distinct areas all of which can be matched up manually or by an IT based accounting system. Even if one of the parts is differently named by someone it will still be recognisable using the other three parts. It would be easier to use a catalogue numbering system, as in national (in UK, ADAC numbers) or NATO (T numbers) inventories, however the majority of the ammunition in many regions is likely to be of Soviet, Chinese or unknown origin and therefore will not have catalogue numbers. These can, however, be allocated by ammunition authorities.

The 'matchable' sections in the 'Ammunition Item' column will be filled in using the following order:

1. Type of Ammunition (i.e. Shell, Round, Grenade).

2. The delivery method, name of item, Calibre or similar (e.g. Hand, Rifle, 7.62mm).

3. The effect, intent or content of the ammunition (e.g. smoke, illuminating, irritant, smoke WP, HE).

4. Model number (e.g. L2A2, M1, DM34).

If there are items found where all 4 sections cannot be filled in there is the 'not known (nk)' option where the other information is completed, which should be enough information to match ammunition up with the same ammunition already on an account.

To get the correct nomenclature, use the following:

If the ammunition is in a SEALED box, use the markings on the box.
If it is in an unsealed box, empty the contents and check whether they are the same as marked on the box. If they are, repack them and mark the correct number of items on the box, then use the markings on the box to record them. If they are different, repack into separate boxes for different items and use the markings from the ammunition.
If the ammunition is loose, use the markings from the ammunition.

List of Names, Descriptions, Abbreviations and combinations to be used.

The table below contains the names and terms to be used and what items they refer to.

First Column -Name/Term	Ammunition item(s) it is used for	Examples (model numbers are sometimes fictitious and are added to show examples)
Bomb (Bomb Mor or Bomb AC)	Explosive munition, not subject to centrifugal forces and with a nearly vertical angle of descent, usually delivered from an aircraft or mortar (cf. Munition).	Bomb Aircraft GP 1,000kg Bomb Mortar 81mm HE L18
Cartridge (Cart)	An item without the projectile, eg a blank SAA cartridge, which is a cartridge case, propellant and cap; an Artillery propelling cartridge without the projectile or fuze, so case, propellant and primer stored separately from the shell and fuze.	Cartridge Propelling 105mm Fd Normal L35 Cartridge Blank 7.62mm L1A4 Cartridge Blank 13Pr 8oz GP L1A1
Charge (Chg)	Can be a propelling charge for use in artillery, mortars, and rockets, or as a component of rocket motors.	Charge Propelling 120 mm Tank HESH L3A2
Demolition Charge (Chg Dem)	A prepared demolition charge designed for a particular purpose. Often known by a colloquial name.	Chg Dem No1 6in Beehive Chg Dem No 11 30lb Nesting Chg
Demolition Accessory (Dem Acc)	Items which are designed for use in demolitions, ie det cord, safety fuze, ISFE, PE4 etc	Igniter Safety Fuze Electric Cord detonating L2A1
Detonator (Det)	A device containing a sensitive explosive intended to produce a detonating wave in response to some stimulus. It may be constructed to detonate instantaneously, or may contain a delay element.	Det Dem Elec L2A1 Det Dem Igniferous L1A1
EOD equipment (EOD)	Items used in the disposal of explosive devices or ammunition. Often known by a colloquial name. Can be Projector, Torch, Disruptor, Extractor, Breaker, Injector	Cartridge Injector L2A1 Pigstick Projector EOD L2 (Flatsword)
Fuze	A device that initiates an explosive train, can be found on explosive projectiles to make them function when required, eg time, proximity, point detonating.	Fuze Nose Percussion L2 Fuze Grenade Hand L36
Generator (Gen)	Smoke Generator is designed to produce, by combustion, a very rapid build up of a dense cloud of white smoke for screening purposes.	Generator Smoke L1
Grenade (Gren)	Munitions that are designed to be thrown by hand or to be launched from a rifle or dispenser.	Grenade Rifle 40mm HE AP L38

	Excludes rocket-propelled grenades (cf. Rocket). Note AP is anti-personnel.	Grenade Hand HE AP L2 Grenade Dispenser Smoke Screening L3A4 (Disp Smk Scr)
Guided Missile (GM)	Guided missiles consist of propellant-type motors fitted with warheads containing high explosives or some other active agent and equipped with electronic guidance devices.	GM AGM 114L (Longbow) GM Milan HEAT J103
Mine	An explosive munition designed to be placed under, on, or near the ground or other surface area and to be actuated by the presence, proximity, or contact of a person, land vehicle, aircraft, or boat, including landing craft.	Mine Anti Personnel M18A1 Mine Anti Tank L7
Primer (Prmer)	A self-contained munition that is fitted into a cartridge case or firing mechanism and provides the means of igniting the propellant charge.	Primer Percussion L17 Primer Elec L10
Rocket (Rkt)	Refers to a Munition consisting of a rocket motor and a payload, which may be an explosive warhead or other device. Can include guided and unguided missiles, although normally unguided missiles.	Rkt H/F Para Illum L5A4 Rkt 66mm HE A/Tk L14 Rocket System 84 mm AT4 Confined Space High Performance L1A2 (CS HP)
Round (Rd)	A complete item of ammunition to be fired from a weapon, eg for SAA the projectile (bullet), cartridge case, propellant and cap; for Artillery the filled shell (projectile), fuze, cartridge case or bag, propellant, and primer or tube. Can also be used for complete grenades for use with a launcher.	Round 5.56mm Ball L1A1 Round 105mm Pack Howitzer Training L65 (PH Trg) Round 120mm Tk HESH M21A3
Shell	Mainly for Artillery and Tank natures, where the shell (projectile) is separate from the propelling charge and can be with or without fuze.	Shell 105mm Fd Smoke Base Ejection L45A2 (Smk BE) Shell 120mm Tk HESH L31A7
Shot	A projectile without propelling method whose payload is non-explosive, ie a kinetic energy weapon.	Shot 120mm Tk APFSDS
Special Purposes and Engineer Assault (SP)	Items for specialised purposes, eg breaching minefields, destroying obstacles, Explosive Reactive Armour etc.	Anti Tank Mine Clearing Equipment L5 – Giant Viper Explosive Kit Rapid Cratering
Tube	A self-contained **munition** which is fitted into the breech of a gun when using bagged charges, ie the equivalent for Non-QF ammunition of a Primer. Provides the means of igniting the **propellant** charge.	Primer Percussion M82 (is a tube despite the US use of Primer) Tube Vent Elec 13mm L4A2

<u>Completing the nomenclature for specific ammunition types.</u>

Some possible combinations are below:

First Name or term	Second Name or term	Third Name or term	Model number Or Mark	Examples ammunition items matching the description
Bomb Mor	Calibre (eg 81mm, 60mm, 3in), so: _ _ _mm _ _ _ in nk	High Explosive (HE)	M1A1 L1A1 Mk 6 etc	HE bomb (fuze and carts fitted).
		Smoke Screening (Smk Scr)		Smk either from bomb body or smoke pots ejected.
		Illuminating (Illum)		Flare pot ejected in flight
		Smoke White Phosphorus (Smk WP)		Bursting bomb containing WP designed to produce an instant smoke screen.
		Smoke Emission (Smk Em)		Smk emits from holes in bomb body.
		Practice (Prac)		Solid or hollow with tracer
		Cluster Munition (Cl Mun)		No longer in NATO armies but many made elsewhere, UN CCM ban
Bomb AC	Weight or other unit of size (eg 500kg, 1000lb), so: _ _ _ _ kg _ _ _ _ lb nk	General Purpose (GP)		Normally HE (fuze fitted) w/o fuze
		High Explosive (HE)		Bulk HE (fuze fitted) w/o fuze
		Carrier		Carrier of cluster munitions or other payload.
Cart	Calibre or size (eg 105mm, 8in, 1.5in, 25pr), so: _ _ _ mm _ _in	Propelling (Prop)		For QF SF rounds, propellant
		Blank (Blk)		Artillery or SAA, no projectile
		Shotgun (SGun)		Named cartridges as the shot in integral to the cartridge case.

	_ _ bore nk	Signal (Sig)		Fires a signal flare
		Illuminating (Ilum)		Fires Illum flare and parachute
		Signal Smoke (Sig smk)		Fires Signal flare and smoke
		Augmenting (Aug)		For Mortar bombs
		Primary (Prim)		
Chg	Calibre (eg 155mm), so: _ _ _mm _ _in nk	Prop		Bagged charges for artillery, normally large calibres
Chg Dem	Weight, size or model number (eg 8oz, 1lb), so: _ _ _kg _ _ _lb _ _oz nk	Type of explosive, so: PE Sheet nk		Chg Dem 8oz PE4 Chg Dem 8oz PE3 Sheet Explosive (SX2) Explosive charges that are not designed for a specific target, so general use
Demolition Accessories and stores (DemSt)	Cord	Detonating		Transfers detonating wave
	Fuz	Instantaneous (Inst)		Fast burning cord to ignite igniferous detonators
		Safety (Saf)		Slow burning cord to ignite igniferous detonators
	Igniter	Saf Fuse Elec		Matchhead initiated electronically which passes flame to fuse
	Charge	Linear Cutting (CLC)		Size of CLC in comments column
	Expl Cutting Tape (ECT)	Blade		Size of Blade in comments
	Chg Dem	Lin Cutting (CDLC)		Size in comments

DemSt *(cont)*	Firing Device Kit (F Dev)	Dem Grip		Safety Fuze initiator
	nk	nk		Type in whatever useful info found
Detonator (Det)	Dem	Elec		Starts detonating wave, electrically fired
		Igniferous (plain)		Starts detonating wave, igniferously fired
		nk		Type in whatever useful info found
EOD Equipment (EOD)	Cart	Inj		Disrupts packages
	Torch	Pyrotechnic (Pyro)		Neutralises mines and light weight munitions
	Destructor (Dest)	Incendiary (Incd)		Destroy low or high explosives by burning
	Breaker (Brkr)	Window (Win)		Breaks windows
	Disruptor EOD (Dis)	Alpha Krait		IEDD Disruptor
		Splinter		Attack through window
	Extractor (Extr)	PawPaw, Poplin		Removes heavy cased objects
	Projector (Proj)	Flatsword or mini Flatsword		Slice through hard cased objects
	nk	nk		Type in whatever useful info found
	Calibre and Mor	Time		Smk BE, Illum, Fragmentation types, Carrier
		Point Detonating (PD)		Instant detonation of HE Mortar Bombs
		Delayed Action (DA)		Delayed detonation of HE Mortar Bombs
		Proximity (Prox)		For HE and A/Pers natures, allows above ground burst at optimum height

Fuze	Calibre and Arty	Time		Smk BE, Illum, Fragmentation types, Carrier – functions after programmed time, set to ensure optimum results
		Point Detonating (PD)		Instant detonation of HE shell
		Delayed Action (DA)		Delayed detonation of HE and fragmentation shell
		Proximity (Prox)		HE and A/Pers natures, above ground burst
	Calibre and Tank (Tk)	Time		For Illum, Smk Base Ejection
		Point Detonating (PD)		Instant detonation of HE, HEAT shell
		Delayed Action (DA)		Delayed detonation of HE Shell
		Proximity (Prox)		HE and A/Pers natures for optimum time/height of burst
		Base DA		For HESH to allow explosive to 'pancake' on target before initiation
	nk	nk		Type in whatever useful info found
Generator (Gen)	Smk	Model		Large, fairly slow build up of smoke
Grenade (Gren)	Dispenser (Disp)	Smk		From armoured vehicle dispensers
	Hand (Hd)	HE Defensive (HE Def)		Thrown, when defending in cover – maximum frag
		HE Offensive (HE Off)		Thrown, when attacking without cover – little frag, mainly blast
		Smk Emission (SmkEm)		Thrown – slow build up of smoke, often for signalling purposes
		Smk WP		Thrown – large volume of instant smoke
		Prac		Thrown
	Rifle (Rfl)	HE		Fired

		Smk		Fired
		Prac		Fired
	Launched (Lnch)	HE		From independent or underslung launcher
		Smk		From independent or underslung launcher
		Prac		From independent or underslung launcher
	nk	nk		Type in whatever useful info found
Guided Missile (GM)	Effect on target, so: Anti Tank (A/Tk)	Milan		Infantry weapon, APC
		Javelin (Jav)		US Infantry weapon
		Swingfire (Sfire)		Infantry weapon, APC
	Surface to Air (SAM)	High Velocity Missile (HVM)		Artillery fired, man portable, APC or multiple launcher, Short range
		Rapier (Rap)		Artillery fired, Long range
	Air to Ground (AGM)	Hellfire (Hfire)		Attack Helicopter Armour defeating
		Longbow (LBow)		Attack Helicopter Armour defeating
	Multi Launch Rocket system (MLRS)	Unitary – complete (Unita)		Full 'missile' – guided to a certain extent. HE Warhead
		HE Sub Munition – complete (HESub)		Full 'missile' with 644 sub-munitions
		Sub Munition (Submu)		644 x M77 (NATO Version) per payload
		Guidance Section (GS)		Front, GPS guided
		Payload Sub Mun (PaySM)		644 x M77 (NATO Version)
		Payload Section (PayS)		Middle, HE warhead, approx 25kg
		Propulsion Section (ProS)		Rear propulsive section – solid or liquid propellant

	nk	nk		Type in whatever useful info found
Mine	Anti Personnel (AP)	Metallic (Met)		Small, designed to maim rather than kill
		Non Metallic (NonMt)		Small, designed to maim rather than kill
	Anti Tank (ATk)	Metallic (Met)		Large, may be directional
		Non Metallic (NonMt)		Large, may be directional
	Projector Area Defence	Command only (Com)		Claymore type, command – directional mass fragmentation
		Command or Victim (Vic)		Claymore type, command or victim - directional mass fragmentation
	nk	nk		Type in whatever useful info found
Primer (Prmer)	Percussion (Perc)	Push Screw		Initiate propellant in cart case
	Electric (Elec)			Initiate propellant in cart case
	nk	nk		Type in whatever useful info found
Rocket (Rkt)	Calibre (66mm HE A/Tk, 1.5in H/F) so: _ _ _mm _ _ _ in nk	Flare		Signalling
		Signal (Sig)		Coloured signal
		Illuminating (Illum)		Light up area
		HE		A/Tk, A/Pers etc – recoiless, shoulder fired
		Incendiary (Incdy)		To ignite
Round (Rd)	Calibre (5.56mm,	Ball		Kill
		Tracer		Follow trajectory of projectile
		Incendiary		Ignite
		Blank		Practice, training
		Armour Piercing		Light armour

Round *(cont)*	.303in, 76mm) so: _ _ _mm _ _ _ in _ _ _pr nk	Ball Tracer mix (BT)		Mixture qty, e.g. 4B1T, 1B1T for machine gun
		Small Arms Spotter (SAAsp)		Indicate target
		HE		Bulk HE
		High Explosive Anti Tank (HEAT)		Shaped charge, anti armour
		Smk Base Emission (SmkBE)		Slow build up of smoke screen
		Illuminating (Illum)		Light up area
		HESH		Anti armour, flattens to target
		Armour Piercing Discarding Sabot (APDS)		High speed kinetic penetrator
		Armour Piercing Fin Stabilised Discarding Sabot (APFSDS)		Very accurate high speed penetrator
		Smk WP		Quick smoke build up
		Spotting (Spot)		Target Indicating
		AP Secondary Effect (APSE)		Tracer, colour, origin
		AP Secondary Effect Incendiary (APSEI)		Tracer, colour, origin
Shell	Calibre or weight (105mm, 8in, 76mm, 25pr) so: _ _ _mm _ _ _ in _ _ _pr nk	HE		Bulk HE W/fuze W/O fuze
		High Explosive Anti Tank (APDS)		Shaped charge, anti armour
		Smk Base Emission (SmkBE)		Slow build up of smoke screen
		Illuminating (Illum)		Light up area

		HESH		Anti armour, flattens to target
		Smk WP		Quick smoke build up
		Spotting (Spot)		Target Indicating
Shot	Calibre or weight (105mm, 8in, 76mm, 25pr) so: _ _ _mm _ _ _ in _ _ _pr nk	Solid Shot (Shot)		Kinetic penetrator
		Armour Piercing Discarding Sabot (APDS)		High speed kinetic penetrator
		Armour Piercing Fin Stabilised Discarding Sabot (APFSDS)		Very accurate high speed penetrator
Special Purposes and Engineer Assault (SP)	Charge Dem	Bangalore Torpedo (BaTor)		To breach obstacles such as barbed wire
		Expl Kit Rapid Cratering (EKRC)		To make large holes in roads, runways etc
		Rapid Bridge Dem System (RBDS)		Destroy bridges
	Expl Reactive Armour (ERA)	Not Applicable (NA)		Reacts to external explosion
	Giant Viper (Viper)	Rocket (Rkt)		Pulls hose from cartridge
		Hose		HE filled, clears A/Tk minefields
	nk	nk		Type in whatever useful info found
Tube	Percussion (Perc)	Push Screw		Initiate propellant in bagged charge
	Electric (Elec)			Initiate propellant in bagged charge
	nk	nk		Type in whatever useful info found

Note: when, in column 2, a weight or measurement is used, the options available should be ‘millimetres’ (mm), ‘inches’ (in), ‘kilograms’ (kg), ‘pounds’ (lb), ‘pounder’ (pr) or ‘ounces’ (oz). The number shall be typed in before the measurement unit, e.g. 120mm, and so on.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 03.20

Third edition
March 2021

Lotting and Batching

UN SaferGuard
Securing ammunition, protecting lives

IATG 03.20:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

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United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Ammunition and explosives may deteriorate more rapidly or become damaged unless they are correctly stored, handled and transported, with the resultant effect that they may fail to function as designed and may become dangerous in storage, handling, transport and use. It is therefore important that the location of specific items of ammunition and explosives can be rapidly identified in order that the appropriate remedial action can be taken to ensure safety during these activities. A system of Lotting and Batching is an important component of this safety mechanism.

Lotting and batching is a means by which a discrete and homogenous quantity of ammunition may be identified. It will usually have been manufactured at the same time, using the same raw materials, using the same process and may therefore be expected to provide a uniform and similar performance. Whether it is appropriate to use Lotting or Batching for an item of ammunition will normally depend upon the complexity of the ammunition (ie the number of different components) and will require technical judgment.

Lotting and Batching is also important for stockpile accounting and to allow for timely and reliable identification of diversions through loss or theft.

Lotting and Batching

1 Scope

This IATG module introduces the concept of Lotting and Batching of ammunition and introduces a system that can be used to support the safe, effective and efficient management of conventional ammunition.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'ban' refers to *a moratorium placed on the issue and use of ammunition, usually pending technical investigation*.

The term 'Batch' refers to *a discrete quantity of ammunition which is assembled from two or more Lotted components (one of which will be the Primary Governing Component), is as homogeneous as possible and under similar conditions may be expected to give uniform performance*. Within the batch a number of sub-batches may be found.

The term 'batch key identity' refers to *a term used to identify a particular Lot or Batch of ammunition*.

The term 'constraint' refers to *the imposition of a limitation or restriction in the use, transportation, carriage, issue, storage or inspection of a munition*.

The term 'Lot' refers to *a predetermined quantity of ammunition or components which is as homogeneous as possible and under similar conditions may be expected to give uniform performance*. *A Lot is normally manufactured from the same raw materials, using the same production technique and in the same production run.*

The term 'primary governing component' refers to *the component in a Batch which is considered to be of major importance to the correct functioning of the round. This component governs the size, homogeneity and the identity of a batch. An ammunition batch contains only one lot of the governing component. It may also be referred to as the Batching Component.*

The term 'secondary governing component' refers *to the component in a Batch which is considered to be second in importance in the correct functioning of a round after the Primary Governing Component. It may also be referred to as the Sub-Batching Component.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background

Explosive safety during the storage, handling, use and transport of ammunition cannot be assessed without detailed technical information on every ammunition item within the national stockpile. This information should include a means of identifying all items of ammunition that are, for example: 1) filled with the same type of explosive or propellant made from the same production run with the same raw materials; or 2) contain the same component(s) made on the same production run from the same raw materials. A system of Lotting and Batching should be used to achieve this.

Empty components that consist of one or more factory pieces (i.e. shell bodies with no explosive content) are produced as empty Lots, each Lot being considered to be homogeneous. Empty Lots should be given empty Lot numbers for identification purposes (i.e. if metallurgical failure is responsible for an ammunition accident, then all filled ammunition made from that particular Lot may be identified and appropriate remedial action taken).

Bulk high explosive and propellants are manufactured from individual constituent materials, and the final product should be given a unique Lot number, which may be considered as the primary governing component when it is used to fill empty ammunition components (i.e. shell bodies).

Empty Lots of components become filled Lots when they are filled with explosive, propellant or pyrotechnic compositions. The explosive used to fill an empty component Lot should also be from a homogeneous Lot of explosive. The filled components should then be given a unique, filled Lot number for future identification and records kept of the Lot numbers of the empty component and the explosive used to make up the filled Lot.

When ammunition is assembled from two or more critical components, the two most critical components should be nominated as the primary and secondary governing components (see Clause 8), and the item should be Batched. The primary governing component should be used to determine the Batch size.

5 Lotting and Batching system requirements

The requirements of a Lotting and Batching system should be:

a) to identify a homogeneous quantity of ammunition which should give uniform performance under similar conditions of use;

b) to simplify the identification of specific items and/or rounds of ammunition items when an unsatisfactory report (due to an ammunition accident, performance failure or fault) is made on a particular Lot or Batch of ammunition;

c) to simplify the tracking in storage and the subsequent withdrawal or replacement of those components which have proved unsatisfactory, have become life expired or have been replaced by later marks, models and types;

d) to enable smaller quantities to have their 'history' tracked, ie where it has been stored and the conditions, how it has been transported and other factors potentially affecting its future condition;

e) to identify a definite quantity in which the results of inspection, proof and test can be representative;

f) to facilitate the establishment and maintenance of technical records and surveillance;[3] and

g) to reduce the amount of marking on ammunition containers.

The terms Lot, Batch and sub-Batch are all used to identify discrete and homogeneous quantities of ammunition. Which term is used depends on the complexity of the ammunition (the number of component parts) and, ultimately, the approving authority.

6 Lotting and Batching system responsibilities (LEVEL 2)

The appropriate authority within the wider ammunition management organisation should:

a) develop and implement a system of Lotting and Batching, or similar, in order that the requirements of Clause 5 are met;

b) determine exactly which ammunition should be Lotted and which should be Batched;

c) determine which components (i.e. HE filling, propellant, fuze etc.) should control the Lotting or Batching of service ammunition; and

d) assign manufacturers monograms and Lot, Batch, sub-Batch, and logistic Batch[4] codes and numbers.

7 Lot and Batch numbering system (LEVEL 2)

7.1 Lot number

The Lot number is a unique identifying number allocated to individual ammunition Lots at the time of manufacture, assembly or modification that identifies a particular Lot. It is normally associated with the identity of a significant, major component (i.e. the Lotting component). An item is Lotted when it is constructed of either only one major component or is of fairly simple construction.

7.2 Batch number

The Batch number is a unique identifying number allocated to individual ammunition Batches at the time of manufacture, assembly or modification. It is allocated in accordance with the identity of the significant, major component (the primary governing component) and the secondary governing component (for a sub-batch – see below). When the lot number of the primary component changes, so does the batch number. This system only works when all components of a batched items are recorded on the accounting system. The reliable way to gain this information is from the manufacturer of the ammunition in a full technical data package.

Sub-Batch number

When the quantity of the governing component used is so large that in the event of a failure of another component the total quantity of the complete round at risk would be unacceptable, the Batch should be divided into sub-Batches. In order to reduce the degree of risk, the secondary component should

[3] This also assists in the investigation of cases of diversion of ammunition to illicit users.

[4] See Clause 7.8 for logistic batching.

be used to govern the sub-Batch size. The addition of a suffix letter to the Batch number should be used to identify the sub-Batch.

7.3 Allocation of Lot numbers (except propellant)

Lot numbers should normally be issued as a process of consultation between the manufacturer and the ammunition management organisation. For ammunition purchased abroad it may be permissible to accept the Lot number allocated by the manufacturer at the time of production.

A system of numbering should be developed that ensures that there can be no repetition of a Lot number. Such a system may look like the example in Table 1:

	Manufacturers Monogram	Date of Assembly or Manufacture	Unique Identification Number	**Suffix**	**Remarks**
Requirement	▪ Up to Three letters	▪ In format MMYY	▪ Up to six numerals	▪ One letter	
Example	**HG**	0817	005	**D**	
Range	▪ A to ZZZ		▪ 000001 to 999999	▪ A to X (Excluding B or R)	▪ B or R are uniquely used for propellant Lot numbers.
Example Lot Number	**HG 0817 005D**				

Table 1: Example system of ammunition and explosive Lot numbering

7.4 Allocation of Lot numbers (propellant)

Propellant Lot numbers should normally be issued as a process of consultation between the manufacturer and the ammunition management organisation. For ammunition purchased abroad it may be permissible to accept the propellant Lot number allocated by the manufacturer at the time of production.

A system of numbering should be developed that ensures that there can be no repetition of a Lot number. Such a system may look like the example in Table 2:

	Manufacturers Monogram	Date of Assembly or Manufacture	**Unique Identification Number**	**Suffix**	**Remarks**
Requirement	▪ Up to Three letters	▪ In format MMYY	▪ 1 numeral onwards (to 6)	▪ One letter	
Example	**BD**	0817	**004**	**(B)**	
Range	▪ A to ZZZ		▪ 1 to 999999	▪ B, R or nothing only	▪ B indicates that the propellant was been re-blended at some stage in its life cycle. ▪ R indicates that the propellant has been reworked at some stage in its life cycle. ▪ A suffix is not mandatory.

	Manufacturers Monogram	Date of Assembly or Manufacture	Unique Identification Number	Suffix	Remarks
Example Lot Number	**BD 0817 004**				

Table 2: Example system of propellant Lot numbering

7.5 Allocation of Batch numbers

Batch numbers should normally be issued as a process of consultation between the manufacturer and the stockpile management organisation. They shall only be used for the calibre and type of ammunition for which they are issued.

A system of Batch numbering should be developed that ensures that there can be no repetition of a Batch number. Such a system may look like the example in Table 3:

	Manufacturers Monogram	Date of Assembly or Manufacture	Unique Identification Number	Remarks
Requirement	▪ Up to Three letters	▪ In format MMYY	▪ 1 numeral onwards	▪
Example	**GD**	**0817**	**020**	▪ It is useful to prefix numbers with a zero.
Range	▪ A to ZZZ		▪ 01 to 999999	▪
Example Batch Number	**GD 0817 020**			

Table 3: Example system of Batch numbering

The Batch number is also often known as the Batch Key Identity (BKI) during accounting and other inventory management processes. A batch number is identifiable by being underlined when written in text and when marked on containers and ammunition bodies.

There are also specific rules that should be followed during the allocation of Batch numbers:

a) the date of assembly or manufacture shall be that of the month in which production commenced;

b) that date of assembly or manufacture may be used for a maximum period of three months, (i.e. if production commenced on 01 August 2017 and finished on 23 October 2017, then the BI would use 0817 as the date); and

c) if assembly or manufacture of a Batch exceeds the three month period, even if the process is continuous, then a new Batch number must be brought into use.

7.6 Special case – small arms ammunition

For small arms ammunition the Lot number (or workdate as it is often known) should consist of the manufacturer's monogram and a work date as shown in Table 4:

	Manufacturers Monogram	Date Filling Commenced	Remarks
Requirement	▪ Up to Three letters	▪ In format DDMMYY	▪
Example	**FG**	**011115**	▪ Laser marking systems for SAA now allow a full Batch number as per Table 3 to be used. ▪ A suffix may be used to identify different Lots (production runs) that commenced production on the same day.
Range	▪ A to ZZZ		▪

	Manufacturers Monogram	Date Filling Commenced	Remarks
Example Batch Number	FG 011115		

Table 4: Example system of Lot numbering for SAA

7.7 Special case – logistic Batching (LEVEL 3)

Logistic Batching is a system of Batching that allows the enhancement of the operational efficiency of ammunition supply units during operations whilst ensuring accounting accuracy. When, for example, HE shells, propelling cartridges and fuzes are supplied separately to an artillery unit during operations, if they run out of one item (i.e. fuzes) then firing must stop until that item is re-supplied. In order to ensure that this does not happen, it may be desirable to have pre-made up pallets containing all the individual ammunition items needed to make a complete round for use (i.e. HE shell, propelling cartridge, primer and fuze). Although this solves a problem for the user, it creates problems for the ammunition manager, because all the individual ammunition items on the pallet would have different and unique BKIs. Either ammunition item has to be accounted for by BKI and pallet, an onerous task, or an alternative system of Batching needs to be developed.

One such system is the use of logistic Batching, which ammunition managers may choose to adopt. A logistic Batch number should be similar to a Batch number but with differences in its makeup. Logistic Batch numbers should normally only be issued by the ammunition management organisation and the individual BKI within each logistic Batch recorded in the ammunition accounting system.

A system of logistic Batch numbering should be developed that ensures that there can be no repetition of a logistic Batch number. Such a system may look like the example in Table 6:

	Assemblers Monogram[5]	Date of Assembly	Unique Identification Number	Remarks
Requirement	▪ One to three letters	▪ In format MMYY	▪ Six numerals	▪
Example	**TTN**	**1117**	**000035**	▪ .A suffix may be used to identify logistic sub-Batch numbers.
Range	▪ Developed from the depot name. For example TTN for Toytown.		▪ 000001 to 999999	▪
Example Batch Number	TTN 1117 000035			

Table 6: Example system of logistic Batch numbering

There are also specific rules that should be followed during the allocation of logistic Batch numbers:

a) a logistic Batch should be as homogeneous as possible in terms of the Lot and Batch numbers of ammunition items within the logistic Batch;

b) only one logistic Batch should be packed on each pallet or in each ammunition container where possible;

[5] Usually the ammunition depot in which the assembly of the multi-item pallets took place.

c) no more than two separate logistic sub-Batches should be packed on each pallet or in each ammunition container. A Logistic Sub-Batch is a predetermined quantity of palletised ammunition, within a Logistic Batch which is formed when the Secondary Governing Component is changed; and

d) details of the ammunition component Lot and Batch numbers of the ammunition items that form the logistic Batch or sub-Batch should be clearly marked on the pallet or on the ammunition container.

7.7.1. Marking logistic Batch containers or pallets

A pallet or logistic container that contains a logistic Batch or sub-Batch should be marked with the following to ease identification:

a) quantity;

b) type of ammunition by complete round (e.g. Round 152mm HE w/Chg Prop);

c) model or mark (if applicable);

d) logistic Batch number or logistic sub-Batch number;

e) monogram of assembler;

f) date of assembly; and

g) details of the ammunition items forming the logistic Batch or sub-Batch (see Clause 7.8(d)).

8 Lotted or Batched governing components (LEVEL 2)

In order to provide guidance on which generic types of ammunition should be Lotted or Batched, and what the primary governing component should be, Table 7 illustrates a system that may be considered for use by the stockpile management organisation:

Generic Ammunition Type	Lotted or Batched	Primary Governing Component	Secondary Governing Component
Flare (illuminating)	Lotted	Filled Flare	
Grenades (Hand)	Lotted	Filled Lot	
Grenades (Rocket Propelled)	Batched	Propellant	Fuze
Mortar Bomb HE (>60mm)	Batched	Primary Cartridge	Fuze
Mortar Bomb HE (81mm – 160mm)	Batched	Augmenting Cartridge	Primary Cartridge
Mortar Bomb Smoke (>60mm)	Batched	Primary Cartridge	Augmenting Cartridge
Mortar Bomb Smoke (81mm – 160mm)	Batched	Augmenting Cartridge	Primary Cartridge
Round Cannon HE (20mm – 30mm)	Batched	Propellant	Primer
Tank Round HE	Batched	Propellant	TVE (Tube) (Primer)
Tank Round Smoke	Batched	Propellant	TVE (Primer)
Artillery Shell HE (Complete Round) (>155mm)	Batched	Propellant	Fuze
Artillery Shell Smoke (Complete Round) (>155mm)	Batched	Propellant	Fuze
Artillery Shell HE (>155mm)	Lotted	Filled Shell	
Artillery Shell Smoke (>155mm)	Lotted	Filled Shell	
Propelling Charge (Separate) (>155mm)	Lotted	Propellant	
Fuzes Nose Percussion	Lotted	Filled Fuze	
Fuzes Nose Mechanical Time	Lotted	Filled Fuze	
Primer Percussion	Lotted	Filled Primer	
Primer Electrical	Lotted	Filled Primer	
Safety Fuze	Lotted	Filled Lot	
Fuze Instantaneous	Lotted	Filled Lot	
Detonating Cord	Lotted	Filled Lot	
Detonator Non-Electric	Lotted	Filled Lot	

Generic Ammunition Type	Lotted or Batched	Primary Governing Component	Secondary Governing Component
Detonator Electric	Lotted	Filled Lot	
Charge Linear Cutting	Lotted	Filled Lot	
Charge Demolition HE	Lotted	Filled Lot	
Mine Anti-Tank	Lotted	Filled Lot	

Table 7: Example system of Lotting, Batching and governing components by generic type

9 Availability of ammunition technical data (LEVEL 2)

The availability of the following basic data for the specific types of ammunition in a national stockpile is essential to the development of an effective, efficient, safe and secure ammunition management system:

a) ammunition Lot numbers;

b) ammunition Batch numbers (if applicable); and

c) technical drawings.

If this basic technical data is not available for each specific item of ammunition then the integrity of the overall ammunition management system is dangerously compromised. This is the basic data that allows for effective and appropriate remedial action when a technical investigation identified a fault in the ammunition. Without this data the only option is to take remedial action on each individual item of the particular type of ammunition identified as at risk that was manufactured in the same year. (For example, 60mm mortar propellant, where the only available data identifies a year of production of 1967 as this is marked on the rounds and packaging, spontaneously ignites during storage. The only possible and effective remedial action in this case should be the destruction of all propellant for all mortar bombs where the ammunition is marked 1967.)

For those stockpile management organisations that do not hold the technical data above for each item of ammunition, the only short-term solution shall be to conduct a 100% stocktake of all ammunition and record all markings on that ammunition and its packaging. Informed decisions shall then be taken about instigating a Lotting and Batching system, based on the principles of logistic Batching, which is integrated with the ammunition accounting system and that allows the ammunition managers a degree of visibility of the entire stockpile by individual ammunition type. This may be a massive task, dependent on the stockpile size, but it is the only way to gain effective control over the ammunition and to reduce the inherent explosive risks during storage, handling and use.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviation*. UNODA. 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[6] used in this guideline and these can be found at www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[6] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guide:

b) IATG 01.60 *Ammunition faults and performance failures*. UNODA. 2020;

c) IATG 01.70 *Bans and constraints*. UNODA. 2020; and

d) UK Defence Standard 13-96 *Lotting and Batching of Ammunition*. Parts 1 - 3. UK Defence Standardization. 2009.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[7] used in this guide and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[7] Where copyright permits.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL
AMMUNITION TECHNICAL
GUIDELINES

IATG
04.10

Third edition
2020-xx-xx

Temporary storage

UN SaferGuard
Securing ammunition, protecting lives

IATG 04.20:2020[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult the UN Saf*er*Guard IATG project through the United Nations Office for Disarmament Affairs (UNODA) website at:

www.un.org/disarmament/ammunition .

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United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org
Tel: +1 917 367 2904
Fax: +1 917 367 1757

Contents

Foreword

In 2008, a United Nations group of governmental experts reported to the General Assembly on problems arising from the accumulation of conventional ammunition stockpiles in surplus.[1] The group noted that cooperation with regard to effective stockpile management needs to endorse a 'whole life management' approach, ranging from categorisation and accounting systems – essential for ensuring safe handling and storage and for identifying surplus – to physical security systems, and including surveillance and testing procedures to assess the stability and reliability of ammunition.

A central recommendation made by the group was for technical guidelines for the stockpile management of ammunition to be developed within the United Nations.

Subsequently, the General Assembly welcomed the report of the group and strongly encouraged States to implement its recommendations.[2] This provided the mandate to the United Nations for developing 'technical guidelines for the stockpile management of conventional ammunition', now commonly known as International Ammunition Technical Guidelines (IATG).

The work of preparing, reviewing and revising these guidelines was conducted under the United Nations Saf*er*Guard Programme by a technical review panel consisting of experts from Member States, with the support of international, governmental and non-governmental organisations.

In December 2011 the General Assembly adopted a resolution[3] that welcomed the development of IATG and continued to encourage States' to implement the recommendations of the Group of Government Experts;[1] the GGE Report included a recommendation that States' use the IATG on a voluntary basis. The resolution also encouraged States' to contact the United Nations Saf*er*Guard Programme with a view to developing cooperation and obtaining technical assistance.

In December 2015, the General Assembly adopted a resolution [4] that welcomed the continued application of the International Ammunition Technical Guidelines in the field, including the implementation software and training materials; Encourages, in this regard, the safe and secure management of ammunition stockpiles in the planning and conduct of peacekeeping operations, including through the training of personnel of national authorities and peacekeepers, utilizing the International Ammunition Technical Guidelines; The resolution also encourages States wishing to improve their national stockpile management capacity, prevent the growth of conventional ammunition surpluses and address wider risk reduction and/or mitigation to contact the SaferGuard programme, as well as potential national donors and regional organizations, as appropriate, with a view to developing cooperation, including, where relevant, technical expertise;

These IATG will be regularly reviewed to reflect developing ammunition stockpile management norms and practices, and to incorporate changes due to amendments to appropriate international regulations and requirements. This document forms part of the Second Edition (2015) of IATG, which has been subjected to the second five-yearly review by the UNODA Ammunition Expert Working Group. The latest version of each guideline, together with information on the work of the technical review panel, can be found at www.un.org/disarmament/convarms/ammunition/ .

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[1] UN General Assembly A/63/182, *Problems arising from the accumulation of conventional ammunition stockpiles in surplus*. 28 July 2008. (Report of the Group of Governmental Experts). The Group was mandated by A/RES/61/72, *Problems arising from the accumulation of conventional ammunition stockpiles in surplus*. 6 December 2006.

[2] UN General Assembly (UNGA) Resolution A/RES/63/61, *Problems arising from the accumulation of conventional ammunition stockpiles in surplus*. 2 December 2008.

[3] UN General Assembly (UNGA) Resolution A/RES/66/42, *Problems arising from the accumulation of conventional ammunition stockpiles in surplus*. Adopted on 02 December 2011 and dated 12 January 2012.

[4] UN General Assembly (UNGA) Resolution A/RES/70/35, Problems arising from the accumulation of conventional ammunition stockpiles in surplus. 11 December 2015

Introduction

While the ideal and most efficient method of storing ammunition is in purpose-built ammunition depots to ensure explosive safety, conventional ammunition can be stored safely, effectively and efficiently under temporary conditions. There may be, however, disadvantages to temporary storage in that the service life of ammunition could to be significantly reduced. Rapid turnover of ammunition stocks can minimize these disadvantages. Ammunition that is stored under temporary storage conditions for prolonged periods of time should be subjected to an effective technical surveillance and in-service proof programme.[5] This is the only way to ensure that the ammunition does not deteriorate to a condition that compromises performance or safety in storage.

This concept of temporary storage uses essentially the same Outside Quantity Distances (OQD) as used in IATG 02.20 *Quantity and separation distances*, thereby providing the same degree of protection to the public, non-related personnel and key facilities.[6] A somewhat higher level of risk is entailed with respect to Inside Quantity Distances (IQD), with a concomitant risk to mission safety. This is ameliorated by conservative aggregation rules and by limiting the NEQ of any site to a maximum of 4000 kg.

Temporary storage uses simplified tables which are not intended for long term or non-operational storage. To avoid confusion with the QD tables used in IATG 02.20 *Temporary Storage* uses Temporary Distances (TD) tables.

The temporary storage tables use a much reduced range of Potential Explosion Sites (PES) and Exposed Sites (ES). PES are limited to hardened, semi-hardened and open/light, with adjustments for barricades where appropriate. ES, for IQD, are similarly limited, with the addition of an ammunition processing area, barricaded or not. OQD possibilities are even more restricted: mission-related personnel and unprotected civilian population. This is a pared down system, for operational purposes[7].

Temporary storage should be considered for application in camps on deployed missions. If the camp may develop into a permanent ammunition storage facility, you are advised to use IATG 02.20, not this IATG.

[5] See IATG 07.20 *Surveillance and proof.*

[6] The additional protection afforded to vulnerable buildings is not included with Field Distances, but where considered appropriate, this protection level can be provided by doubling the distance recommended for unrelated personnel.

[7] This IATG is based on AASTP-5 NATO GUIDELINES FOR THE STORAGE, MAINTENANCE AND TRANSPORT OF AMMUNITION ON DEPLOYED MISSIONS OR OPERATIONS. AASTP-5 offers a wider range of PES/ES pairs in that vehicles are included. AASTP-5 is freely available on the internet.

Temporary storage

1 Scope

This IATG module introduces and explains the requirements for the safe, effective and efficient storage of conventional ammunition under temporary conditions.

For the purposes of this IATG module, temporary storage shall cover the storage requirements when appropriate and safe depot storage infrastructure is not available, or when that infrastructure has decayed to a condition where it provides no effective protection to either ammunition stocks or the local civilian community.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

A further list of informative references is given at Annex B in the form of a bibliography, which lists additional documents that contain other useful information on field, and temporary storage of conventional ammunition.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'hazard' refers to *a potential source of harm*.

The term 'exposed site' refers to *a magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the potential explosion site under consideration*.

The term 'potential explosion site' refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content*.

The term 'risk' refers to *a combination of the probability of occurrence of harm and the severity of that harm*.

The term 'risk analysis' refers to *the systematic use of available information to identify hazards and to estimate the risk.*

The term risk mitigation is used to describe the measures taken to reduce the effects should an explosion or deflagration occur. Examples would be following compatibility mixing rules to prevent an item in an incompatible group exacerbating the effects of an explosion, and keeping inhabited buildings outside the yellow line (inhabited building distance).

The term 'risk reduction' refers to *actions taken to lessen the probability, negative consequences or both, associated with a particular risk*. In ammunition management, risk reduction is the term used to describe those measures to be taken to reduce the risk of ammunition exploding or deflagrating. It also refers to the methods used to make the ammunition more secure. Examples would be continuous surveillance of ammunition to ensure any safety problems are detected at an early stage, and storing ammunition in optimum conditions in secure areas and buildings.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background

The storage of ammunition and explosives under temporary storage conditions as a technique for daily storage of a stockpile is not desirable, but safety can still be assured. The impact of temporary storage on the in-service life of the ammunition is less certain, as protection from climatic conditions and diurnal cycling[8] may be less effective under temporary conditions.

Temporary storage may also be used in the design and management of an operational location. This dichotomy of purpose should be kept in mind when reading this IATG module.

Unless specifically stated within this IATG module, the requirements of all other IATG modules shall be observed in order to retain the most stringent safety standards and preservation of assets during temporary storage conditions.

Temporary Storage Areas should always be planned and operated by ammunition specialists in accordance with IATG 01.90 *Ammunition management staff competencies*, as a formal risk management process is necessary as part of the planning process for the establishment of safe separation distances.

5 Risk acceptance (LEVEL 2)

Temporary storage of conventional ammunition may require a balance to be struck between safety, operational requirements and resource requirements. Where safety is to be compromised it shall be subject to a formal risk assessment (in accordance with the principles contained within IATG 02.10 *Introduction to Risk management principles and processes)*, and an Explosion Safety Case (in accordance with IATG 02.10, Clause 13.4 and Annex G) shall be prepared. The appropriate civilian authorities (usually the Ministries of Interior and Defence) shall be informed of the risk in detail, particularly if it involves an increased risk to the general public. The appropriate authorities shall also be informed of the resources required by the ammunition management organisation to reduce or mitigate that risk to a tolerable level. If the recommended resources are not made available for whatever reason, then the residual risk should be formally accepted at Ministerial level, and this risk acceptance shall be appropriately recorded. Any reduced safety criteria should be authorised in progressive stages for each reduction in Quantity Distances (QDs).

[8] The exposure of ammunition and explosives to the temperature changes induced by day, night and change of season.

6 Temporary Storage Areas (LEVEL 1 and 2)

Ammunition shall be deemed to be under temporary storage conditions when appropriate and safe depot storage infrastructure is not available (see IATG Volume 05), or when that infrastructure has decayed to such a condition that it provides no effective protection to either ammunition stocks or the local civilian community. In some circumstances, temporary storage conditions may last for some time if resources are limited or unavailable to develop appropriate depot storage infrastructure.

As explained in the Introduction, temporary storage uses simplified tables which are not intended for long term or non-operational storage. To avoid confusion with the QD tables used in IATG 02.20, *Temporary Storage* uses Temporary Distances (TD) tables. The temporary storage tables use a much reduced range of Potential Explosion Sites (PES) and Exposed Sites (ES). PES are limited to hardened, semi-hardened and open/light, with adjustments for barricades where appropriate. ES, for IQD, are similarly limited, with the addition of an ammunition processing area, barricaded or not. OQD possibilities are even more restricted: mission-related personnel and unprotected civilian population. This is a pared down system, for operational purposes[9].

Temporary storage conditions permit the use of reduced Inside Quantity Distances (see Clause 7.4), while essentially retaining the same Outside Quantity Distances. The reduced Quantity Distances should be used sparingly, and all efforts shall be made to ensure that normal Quantity Distances in accordance with IATG 02.20 *Quantity and separation distances* are applied. The use of reduced Quantity Distances shall not be used as a justification for limited or reduced resource allocation for the stockpile management of conventional ammunition in appropriate permanent ammunition depot infrastructure. Should the reduced Quantity Distances not be achievable then an Explosion Safety Case shall be compiled in accordance with IATG 02.10 Clause 13.4 and Annex G.

During the planning of Temporary Storage Areas, decisions are made that may be difficult to rectify at a later date. Planning should therefore be focussed and conducted by qualified personnel. During the planning process, provision should be made to involve those personnel responsible for the storage and management of the ammunition that will be stored in the site. Engineers should cooperate closely in the planning phase, as they will be responsible for any construction works that may be required.

6.1 Location of Temporary Storage Areas

There are a range of factors that should be considered when selecting a location for a Temporary Storage Area. These are shown in Table 1.

Critical Factors	Requirements
Ground	▪ No underground hazards, such as oil or gas tanks and pipelines. ▪ Firm ground capable of taking heavy vehicles (of up to 14 tonnes) even during inclement weather. ▪ Ideally, the ground should be dry, well drained, pervious to water and fairly level. ▪ Natural barricades fformed by hills are desirable to reduce the size of the area required and the risk to neighbouring areas. ▪ Large quarries or farm complexes normally make suitable Temporary Storage Areas.
Dispersion	▪ Adequate space must be allowed for dispersion of the stock and separation between the different PES. ▪ Specific ammunition natures should be split between at least two locations to prevent all the stock of a specific nature being lost in a single accident.

[9] This IATG is based on AASTP-5 NATO GUIDELINES FOR THE STORAGE, MAINTENANCE AND TRANSPORT OF AMMUNITION ON DEPLOYED MISSIONS OR OPERATIONS. AASTP-5 offers a wider range of PES/ES pairs in that vehicles are included. AASTP-5 is freely available on the internet.

Critical Factors	Requirements
Expansion	▪ Extra space must be planned to allow for expansion in case of a requirement to hold increased levels of stock. ▪ Such extra space can alternatively be used should a part of the area in use become unsuitable as a result of inclement weather or the cutting up of tracks by heavily laden vehicles.
Communications	▪ Temporary Storage Areas must be readily accessible to major roads or railways, yet far enough away that they do not present an explosive hazard. ▪ Good minor roads are required on the approaches to, and in, the area.
Natural Fire Protection	▪ Natural firebreaks to prevent the spread of fire from one PES to another are advantageous. ▪ Similarly, roads can be used as effective firebreaks.
Security	▪ Temporary Storage Areas are necessarily large and security will be a concern. ▪ Access can be temporarily denied by the use of armed guards and guard dogs. ▪ More permanent structures, such as barbed wire fences, will be required for longer-term use as Temporary Storage Areas.
Isolation	▪ A Temporary Storage Area should not be located adjacent, or close to, other main storage areas, airfields or hospitals. ▪ They should be located well away from any large radio transmitters.
Improvement	▪ The selected site should be capable of improvement if it is to become a permanent storage area[10].

Table 1: Temporary Storage Area location criteria

A Temporary Storage Area may require a range of supporting facilities and activities to ensure its efficient operation. These should include:

Facility or Activity	Requirements
Administrative Area	▪ This should be co-located with the Site Access Control. ▪ An appropriate Outside Quantity Distance (OQD) between the administrative area and the nearest field storage sites should be implemented to ensure the reduction and/or mitigation of the risk to site workers. ▪ The administrative area should have line communications to the civilian exchange.
Disposals area	▪ A small disposals area should be identified that can be used for the destruction of unsafe ammunition that presents an immediate risk of detonation or deflagration.
Returned Ammunition Group (RAG)	▪ At least one PES should be kept empty and used for the storage of ammunition returned from units. ▪ This ammunition will require technical inspection before it can be stored normally or re-issued.
Ammunition Processing Area	▪ Tasks could include, for example, repackaging, defuze/refuze and/or inspections. ▪ At least one PES should be kept empty and used for the storage of ammunition awaiting ammunition processing. ▪ This shall comply with the requirements of IATG Volume 07 *Ammunition processing*.
Site Access Control	▪ Access to the Temporary Storage Area, or individual PES, should only be permitted for authorised personnel. ▪ A strict system of access control should be implemented. ▪ The access control system shall ensure that contraband (smoking materials, matches, lighters, mobile telephones etc) is not permitted within the storage area.

[10] If a temporary storage area is likely to be developed into a permanent storage area, consideration should be given to implementing QDs as per IATG 02.20 as early as possible.

Facility or Activity	Requirements
Traffic Circuits	▪ Traffic circuits within the Temporary Storage Area should be signposted and made one way wherever possible. ▪ A sketch map of the Temporary Storage Area should be made available to drivers of ammunition vehicles.

Table 2: Temporary Storage Area facilities and activities

7 Explosive safety

7.1 Mixing rules (LEVEL 2)

Ideally each PES should consist of ammunition belonging to a single Compatibility Group (CG).[11] Should CGs have to be mixed then the rules at Table 3 shall apply.

Compatibility Group	A	B	C	D	E	F	G	H	J	K	L	N	S
A	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B	NO	YES	(1)	(1)	(1)	(1)	(1)	NO	NO	NO	NO	NO	YES
C	NO	(1)	YES	YES	YES	(2)	(3)	NO	NO	NO	NO	(5)	YES
D	NO	(1)	YES	YES	YES	(2)	(3)	NO	NO	NO	NO	(5)	YES
E	NO	(1)	YES	YES	YES	(2)	(3)	NO	NO	NO	NO	(5)	YES
F	NO	(1)	(2)	(2)	(2)	YES	(2,3)	NO	NO	NO	NO	NO	YES
G	NO	(1)	(3)	(3)	(3)	(2,3)	YES	NO	NO	NO	NO	NO	YES
H	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES
J	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	YES
K	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
L	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	(4)	NO	NO
N	NO	NO	(5)	(5)	(5)	NO	NO	NO	NO	NO	NO	(7)	(6)
S	NO	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	(6)	YES

Table 3: Compatibility Group mixing rules

NOTE 1 Compatibility Group B fuzes may be stored with the articles to which they belong, but the NEQ shall be aggregated and treated as Compatibility Group F. Compatibility Group B ammunition (other than fuzes) shall be stored in a separate site.

NOTE 2 Storage in same area permitted if effectively segregated to prevent propagation.

NOTE 3 Providing Compatibility Group G is in its authorised outer packaging and at discretion of national authority.

NOTE 4 Compatibility Group L articles shall always be stored separately from all articles of other compatibility groups as well as from other articles of different types of Compatibility Group L.

NOTE 5 Articles of Compatibility Group N should not be stored with other Compatibility Groups except S. However, if such articles are stored with articles of Compatibility Groups C, D and E, the articles of Compatibility Group N should be considered as having the characteristics as Compatibility Group D and the Compatibility group mixing rules apply accordingly.

NOTE 6 A mixed set of munitions of HD 1.6N and HD 1.6S may be considered as having the characteristics of Compatibility Group N.

NOTE 7 It is allowed (see comment).

[11] See IATG 01.50 *UN Explosive Classification System and Codes*.

7.2 Ammunition requiring separate storage (LEVEL 1)

In addition to the mixing rules (Clause 7.1) certain types of conventional ammunition should always be stored in separate PES, or under specific conditions, from other types of ammunition:

a) white phosphorous (WP). The PES for this ammunition should be very near to a source of water, or a water container large enough to fully accept the largest ammunition container should be on the site. If unpackaged, WP ammunition should be stored in an upright position with the base nearest the ground;

b) missiles in a propulsive state. These should be stored in a barricaded PES with the warheads pointing away from other ammunition stocks and away from civilian populations. If barricading is not available, then they should be stored at a PES near the external perimeter of the Temporary Storage Area, even if this complicates security requirements. It should be pointed slightly downwards into a structure which will disrupt its flight, eg 1.4S ammunition pallets, sandbags etc;

c) damaged ammunition. If considered unsafe for storage, damaged munitions should be destroyed at the earliest convenience;

d) ammunition in an unknown condition, of unknown origin or which is unpackaged. This shall be stored at such a distance that detonation of this ammunition will not jeopardize other stocks;

e) ammunition awaiting destruction or demilitarization;

f) ammunition that is constrained[12] or banned for use; and

g) ammunition that has deteriorated and become hazardous. (This shall be stored in isolation and destroyed at the earliest convenience).

7.3 Aggregation rules (LEVEL 1)

When the quantity distances at Clause 7.4 are used, all ammunition with the exception of HD 1.4 must be treated as HD 1.1. The aggregate must be 4000 kg or less. Otherwise the Quantity Distances and aggregation rules must be applied in accordance with IATG 02.20 *Quantity and separation distances*.

7.4 Quantity and Separation Distances (LEVEL 2) [13]

Ammunition in Temporary Storage Areas is particularly vulnerable to fire. Inadequate separation from site to site may cause large losses through secondary effects, such as explosions initiated by the fire. It is therefore important that consideration be given to applying adequate Quantity Distances[14] between sites and ensuring that natural barricades and overhead cover are used wherever possible. The use of reduced Quantity Distances from those contained within IATG 02.20 *Quantity and separation distances* may be permissible subject to formal approval by the appropriate national authority. IATG 02.20 *Quantity and separation distances* should be consulted at all stages during the determination of the reduced QD permitted in this Clause. The aim of this Clause is to detail the reduced QDs that may be authorised for the storage of ammunition in Temporary Storage Areas. In all cases, QDs shall be measured from the nearest point of the

[12] Not all ammunition that is constrained needs to be stored separately. The nature of the constraint should make clear the need for separate storage.

[13] Derived from NATO AASPT-5, Part 2. (See Annex B as informative reference)

[14] See IATG 02.20 *Quantity and separation distances* for further information on this risk management concept. QD prevents propagation from prompt sympathetic detonation, primary fragmentation and thermal flux, there is no guarantee that there will not be delayed propagation from the results of fire.

Potential Explosion Site (PES) to the nearest point of the Exposed Site (ES). (See Clause 7.4.2 for limitations on the semi-permanent use of reduced Quantity Distances for Temporary Storage Areas).

Each Potential Explosion Site (PES) shall store no greater than 4,000 kg Net Explosive Quantity (NEQ). This is to ensure that the Maximum Credible Event (MCE) should avoid or reduce the loss of personnel and material, minimize the effects of unintended detonations/reactions during storage, transportation and handling or as a result of enemy action. If the 4,000 kg MCE is exceeded, then IATG 02.20 *Quantity and separation distances* shall apply.

If Temporary QDs (see below) cannot be achieved in a particular situation, the advice of an explosives safety expert should be sought, to conduct an explosives safety case using Risk Assessment techniques and commercially-available software.

7.4.1. Temporary Distances (TD)

The term Temporary Distance (TD) is introduced to distinguish between the Quantity Distances contained within IATG 02.20 *Quantity and separation distances* and the reduced Quantity Distances authorized by this IATG module. A TD is; 1) a distance between two PES whereby prompt sympathetic detonations will be avoided; or 2) the distance between a PES and ES where the TD will maintain adequate protection levels.

The TD recommended in this IATG module;

a) are dependent on the PES, ES, NEQ, HD and type of ammunition. The TD may be reduced by using appropriately designed barricades, (Clause 7.5);

b) requires that all ammunition, with the exception of HD 1.4, is considered to be of HD 1.1; and

c) provide a high level of protection against sympathetic detonation, but other types of reaction, such as occasional explosions of single articles (HD 1.2), mass burning (HD 1.3) or delayed mass explosions may occur.

As protection of stocks by appropriate infrastructure is not in place during temporary storage conditions the Potential Explosion Sites shall be assumed to be either Open Stack or Open Stack (Barricaded).

7.4.2. Reduced Inside Quantity Distances (TD) (LEVEL 2)

The reduced IQD (TD) at Tables 5 and 6 may be applied in a Temporary Storage Area. The TD is the temporary quantity distance reference to be used in Table 6.

ES (Structures containing explosives)	PES (Structures) [1,2]				
				Open / Light	
				Barricaded	Un-Barricaded
Hardened				**TD1**	**TD1**
Semi-Hardened Barricaded				**TD1**	**TD1**
Semi-Hardened Un-Barricaded				**TD1**	**TD2**
Open / Light Barricaded				**TD1**	**TD1**

ES (Structures containing explosives)	PES (Structures) [1] [2]				
				Open / Light	
				Barricaded	Un-Barricaded
Open / Light Un-Barricaded				TD1	TD3
Ammunition Process Area [4] Barricaded				TD1	TD1
Ammunition Process Area Un-Barricaded				TD1	TD3

Table 5: IQD (TD) for Temporary Storage Areas

NOTE 1 Non-earth covered buildings that can generate debris like structures of concrete or bricks shall NOT be used as PES, unless constructed in accordance with Clause 7.5.

NOTE 2 Reduced distances may be implemented if authorised by the national authority.

NOTE 3 Hardened structures are by definition barricaded.

NOTE 4 Only for ammunition related personnel. For an ammunition process area as a PES use the appropriate PES structure type column.

NEQ	IQD (TD)'s (m)		
	TD1	TD2	TD3
25	4	7	14
50	4	9	18
75	4	10	20
100	4	11	22
150	4	13	26
250	4	15	30
500	4	19	38
750	4	22	44
1000	4	24	48
1500	7	28	55
2000	8	30	61
2500	8	33	65
3000	9	35	69
4000	10	38	76

Table 6: IQD (TD) (metres) for Temporary Storage Areas

7.4.3. Outside Quantity Distances (TD) (LEVEL 2)

The OQD (TD) at Tables 7 and 8 may be applied in a Temporary Storage Area.

The TD is the temporary quantity distance reference to be used in Table 8.

ES (not	PES (Structures)

containing explosives)	Hardened	Semi-Hardened		Open / Light	
		Barricaded	Un-Barricaded	Barricaded	Un-Barricaded
Hardened	TD4	TD4	TD4	TD4	TD4
Semi-Hardened Barricaded	TD4	TD4	TD4	TD4	TD4
Semi-Hardened Un-Barricaded	TD5	TD5	TD6	TD5	TD6
Open / Light Barricaded	TD8 TD7 [1]	TD8 TD7 [1]	TD8 TD7 [1]	TD8 TD7 [1]	TD8 TD7 [1]
Open / Light Un-Barricaded	TD8 TD7 [1]	TD8 TD7 [1]	TD9	TD8 TD7 [1]	TD9
Open Mission Related Personnel	TD8 TD7 [2]	TD8 TD7 [2]	TD9	TD8 TD7 [2]	TD9
Unprotected Civilian Population	TD8	TD9 TD8 [3]	TD9	TD9 TD8 [3]	TD9

Table 7: OQD (TD) for Temporary Storage Areas

NOTE 1 If an Overhead Protection protects against falling fragments then FD7 may be applied.

NOTE 2 Reduced distances may be implemented if the national authority has approved the storage structures.

NOTE 3 TD9 shall be applied except for heavy calibre artillery shells stored in a vertical position where TD8 may be applied.

NEQ	OQD (TD)'s (m)					
	TD4	TD5	TD6	TD7	TD8	TD9
25	12	18	23	23	100	130
50	15	22	30	33	100	212
75	17	25	34	40	100	260
100	19	28	37	46	100	294
150	21	32	43	56	100	342
250	25	38	51	73	100	400
500	32	48	64	103	155	400
750	37	55	73	118	203	400
1000	40	60	80	130	235	400
1500	46	69	92	149	283	400
2000	51	76	101	164	320	400
2500	54	82	109	177	352	400
3000	58	87	116	188	381	400
4000	64	95	127	207	400	400

Table 8: OQD (TD) (metres) for Temporary Storage Areas

7.5 Barricades (LEVEL 2)

7.5.1. General

The QD (TD) shown in Clauses 7.4.2 and 7.4.3 for barricaded structures assume that an effective barricade is in place. If the barricade is deemed to be non-effective then the Open/Light Un-Barricaded Stack QD (TD) shall be used. Information on the requirements for purpose built effective barricades may be found in IATG 05.30 *Barricades*, which should be referred to before using the QD (TD) for Open/Light Un-Barricaded Stack. Information on temporary barricades that may be used follows.

An effective barricade at an Exposed Site will arrest high velocity projections at low elevations from an adjacent explosive event in a Potential Explosive Site (PES) and thereby mitigate the risk of direct propagation. A vertical faced barricade sited close to a PES also reduces the projection of burning packages, explosives and debris.

The main advantage of interposing barricades between explosives stacks is in the storage of explosives in HD 1.1. Significantly reduced IQD (TD) may be permitted compared to the un-barricaded situation, thus permitting much greater storage density. For this simple reason, all Temporary Storage Areas should be constructed on the principle of barricaded storage.

Temporary barricades shall be used if the use of purpose-built barricade is impracticable. The construction of proper barricades is a major civil engineering task, whereas temporary barricades can be installed relatively quickly. Temporary barricades should be maintained regularly to ensure that they remain effective.

7.5.2. Types of temporary barricade

Table 9 summarises the more realistic options for temporary barricades in ascending order of costs.

Barricade Option	Requirements	Remarks
Waste Oil Drums	▪ Filled with sand, earth or gravel (<20mm diameter). ▪ 1m wide. ▪ Height to be 300mm above the stack height.	▪
Bastion / Gabion	▪ A wire frame filled with sand, earth or gravel (<20mm diameter). ▪ 1m wide. ▪ Height to be 300mm above the stack height.	▪ A Gabion is a cage within which can be placed various fill materials (e.g. gravel, sand, earth), and which is used for building walls, barricades and protective barriers.
Water Tank Barriers or Walls	▪ Filled with water. ▪ 1m wide. ▪ Height to be 300mm above the stack height. ▪ Can be reused.	▪ Propriety brand systems (such as MRP or Waterwall)[15] are available at relatively low cost. ▪ Require anti-freeze additives in cold climates.
ISO-Containers	▪ Filled with sand, earth or gravel (<20mm diameter). ▪ Double width. ▪ Stacked two high.	▪
HD 1.4S Ammunition	▪ 450mm wide. ▪ Height to be 300mm above the stack height.	▪ Only practicable in limited situations.
Concrete Walls (Thick)	▪ 450mm wide. ▪ Height to be 300mm above the stack height.	▪

[15] http://www.mrpsystemsuk.com/ballistic.html or http://www.waterwallblastprotection.com/ammunition.php. IATG does not specifically endorse these products, they are used to illustrate a protection concept.

Barricade Option	Requirements	Remarks
Concrete Walls (Thin)	▪ Require an earth backing on the side away from the ammunition.	▪ See IATG 05.30: for earth requirements.
Empty Ammunition Containers	▪ Filled with sand, earth or gravel (<20mm diameter). ▪ 450mm wide. ▪ Height to be 300mm above the stack height.	▪ Only practicable where an adequate supply exists. ▪ The least practicable temporary option.

Table 9: Options for temporary barricades

A barricade does not necessarily prevent subsequent propagation or damage caused by blast, lobbed items, debris or secondary fires.

7.5.3. Configuration of gabion barricades

Gabions are the most generally used type of temporary barricade, so specific advice is provided. Only gabion barricade configurations shown at Figure 1 with the measurements mentioned in Table 9 should be used between adjacent PES.

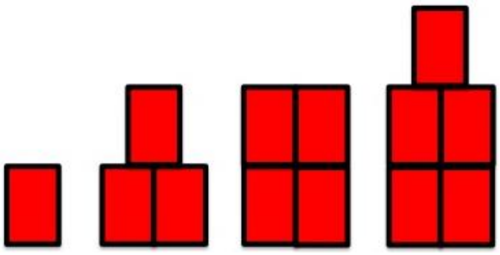

Figure 1: Temporary barricade configurations (Side of PES)

The maximum stock levels shown at Table 10 shall only be stored in each PES for Figure 1 configurations:

Figure 1 Barricade Configuration	Maximum NEQ (kg)
1	100
2 + 1	1000
2 + 2	4000

Table 10: Maximum stock levels (NEQ) for barricade configurations

The barricade configurations shown at Figure 2 do not provide more protection than those configurations at Figure 1 but can produce more mass movement onto the adjacent storage container, which may not necessarily be advantageous. The configurations shown at Figure 2 should therefore only be used in front of the container opening.

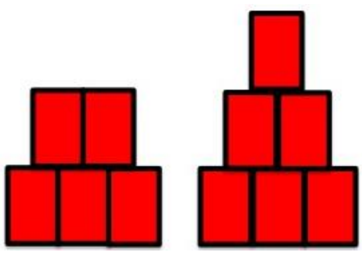

Figure 2: Temporary barricade configurations (Front of PES)

The maximum stock levels shown at Table 11 shall only be stored in each PES for Figure 1 configurations:

Figure 2 Barricade Configuration	Maximum NEQ (kg)
3 + 2	4000
3 + 2 + 1	4000

Table 11: Maximum stock levels (NEQ) for barricade configurations

7.5.4. Overhead protection

Overhead protection (OHP) may be used, under certain circumstances, to reduce explosion effects and protect against enemy fire. OHP also has the added benefit of providing shading for the ammunition (see Clause 8.2). Any OHP provided shall have the following requirements;

a) in a row of PES separated by barricades with OHP, each PES should have its own independent OHP;

b) combustible materials shall not be used for OHP;

c) the fill material for OHP shall not be hazardous to surrounding ES should it be launched. The fill material should be free of organic material and shall consist of sand, earth or gravel of less than 20mm diameter;

d) the fill material shall be at least 600mm deep and must cover the entire roof area of the PES;

e) a gap of at least 600mm shall be provided between the top of the barricade and the OHP to allow for rapid venting of blast overpressure. This gap also has additional ventilation advantages; and

f) any columns required as support for the sectional roof may be inserted within the barricade.

One recommended design for OHP is at Figure 3.

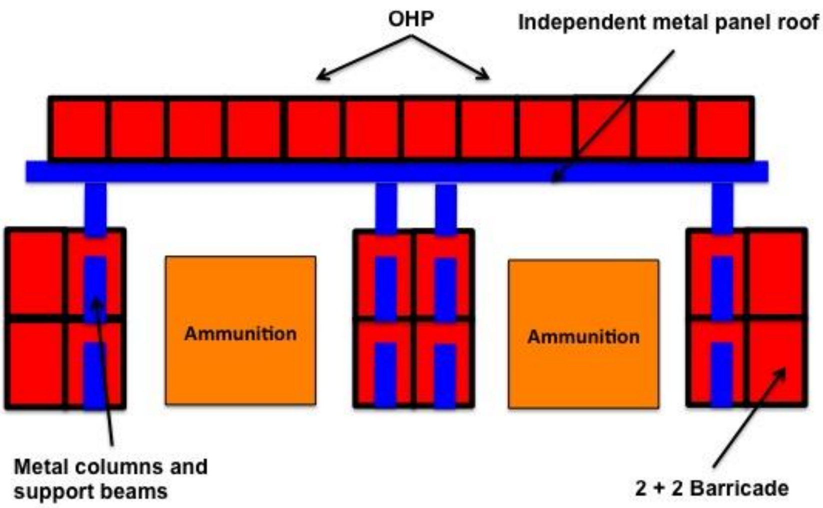

Figure 3: Recommended OHP design

7.6 Safeguarding

The requirements for safeguarding in accordance with IATG 02.40 *Safeguarding of explosive facilities* shall apply for all temporary storage areas.

8 Stock protection from environmental factors (LEVEL 1)

8.1 Degradation of explosives and the weather

The effects of weather, hot temperatures, direct solar radiation, daily temperature changes (diurnal cycling) and high humidity may rapidly degrade the performance and safety of explosives. Ammunition is designed for use under stated climatic conditions, and its service life will be significantly reduced if it is stored under climatic conditions that it was not designed for. In some cases, the ammunition may rapidly become unserviceable and dangerous to use. [16]

Although it is safe to store ammunition under temporary conditions, if appropriate conditions are met, it is unusual as it usually significantly reduces the safe service life of the ammunition. The worst condition for storing explosives under temporary conditions is where there is a considerable temperature fluctuation from day to night, combined with high humidity.

IATG 07.20 *Surveillance and proof* contains further technical information on the degradation of explosives due to climatic conditions and should be consulted prior to undertaking temporary storage of ammunition. As an example, this IATG module will consider the impact of high temperature and direct solar radiation (also see Clause 9).

In the Middle East recorded temperatures have ranged from -1^{0}C to +31^{0}C in the winter months and from +22^{0}C to +51^{0}C in the summer months. This means that the ammunition was exposed to daily diurnal cycles of up to +31^{0}C in the winter months and +29^{0}C in the summer months. These are usually considered as extreme ranges for ammunition, and a reduction in service life shall be exected. Yet, these temperatures are ambient air temperatures and do not take into account the effects of direct solar radiation on ammunition or on packaged ammunition.

Tests have shown that, when fully exposed to the sun, the temperature on the external surface of the ammunition can be as much as 50^{0}C higher than the ambient air temperature. This means that ammunition could theoretically reach external surface temperatures of 101^{0}C in the Middle East. It should be noted that the melting point of TNT based explosives is approximately 80^{0}C; **the very real danger of using TNT filled ammunition at this temperature cannot be overstated.**

8.2 Climatic protection options (LEVEL 1)

The options for the protection of ammunition stocks in Temporary Storage Areas from climatic conditions are limited unless covered infrastructure is available. Table 13 summarises the available options. The option selected should depend on what sort of protection is required.

Option	Impact	Remarks
Directly covered by tarpaulins (or equivalent) in contact with ammunition.	▪ Protects ammunition from rain and wind. ▪ The temperature at the external surfaces of ammunition temperature is up to 5^{0}C greater than if left unprotected. ▪ Condensation due to poor air ventilation may lead to moisture ingression in very hot climates.	▪ WARNING. This option should NOT be used in hot climates.

[16] More technical detail on this issue may be found in IATG 07.20 *Surveillance and proof*.

Option	Impact	Remarks
Shaded by camouflage nets or sheeting raised above the ammunition.	▪ Protects ammunition from radiant heat. ▪ The ammunition is vulnerable to rain and wind, hence moisture ingression is possible. ▪ In hot climates, the temperature at the external surfaces of the ammunition can be reduced by up to 23^{0}C compared to unprotected ammunition.	▪ The nets or sheeting should be raised to at least 300 mm to 500mm above the surface of the ammunition or ammunition packaging. ▪ Much preferred to direct coverage.
Raised off the ground by use of dunnage.	▪ Protects ammunition from moisture ingression. ▪ This allows for free air circulation, which will reduce the build up of moisture and condensation.	▪ A height of 75mm should be achieved. ▪ Regular maintenance is required to ensure that sand, earth etc does not build up around the base of the ammunition.
ISO-Containers	▪ Protects ammunition from radiant heat, rain and wind.	▪ These shall be grounded to earth. ▪ Ammunition shall not touch the walls or roof of the container. ▪ Paint containers white in order to reduce heat load ▪ They should be elevated.
Improvised Structures such as large tents, locally constructed shelters etc.	▪ Protects ammunition from radiant heat, rain and wind.	▪ Should be the minimum requirement for ammunition in temporary storage.

Table 12: Ammunition stock protection options from high temperature

8.2.1. Priorities for covered storage (LEVEL 1)

When covered storage is not available for all the explosives in Temporary Storage Areas, priority should be given to the natures that are likely to deteriorate most rapidly. However, rigid adherence to fixed guidelines may not always be feasible. The priorities may have to be altered to take into account, for example, the packaging of individual natures. For instance, in extremely hot climates, shells containing WP, which are normally fairly robust, may have to be accorded a high priority for covered storage because circumstances do not allow them to be stored in an upright attitude.

Assuming a normal standard of packaging, with no other requirements, the following order of priority for covered storage should be applied:

a) water activated explosives;

b) guided weapons and torpedoes;

c) anti-tank, ranging and spotting ammunition;

d) propelling charges;

e) pyrotechnics;

f) mortar ammunition;

g) grenades and mines;

h) boxed shell;

i) small arms ammunition (SAA); and

j) loose shell.

9 Surveillance and in-service proof (LEVEL 2 and 3)

It is highly likely that the service life of ammunition would be significantly reduced if kept under temporary storage conditions for prolonged periods of time. It should be subjected to an effective technical surveillance and in-service proof programme. This is the only way to ensure that the ammunition does not deteriorate to a condition that compromises performance or safety during handling, storage, and transportation.

An example of the impact that temporary storage conditions have on ammunition is the chemical deterioration of propellant. When propellant is stored in high temperature environments for prolonged periods the stabilizer is depleted far quicker, and the probability of spontaneous combustion due to auto catalytic ignition becomes much higher. For instance, most propellants have a shelf life of at least 15 to 40 years when stored at a constant 25°C and will last much longer in temperate climates. Well acknowledged methods for the determination of safe storage life of propellants[17] allow prediction of stability for a period of up to 10 years. This is the longest period recommended before reinspection should be conducted. At 10 degrees above the 25 degree baseline, the rate of deterioration may be as much as tripled. For example, if a propellant is stored at 50°C for one year, this would be equivalent to 12 years storage at 25°C. Therefore, if a propellant has a certificate of chemical stability for 10 years, this certificate is outdated after one year [18]of storage at 50°C, which means that the health status of the propellant is no longer defined and has to be checked. It doesn´t necessarily mean that propellant is unsafe, but the safe storage life has to be re-established.

Clause 8.1 indicated that ammunition could theoretically reach external surface temperatures of 101^{0}C in the Middle East, although internal temperatures would be substantially less. Propellant degradation and stabiliser depletion is not linear, and the decay rate reduces during the night when the ammunition cools. Yet it is clear that temporary storage conditions for propellant in these types of temperature extremes would not be a particularly sensible idea. If temporary storage is operationally necessary under such climatic conditions, the propellant should be separated from the parent ammunition wherever possible.

IATG 07.20 *Surveillance and proof* contains further technical information on the degradation of explosives and should be consulted prior to undertaking temporary storage of ammunition.

10 Fire precautions (LEVEL 1)

Ammunition that is being stored in Temporary Storage Areas is more vulnerable to fire than ammunition held in purpose-built ammunition depots. Therefore, even more importance shall be paid to fire prevention and fire fighting measures.

The fire precautions, fire-fighting principles and procedures contained within IATG 02.50 *Fire safety* shall be complied with as far as is reasonably practicable.

10.1.1. Fire precautions (supplementary to IATG 02.50)

Firebreaks, 2m wide, shall be maintained around all PES. Additionally, all vegetation within 10m of a PES should be strictly controlled by cutting back and weed killing.

[17] STANAG 4620 and related AOP 48, STANAG 4582

[18] A standard test replicates 10 years of 25°C aging in 301 days at 50°C, 191 days at 55°C….or 3.43 days at 90°C.

10.1.2. Fire fighting (supplementary to IATG 02.50])

The equipment recommendations in IATG 02.50 *Fire safety* shall be supplemented by an adequate supply of fire extinguishers (water and powder), fire-beaters, shovels, machetes etc near each PES to deal with bush and scrub fires that are not normally encountered within an ammunition depot.

An Emergency Water Supply should be located near each PES.

The appropriate Fire Division Signs and Supplementary Fire Signs shall be displayed on posts at the approaches to each PES, although black and green tactical versions may be used if justified by the operational environment. Standard orange signs shall be used in Temporary Storage Areas after one year.

All fires in the vicinity of the ammunition should be fought until stacks of ammunition or explosives become involved in the fire or the fire is extinguished. If ammunition becomes involved in a fire, personnel shall be removed immediately from the site to safe locations/distances.

All personnel shall be made aware of the appropriate emergency withdrawal safe distance that they shall place between themselves and the ammunition should immediate firefighting prove to be ineffective at controlling the spread of the fire. This safe distance shall not be less than 800m.

Personnel whose duties require them to fight secondary fires shall not approach within 300 m of any fire involving ammunition and explosives other than Fire Division 4. They shall immediately withdraw to the designated safe distance, (at least 800m or to the IBD, whichever is greater), when the fire fighting teams at the ammunition site withdraw.

After an ammunition fire has been extinguished, personnel shall wait at least six hours before entering the area to inspect the consequences of the fire.

10.2 Lightning protection (LEVEL 1)

In cases where Temporary Storage Areas are likely to be a mid-term (> 2 years) solution to ammunition storage appropriate lightning protection should be deployed. Protection should be fitted in accordance with the requirements of IATG 05.40 *Safety standards for electrical installations*.

In all cases ammunition stacks should be located no less than 15m from trees, telegraph poles, and pylons in order to reduce side flash should there be a lightning storm in the area.

11 Security (LEVEL 1 and 2)

The security for Temporary Storage Areas is always problematic due to the large ground area that they have to cover for explosive safety reasons. Although many of the security principles contained with IATG 09.10 *Security principles and systems* should be implemented, many of the guidelines for technical protection systems such as alarms, Class 1 to 4 security fencing etc are clearly inappropriate on financial grounds alone.

Perimeter security should be the highest priority, and this may be achieved by using a combination of armed guards, patrols, guard dogs and temporary fencing. Figure 4 shows examples of temporary fencing that can be erected by unskilled labour and upgraded through Levels 1, 2 and 3 as resources become available.

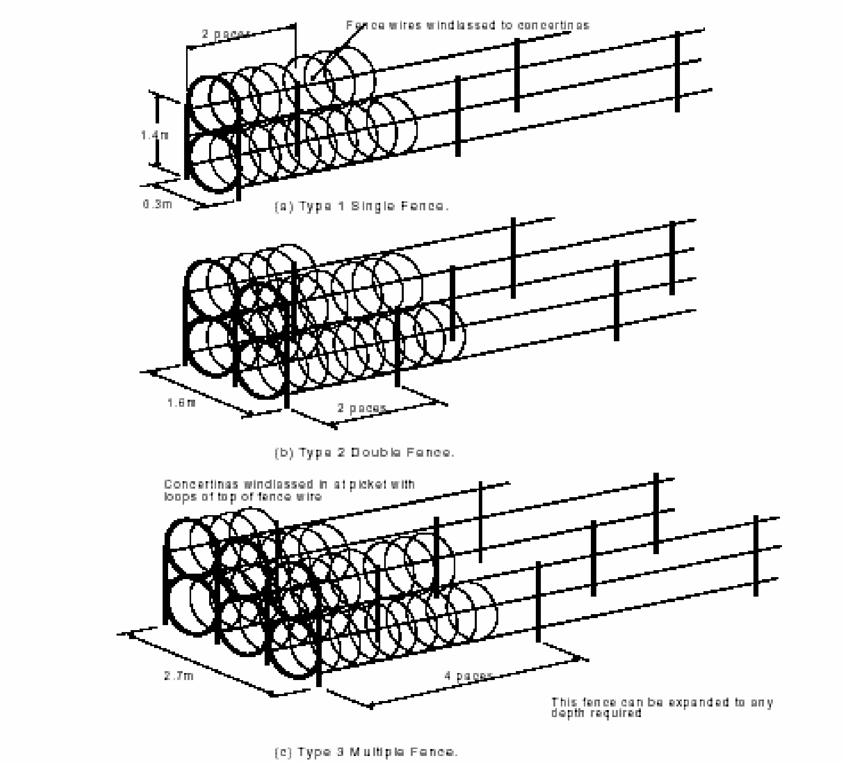

Figure 4: Temporary fencing options

Annex A
(normative)
References

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

a) IATG 01.40*Terms, glossary and definitions*. UNODA.;

b) IATG 01.50*UN Explosive classification system and codes*. UNODA.;

c) IATG 01.90*Ammunition management staff competencies.* UNODA.;

d) IATG 02.20*Quantity and separation distances*. UNODA.;

e) IATG 02.50*Fire safety*. UNODA.:

f) IATG 05.30*Barricades*. UNODA.;

g) IATG 05.40*Safety standards for electrical installations*. UNODA.; and

h) IATG Volume 07 *Ammunition processing*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[19] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[19] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions which should also be consulted to provide further background information to the contents of this guideline:

i) AASPT-5, Edition 1, Version 3, *NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations*. NATO Standardization Organization (NSO). June2016;

j) Joint Service Publication 482, Edition 4, *MOD Explosive Regulations*. Chapter 11. UK MOD. January 2013 – updated 10 April 2017. www.gov.uk/government/publications/jsp-482-mod-explosives-regulations.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[20] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[20] Where copyright permits.

Examples of Hardened, Semi-Hardened and Light Structures

Examples of hardened structures.

Examples of semi-hardened structures.

Examples of light structures.

Amendment record

Management of IATG amendments

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

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

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

The most recently amended, and thus extant, IATG will be the versions that are posted on the UN *Safer*Guard IATG website at www.un.org/disarmament/convarms/ammunition/ .

Number	Date	Amendment Details

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 05.10

Third edition
March 2021

Planning and siting of explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 05.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consultwww.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module details the general requirements and procedures for planning, siting and subsequent approval of new explosives facilities. These procedures vary considerably depending on whether the requirement is for a major new facility, such as an ammunition storage area (ASA), an individual new facility, such as an explosive storehouse (ESH) or ammunition process building (APB), or substantial alteration to an existing building. The requirements contained in this IATG module can also be retrospectively applied to existing facilities, and this should be encouraged.

Ammunition in transit that stops for more than a temporary halt, or that is being loaded to or unloaded from or between transportation conveyances, shall have each such location considered as an explosives facility or location that must meet the planning and siting requirements of this IATG module and shall have appropriate Quantity Distances (QD), as discussed herein, applied to all surrounding exposures. Examples include transportation hubs such as ports, airfields, railyards, inter-modal change areas (e.g. rail-to-truck, ship-to-truck, truck-to rail or ship), secure holding areas for ammunition conveyances, safe havens (stopping places for safe and secure temporary holding of an ammunition conveyance en-route to its final destination), etc. It is the aim of this IATG module to explain these procedures in detail to enable the reader to carry out all of the actions necessary to safely establish the required facility.

Planning and siting of explosives facilities

1 Scope

This IATG module introduces the principles and requirements for the planning and siting of explosives facilities.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'ammunition storage area' refers to *an area used for the storage of ammunition and explosives and within which authorised ammunition or missile preparation, inspection and rectification operations may also be carried out.*[3] (c.f. explosives area).

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'potential explosion site' refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content*.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

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4 Siting considerations

The explosives location or site, whether existing or proposed, should be formally selected by a Siting Board set up and approved by the national technical authority. When planning for a new location it is essential that all interested parties are involved from the earliest stage in the proceedings and take advice as necessary from appropriate technical experts.

When siting any explosives facility, whether above ground or underground, all factors that may affect its operation under all conditions should be considered. It is unlikely that one area or site will be found which meets all requirements, so the best combination of desirable features is to be aimed for and an acceptable compromise sought. The need for possible future expansion is a primary requirement.

Careful and correct assessment, planning, siting and construction of major ammunition storage areas (ASA) are essential to:

a) ensure that they can be operated safely, economically and efficiently;

b) ensure an acceptable level of protection to the public and individuals not connected to the ASA;

c) keep the risks from explosive sites at a level that is preferably negligible, but at least as low as reasonably practicable (ALARP);[4]

d) minimise the loss of stocks due to an accidental or deliberate explosive event;

e) provide a storage and handling environment in which ammunition can be maintained in a fully serviceable condition to enable users to be supplied with reliable explosives natures at the right time and place; and

f) ensure that the explosives licences of existing Potential Explosion Sites (PES) are not compromised.

4.1 Quantity distances (LEVEL 1)

The main consideration when siting a PES shall be to ensure that the quantity distances,[5] both inside and outside, are adequate, and that the best use is made of the area available. To achieve these aims, and to minimise the area subject to safeguarding restrictions,[6] PES for the most hazardous stores (Hazard Division (HD) 1.1) should normally be sited at the centre of the area, whilst those for the least hazardous (HD 1.4) should be nearest the perimeter. By ensuring that minimum inter-magazine distances are met between explosives sites, the maximum credible explosive event (MCE) will be limited, thereby minimizing required outside quantity distances.

Maximum safety and flexibility of use of buildings may be achieved by traversing all non-earth covered explosives buildings. However, the selection of the optimum combination of types of construction of PES, quantity distances (QDs) and explosive storehouse (ESH) construction requires a balance between construction costs, the cost of land and the cost of the ammunition to be stored. The Hazard Division (HD) and Compatibility Group (CG) of the ammunition natures to be stored should also be taken into account as some CG will require special storage. Therefore, the most vital piece of information required by the planners is the nature and quantities of ammunition to be stored.

The IATG Implementation Support Toolkit includes a Quantity-Distance Map[7] tool that can be used in the early planning stages to determine the area at risk from a given quantity of HD1.1 ammunition.

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[4] See IATG 02.10 *Introduction to risk management principles and processes.*

[5] See IATG 02.20 *Quantity and separation distances*.

[6] See IATG 02.40 *Safeguarding of explosive storage areas*.

[7] www.un.org/disarmament/un-saferguard/map

If the IATG-listed QDs cannot be achieved in a particular situation, the advice of an explosives safety expert should be sought, to conduct an explosives safety case using Risk Assessment techniques and commercially-available software

4.2 Location

In the event of a completely new facility being built, location shall be of vital importance. In the event of modifications to PES, then some of the following factors may apply.

4.2.1. Isolation

In order to meet the safety distance requirements of IATG 02.20 *Quantity and separation distances* it is necessary for the new facility to have a degree of isolation. PES should not normally to be sited closer than 25m from the explosive storage area (ESA) fence and should be increased to 50m where there is an external road giving access for vehicles to the fence-line.[8]

New building encroachment within the outside quantity distances is always possible where quantity distances extend beyond the perimeter of the ESA. Where this is a possibility, the land in question should be purchased to prevent such encroachments or appropriate safeguarding arrangements should be made.[9] Particular consideration should be given to exposed sites that are considered to be of 'vulnerable construction'.

Overhead power supply systems and associated networks and installations should be avoided but, if this is not possible, then the facility should be sited in accordance with IATG 05.40 *Safety standards for electrical installations*. Similarly, mains water, gas and oil networks should be avoided.

To reduce and/or mitigate the risk from aircraft accidents in explosives areas during take-off and landing, the sites selected should not normally be within an airfield circuit. If the facility is to be constructed at an airfield, PES shall not form an obstruction to flying and shall not be built within the flight strips or approach/departure funnels associated with runways. The air traffic control organisation should be involved at all stages of planning.

Due consideration should also be given to the effects on the ammunition and explosives of radiation hazards (RADHAZ) from mobile and fixed transmitters that are often found near airfields, ports and other major transportation hubs and the risk to these facilities from the explosives.[10]

4.2.2. Accessibility

The explosives facility should have a certain level of accessibility to:

a) the customer units which the facility is intended to supply;

b) stockage support facilities such as the sources from which stocks are likely to be received, e.g. ammunition manufacturers and other explosives storage facilities;

c) roads, rail, ports and airfields from which shipments will be made and received; and

d) the civilian labour force (if required).

[8] The quantity distances will generally be much greater than the recommended minimum for the fence and therefore the area should be safeguarded in accordance with IATG 02.40 *Safeguarding of explosive facilities.*

[9] See IATG 02.40 *Safeguarding of explosive facilities.*

[10] See IATG 05.60 *Hazards of electromagnetic radiation*.

There should also be a clearly defined internal traffic circuit within the ESA with distinct IN and OUT routes to each ESH. The layout of the ESH, Process Buildings (PBs) and other ancillary buildings should be such that vehicles need not retrace their steps.

4.2.3. Storage and handling capacity

The area or site selected should be able to store the specified quantity of ammunition as described at Clause 4.1 above and it should also have the facilities for handling this ammunition in a logistically efficient manner.

4.2.4. Communication – road and rail

The area selected should be accessed by good roads of sufficient width and strength to allow constant use by heavy traffic. However, care must be taken to ensure that Public Traffic Route Distances (PTRD) do not cause a storage problem.[11] Access roads and rail tracks should not pass through congested towns, thereby reducing the hazard from an accident involving a vehicle or rail carriage carrying ammunition.

The facility should have a one-way traffic system, where possible, with appropriate speed limitations imposed. Roads within an explosives area should serve all significant explosive storehouses and process buildings and should be capable of use by the largest and heaviest vehicles likely to be used. Gradients should be minimised wherever possible and it is recommended that no gradient should exceed 1:20 and, where trolleys without brakes are used, e.g. alongside buildings or open bomb bays, the gradient should not exceed 1:100. The minimum inside radius at corners should be not less than 9m for normal road vehicles and may be increased to cater for trailers if they are used. Stabling and lay-be areas should also be established.

Unless a railway system exists, or can be constructed, good road communication with the nearest railhead is essential. Ideally, major explosives facilities should be served by rail as well as road systems, both inside the explosives area (in the case of larger depots) and connecting the depots with the public main lines. If this is the case, it is essential that the rail authorities should certify that the public railway system is capable of handling the increased amount of traffic. In order to reduce delays in loading and unloading, adequate provision should be made for marshalling and shunting trucks. The facility should also include stabling facilities, exchange sidings, sorting sidings, emergency alternative lines, turning facilities and rail lines to explosive storehouses, storage bays and ammunition process buildings.

4.2.5. Climate and terrain

Dry storage conditions are highly desirable, so the area chosen should be well drained and as dry as possible. Areas with high incidences of electrical storms or other atmospheric abnormalities, or terrain that is liable to flooding, should be avoided, as should areas in which the roads become easily blocked by snow.

The subsoil should be firm and stable, otherwise subsidence of barricades, roads and hard standings may result.

Thickly wooded sites have an inherent fire risk in dry weather and may require clearing of undergrowth and firebreaks. Such sites are normally poorly ventilated and are consequently excessively humid. They should be avoided.

Dry, gently undulating land provides natural barricades and is the most suited to the storage of ammunition.

[11] See IATG 02.20 *Quantity and separation distances*.

5 Types of facilities within a depot (LEVEL 2)

5.1 Disposals area

Wherever possible, a major facility should possess its own disposal area to enable unserviceable or dangerous ammunition to be destroyed on site. The disposal area should be remote from the storage area to ensure complete safety, but it should also be easily accessible. See Annex D to IATG 10.10 *Demilitarization and destruction* for disposal area requirements.

5.2 Explosives storehouses (ESH)

These buildings should be sited with due regard to the quantity distances calculated[12] to meet the forecast storage requirement.

ESH should be designed and constructed in accordance with IATG 05.20 *Types of buildings for explosives storage.*

5.3 Ammunition process buildings (APB)[13]

If possible, APBs should be located in an area away from explosives storage facilities. If this is not possible, they are to be located in an area where the quantity distances for processing activities are achievable in accordance with IATG 02.20 *Quantity and separation distances*. Siting should also take into account the requirement to move and process ammunition. If the construction of buildings is impracticable, a mobile processing facility may be employed.[14]

APBs should be designed and constructed in accordance with IATG 05.20 *Types of buildings for explosives storage.*

5.4 Administrative buildings, non-explosive storage and other facilities

These types of buildings directly connected with the operation of the ammunition storage facility should be located outside the explosives area but should be as close as quantity distances allow. Those facilities not directly connected with the presence of ammunition should be sited at greater distances. However, attention should be paid to the potential difficulties in explosives licensing, and the permissible limits thereof, if protective and non-protective structures are mixed together, particularly with regard to man-limits and construction considerations such as windows, walls and roofs. They should be in a separate administrative area which, together with the explosives area, makes up the overall explosive facility.

5.5 Temporary storage of vehicles loaded with ammunition

When the ammunition storage facility is not suitable for use as a unit staging facility, then any fenced area outside the administrative area may be considered for use. However, this location should be patrolled or controlled under strict security arrangements. If an area is not fenced, it may still be used for staging, provided the security arrangements are agreed by the national technical authority. Areas adjacent to domestic accommodation should not be used.[15]

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[12] See IATG 02.20 *Quantity and separation distances*.

[13] Also referred to as Process Buildings (PB).

[14] Specialist technical advice should be sought on the design of a mobile processing facility as it will be dependent on the processing tasks needed to be carried out.

[15] See IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*

5.6 Lighting arrangements

Street lighting to the standard required in civilian built up areas should be provided for reasons of safety and security. They should be in accordance with the requirements of IATG 05.40 *Safety standards for electrical installations.*

6 Underground storage (LEVEL 2)

The storage of ammunition in underground caves or caverns or the construction of new underground facilities is a complicated issue and the factors listed below should be considered if this type of storage is planned.

6.1 Advantages

The advantages of underground storage are:

a) a smaller total land area is usually required in comparison with above ground storage, and land requirements are generally directional from the entrance;

b) the area is easier to guard;

c) should an explosive event occur in a storage chamber, damage to explosives in other chambers can be prevented. In above ground storehouses, other than those that are earth covered, damage could be severe, dependent on construction type and separation distance used;

d) the temperature in underground sites remains fairly constant and is thus more conducive to the chemical stability of the ammunition, (but see also the disadvantages below);

e) climatic changes such as rain, snow and ice, which may cause difficulties in above ground storage, may be more easily avoided;

f) better protection is afforded against externally induced threats, such as fire, lightning strike, explosive accident; and

g) maintenance of the underground infrastructure is less expensive than for that above ground so the initial high costs of providing underground storage may be offset in the long term.

6.2 Disadvantages

The disadvantages of underground storage are:

a) the costs of the new excavation or modification of an existing excavation and the installation and maintenance of special equipment;

b) restrictions imposed by the locality of the site due to unsuitable terrain features;

c) the need to provide blast doors in a connected chamber storage site, or to accept the possibility of total loss of personnel and stocks;

d) relatively high humidity underground may cause deterioration of stocks or packaging. Special attention may have to be given to controlling humidity where valuable or humidity sensitive items are to be stored; and

e) it may be necessary to provide special mechanical handling equipment (MHE) and other vehicles unless the facility is designed to accommodate normal vehicles.

6.3 Terrain considerations

Some types of terrain are unsuitable for the construction of underground facilities namely:

a) sand, clay, shale or broken rock, due to an inherent lack of structural strength;

b) coal bearing strata due to the risk of combustion;

c) rock which is steeply dipping due to potential instability during construction operations;

d) areas with extensive underground workings where serious subsidence may occur; and

e) permeable rock with a high-water table or fissured rock with underground water channels, even if dry as in limestone country.

Massive igneous rocks such as granite, though technically suitable, may give rise to prohibitive excavation costs.

Directional explosion effects from a potential incident may place serious limitations on the orientation of an underground facility. This is obviously applicable to the direction of the adit (the tunnel exit point) but also applies to crater projections in the event of an explosion, particularly where the cover surface is inclined.

6.4 Some design considerations

The advice of a mining engineer shall be essential and such a skill set should be involved at the very earliest stages of planning.

Connected chamber storage sites should have more than one entrance. Single entrances should be avoided because, in the event of an explosion, some of the chambers could be totally blocked. Ideally, adjacent chambers should be parallel to each other and the axes of the chambers at right angles to the axis of the main passageway rather than inclined. Adjacent junctions of branch passageways in connected chamber storage sites, with chambers on both sides of the main passageway, should be separated as much as possible.

Should a cavern storage site be chosen, the roof should be cleared of loose material, and any weak parts should be pinned or supported by some other method. Faults and fissures in the walls should be filled with concrete to prevent the passage of hot gasses or blast in the event of an explosion. Caverns with high roofs should be avoided because of the danger of roof falls and the difficulty of inspecting the roof.

Material excavated during construction may be of use in other parts of the project such as barricades.

7 Smaller facilities (LEVEL 2)

Requirements sometimes arise for smaller ammunition storage facilities e.g. unit ammunition storage facilities. The proposed facility shall still undergo the full approval process to ensure that all safety processes are carried out, and all interested parties shall be involved to define the extent of the works required and if it is possible to issue an explosives licence. A site visit should be carried out to ascertain the following factors:

a) the need to identify the Net Explosives Quantity (NEQ) by nature(s), HD and CG to be stored;

b) identification of the type, number and size of facilities required (including administrative buildings) and associated area and layout;

c) the suitability of any existing buildings for their current task;

d) the suitability of the planned facilities for their future task;

e) the cost of the buildings when compared to the task both short-term and long-term;

f) the technical specifications required for safe storage e.g. construction, barricades, heating, lighting, security features etc;

g) the proximity of any protected areas such as UNESCO sites, sites of special scientific interest etc;

h) the proximity of any structures which will affect storage such as hospitals, schools, churches, public roads etc; and

i) the suitability of existing construction and buildings at sited IQDs.

The feasibility of the planned layout, adapted as necessary to meet local conditions, should then be discussed, along with confirmation of the type, number, size and layout of facilities required, enabling a formal Siting Board to be held.

8 Approval of facilities (LEVEL 1)

8.1 New facilities

Plans for the siting of any proposed new explosives facilities and the Siting Board results shall be submitted to the relevant authority for approval no later than the primary phase of the proposed procurement process. The plans should include the following:

a) suitably scaled maps which show the location of each PES and ES within the impacted QD;

b) NEQ and HD associated with each PES;

c) a description of the purpose of each PES and ES and the numbers of persons located in each;

d) the site perimeter, the actual boundaries of national authority owned real estate, the safeguarded area and the yellow and purple lines;

e) the extent of any leased real estate;

f) construction drawings, as appropriate, to ensure compliance with explosives safety requirements;

g) any local authority, national and international borders; and

h) any special sites or buildings that have sensitive scientific, cultural or other properties that lie within the purple zone (VBD) of the proposed facility.

On receipt of the above, the relevant body appointed by the national technical authority shall examine the documents and, if found suitable, shall officially confirm that the planned site and/or facility is suitable and formally approve commencement of construction. Official approval shall be in writing and copies of such documents kept indefinitely.

8.2 Changes to existing facilities

When there is a requirement to substantially alter an existing facility then a formal siting board shall be convened. Examples of substantial alterations include, but are not limited to:

a) use of an existing non-explosive facility as a PES;

b) change of use, including ammunition processing, of an existing PES or ES;

c) major structural alterations to, or refurbishment of, a PES; or

d) any change of frangible materials, or alterations to designed operating criteria, such as venting arrangements.

Plans as described at Clause 8.1 a) – h) above should be submitted for consideration and approval.

When minor work, refurbishment, or any other modification, irrespective of size or value of the works is planned, the proposals should be co-ordinated with the relevant national technical authority. However, this may not apply to routine maintenance, if the work carried out is like for like and the existing facility is already fully compliant with IATG specifications.

The siting board results should be forwarded to the responsible national technical authority.

When it is proposed to construct, change the use of, or otherwise modify any non-explosives facility in the vicinity of an existing PES, a siting board shall be convened, the proposal reviewed, and the consequences considered. Failure to do so may render the PES unable to be licenced, and therefore unusable.

9 Possible procurement process

Each national technical authority should have its own procurement and legal processes and bodies in place which govern and authorise expenditure, building processes etc. However, the following procedure covers a logical flow process and the national technical authority may consider these principle stages as part of its own processes, having agreed to the work taking place:

a) project definition;

b) project brief production;

c) project manager (PM) appointment;

d) project planning and initial design of the facility;

e) interim approval by the national technical authority;

f) detailed design, works tender preparation and the final project appraisal;

g) invitation to tender (ITT), bid evaluation and awarding of contract;

h) works construction period, quality assurance (QA) and staged payments authorisation;

i) final approval and handover of facility; and

j) financial completion.

9.1 Key skills requirements

Notwithstanding national technical authority requirements, the following key skills should be involved at all stages of the process during the planning and construction phases:

a) trained ammunition technical personnel to advise on ammunition licensing, receipt, movement, storage, processing, issuing and disposal matters;

b) the project manager (PM) to coordinate effort, establish technical and financial guidelines, and manage goal management;

c) civil engineering technical advisors to advise on design, project management, contractual, construction and maintenance works matters; and

d) specialist technical advisors to provide advice on the electrical design, lightning protection and suitability of electrical equipment for explosives related facilities.

10 Handover and takeover procedures for new or modified facilities (LEVEL 2)

Before a new PES, or an existing PES which has had major works services carried out, is taken into use for the storage or processing of explosives, it should be formally handed/taken over for this purpose and licensed.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.10 *Introduction to risk management principles and processes*. UNODA;

d) IATG 02.20 *Quantity and separation distances.* UNODA;

e) IATG 02.40 *Safeguarding of explosive storage areas (ESA)*. UNODA;

f) IATG 05.20 *Types of buildings for explosives storage.* UNODA;

g) IATG 05.40 *Safety standards for electrical installations.* UNODA;

h) IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*. UNODA;

i) IATG 05.60 *Hazards of electromagnetic radiation*. UNODA;

j) IATG 06.50 *Specific safety precautions*. UNODA; and

k) IATG 08.10 *Transport of ammunition*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[16] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[16] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions which should also be consulted to provide further background information to the contents of this module:[17]

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

b) *Handbook of Best Practices on Conventional Ammunition*, Chapter 2. Decision 6/08. OSCE. 2008. www.osce.org/fsc/33371;

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

d) The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[18] used in this module and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[17] Data from many of these publications has been used to develop this IATG.

[18] Where copyright permits.

Amendment record

Management of IATG amendments

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 05.20

Third edition
March 2021

Types of buildings for explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 05.20:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consultwww.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module details the general, and, in some cases, recommended mandatory requirements, for the design of buildings that are to contain explosives for either storage or processing. Most potential explosion sites (PES) are a *de facto* potential hazard to personnel, other explosives facilities, and other buildings that are in the vicinity. Correct building design, construction and siting is essential in order to make effective use of the quantity distances (QDs) calculated.[3]

This IATG module will describe the potential consequences of explosive events that may occur and the subsequent effects on the building containing the explosives and other nearby buildings. It will also describe how correct building design will mitigate these effects and it provides descriptions and schematics of some typical ammunition storage buildings.

[3] See IATG 02.20 *Quantity and separation distances*.

Types of buildings for explosives facilities

1 Scope

This IATG module will describe possible scenarios and effects resulting from unplanned explosive events in explosive facilities, how various building designs will respond to such events, and how the design of those buildings and their associated QD's may be optimised to produce safe and efficient explosive storage.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'ammunition process building (APB)' refers to *a building or area that contains or is intended to contain one or more of the following activities: maintenance, preparation, inspection, breakdown, renovation, test or repair of ammunition and explosives.*

The term 'exposed site (ES)' refers to *a magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the potential explosion site under consideration.*

The term 'explosive storehouse (ESH)' refers to *any building or structure approved for the storage of explosive materials*.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'potential explosion site (PES)' refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Explosive effects

Various physical effects are produced by an explosion and the aim of explosives storage is to reduce the effects of an explosion should it occur. This is done by a combination of factors such as imposing the correct quantity or separation distances (QD) for the explosives being stored, ensuring that Compatibility Group (CG) mixing rules are adhered to and ensuring the storage building design is suitable.

4.1 Fragments and debris

Various types of fragments and debris will be generated by a Hazard Division (HD) 1.1 explosion. Fragments are produced by casings of explosive articles, as well as the packaging. These fragments will have speeds of around 3000m/s and be of varying mass, dependent upon the ammunition nature generating them, but the mass will range from 1g upwards. These fragments can kill or injure personnel and may initiate adjacent ammunition and explosives if of sufficient energy.

Debris comes from structural materials, including earth from barricades or cover, arising from the break-up of the potential explosion site (PES). Debris has much lower velocity than fragments (10m/s to circa 500m/s), and consequently do not travel as far, but could kill or injure personnel and even initiate adjacent explosives if they can transfer sufficient energy.

Some debris projection is directional in effect and less debris is projected from the corners of a structure, increasing to a maximum when at right angles to each face of the structure. This applies to all sides of the structure irrespective of whether a barricade[4] is present.

There is also a debris crater formed by the expulsion of material from the seat of the explosion. This has no directional effects and normally has a low velocity, so does not travel far from the source of the explosion. Though crater debris can present an impact hazard to personnel and could even initiate adjacent explosives if the material has enough energy, it is generally not a consideration, as fragments and structure debris have significantly greater mass and velocities and therefore present the greater threat.

Fragments and projections can travel significantly further than the Inhabited Building Distance (IBD), which represents a 1% probability of an average person being hit by a fragment that could seriously injure and possibly kill them. This probability is further defined as one hazardous fragment of 80 joules hitting within an area that measures 56m^2. Because of the significant real estate required to provide complete protection, this hazardous fragment density has been internationally recognized as the acceptable level of risk from an accidental explosion event. For intentional explosion events, such as at a detonation range, protective distances are based on maximum fragment throw, which is calculated or based on testing.

4.2 Fire and thermal radiation

The flame and heat effects of an explosion are highly dependent upon the explosive types involved. The detonation of any explosive results in the production of a fireball. However, explosives in HD 1.1 produce a very short-lived flame, which is of negligible hazard in comparison with the blast and fragment effects.

[4] See IATG 05.30 *Barricades.*

On the other hand, explosives of HD 1.3 differ from detonating explosives of HD 1.1 because, unless they are heavily confined, their reaction does not result in the generation of the high-pressure gases and subsequent blast wave associated with HD 1.1 explosives. The total energy release by a HD 1.3 classified item is comparable with that of a detonation but is released over a longer period, typically seconds or longer as opposed to milliseconds (ms). This energy is released in the form of an intense flame and associated thermal radiation and may cause hazard by the direct impingement onto explosives and personnel.

Burning HD 1.3 material produces combustion gasses which, when burning within a structure, can generate significant internal gas pressure which may be sufficient to cause a breaching/bursting of a structure and the generation of structural debris. The debris will be larger and will have relatively lower velocities. The effects are governed by the amount of HD 1.3 present and burning, the rate of burning, the venting area present in the facility, as well as the structural hardness of the structure. The effects are comparable to a rupture of a pressure vessel that has exceeded its internal pressure limit.

4.3 Ground shock

When an HD 1.1 high order detonation takes place on or near the ground, shock loading is imparted to the ground surface. Energy is also transmitted through the air to form air-induced ground shock, and some through the ground as direct-induced ground shock. Air-induced ground shock occurs when the air blast shock wave strikes the ground surface and induces a stress impulse. The directly induced ground shock results from the energy of the detonation wave being transferred directly into the ground. The net ground shock experienced is a combination of the two.

The size and effect of the ground shock are affected by the soil type and air temperature and density through which the shock travels, and by the distance from the seat of the detonation. The effects of ground shock are small compared with air blast, and are generally ignored for aboveground structures. However, for underground storage, the effects and consequences of ground shock must be assessed.

4.4 Blast

The air blast from an explosion involving HD 1.1 is in the form of a pressure increase or shock front which expands radially from the centre of the explosion at supersonic velocity. When this shock front impinges on a rigid object such as a building, a higher pressure is produced due to reflection of the wave. As the wave expands from the explosion, it decays in strength, lengthens in duration and decreases in velocity. In general, strength decay is an inverse cube root function of distance.

In addition to the shock wave for each pressure range, a positive particle or wind velocity is produced by the shock front that causes a dynamic pressure on objects in its path. In the free field, these pressures are functions of the air density and particle velocity. In addition, a negative (-) wind velocity (also called a negative phase) will also be produced as air rushes back in after an explosion in order to equalize air pressure. This negative phase can cause further significant damage to structures already impacted by the positive phase pressure loading.

The damaging effects of blast overpressure result from the impulse associated with the blast wave, and which is the inverse of the blast pressure. Higher net explosive quantities (NEQs) produce higher pressures of longer duration, resulting in higher impulses that act on surrounding exposed sites (ES). The longer the duration, the greater “work” associated with the energy acting on the structure, corresponding to greater damage potential to the structure. For example – 5kPa incident overpressure from a 5kg detonation generates an impulse of 23.3Pa-s; whereas 5kPa incident overpressure from a 50,000kg detonation generates an impulse of 501Pa-s. When designing a protective construction or conducting an analysis to determine the adequacy of a building design, the blast impulse is the value that is used to determine the adequacy of a structure to protect its inhabitants battered by the positive pressure blast wave.

4.5 Summary of effects

The sensitivity of ammunition and explosive stocks to blast over-pressure, structural motion, fire, and impact by fragments varies with the type of ammunition or explosives being stored. Except where extremely high over-pressures occur (mbar), most explosives, particularly military ones, are insensitive to the effect of direct blast over-pressure. However, a combination of blast over-pressure and structural motion (e.g. wall displacement, roof collapse, or structural breakup) could cause translation or crushing of explosives, which may result in impact and subsequent initiation. Direct attack by low angle, high velocity primary fragments (as opposed to high angle, low velocity fragments) is predominantly the main cause of initiation of explosives at an un-barricaded or un-strengthened exposed site (ES). For more sensitive and less robust explosive substances, or light cased explosive articles, additional threats for initiation could be debris or spall from building walls.

It follows, therefore, that the hazard to explosives at an ES will depend on the ability of the ES structure to resist external explosion effects/blast loading without extensive structural deformation, and generally, to prevent perforation by fragments and debris. The primary design objective must be to prevent significant deformation of adjacent explosives storage structures from an explosion at a nearby PES and to introduce measures to stop fragment/debris penetration and prevent spalling from the internal faces.

The projection hazard from a PES cannot be easily related to the scaled distance for blast effects. However, it is generally accepted that there is likely to be a hazard from projections at all scaled distances less than twice the recommended Inhabited Building Distance (2 x $22.2Q^{1/3}$), the hazard being greater when the PES is not barricaded. Unless the ES (at the desired reduced distance) has been shown to provide equivalent protection as that afforded at the required minimum distance, the minimum distances should be applied as described in IATG 02.20 *Quantity and separation distances*.

4.6 Air blast effects

Blast overpressure effects at a given scaled distance can be easily predicted (see IATG 01.80 *Formulae for ammunition management)*. If it is assumed, for planning purposes, that the blast overpressure from a light structure is the same as that from a bare charge of equal net explosive quantity (NEQ), then the quantity distances at Table 1 are examples of the overpressure calculations for a given quantity of explosive at a set distance:

Quantity Distance (m) (Q =NEQ in kg)	Peak Incident (Side-on) Overpressure Expected (kPa)
$44.4Q^{1/3}$	2
$22.2Q^{1/3}$	5
$14.8Q^{1/3}$	9
$8.0Q^{1/3}$	21
$3.4Q^{1/3}$	80
$2.4Q^{1/3}$	180

Table 1: Blast overpressure from a bare charge or light structure

Earth covered structures will attenuate blast overpressure to the sides and rear, with the most reduction from the rear of the building. The figures at Table 2 are for a side-on orientated ECM containing up to 250,000 kg of explosives.

Quantity Distance (m) (Q = NEQ in kg)	Peak Incident (Side-on) Overpressure Expected (kPa)
$19.0Q^{1/3}$	5
$14.0Q^{1/3}$	8

Quantity Distance (m) (Q = NEQ in kg)	Peak Incident (Side-on) Overpressure Expected (kPa)
$11.0Q^{1/3}$	9
$6.0Q^{1/3}$	21

Table 2: Blast attenuation associated with an explosion in an earth-covered ECM (side-on)

5 Protection against explosive propagation

The protection of explosives at an ES from the effects of an explosion at a PES can be achieved by a combination of: 1) the provision of adequate separation distances between all explosive storage facilities; and 2) ensuring the buildings used for explosive storage are buildings designed to protect the contents from the effects of an explosion. An adequate separation distance will greatly reduce the effects of the blast, fragments and heat radiation to a level that makes the construction of a protective structure at the ES cost effective and the loss of their contents highly unlikely. Adequate separation distance also ensures that if events did occur at both a PES and an ES, the timing between the two events would be sufficient that the two blast waves would not coalesce into a single blast wave as if the event happened concurrently. Blast waves from two independent 10,000kg explosions would not be as far-reaching as coalesced blast waves from two storage sites, each containing 10,000kg, which would represent an explosion event of 20,000kg.

To provide maximum protection, ES should be barricaded (to stop high velocity, low angle fragments/debris which are the predominant threat to ES from HD 1.1 explosions), and either strong enough to withstand the force of the explosion, or light enough so that collapse and any debris formed will not initiate the contents. Buildings should preferably be able to resist the blast loading without extensive deformation and to prevent perforation by fragments and debris. From this it can be seen that different Hazard Divisions[5] pose different problems in the prevention of propagation.

5.1 Hazard division 1.1

The protection against propagation of explosions in open stacks should be achieved by the provision of adequate Quantity Distances (QDs) between storage locations and by effective barricading[6]. The QDs are intended to negate the effects of blast, fragmentation and radiated heat to levels at which propagation should not promptly occur.[7] Barricades are structures that are used to primarily intercept high velocity, low-angle fragments and either arrest them or reduce their velocity to levels below which propagation should not occur. When subjected to blast loading, a barricade should remain substantially intact for a sufficient length of time to enable the interception of fragments to be achieved.

Compartmentalised storage (such as dividing walls and internal barricades) and specialized techniques[8] can control the effects of an explosion and allow the application of the rules contained in IATG 02:20 *Quantity and separation distances,* by reducing the maximum credible event (MCE) and allowing QDs based on the worst-case MCE to be used. The function of such storage is to delay or totally prevent prompt propagation of an explosion between explosives items separated in this manner. Special walls can be designed to prevent prompt propagation for larger quantities of explosives, but the result is generally loss of all assets through significant damage of the munitions on the ES side of such walls. For this reason, the application of such storage and techniques should only be pursued after detailed examination and consideration.

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[5] See IATG 01.50 *UN Explosive hazard classification system and codes*.

[6] See IATG 05.30 *Barricades*.

[7] See IATG 02.20 *Quantity and separation distances*.

[8] See DDESB Technical Paper 15, *Approved Protective Construction*, Revision 3 (Annex B refers).

ESH and APBs constructed from masonry, unreinforced concrete, timber and suchlike are not suited to resist external blast loading. These materials are not ductile and sudden failure under load is likely to occur. Such failure will also be a source of structural debris that may initiate the explosives stored inside. Reinforced Concrete (RC) and earth-covered structures, however, are specifically designed to provide a level of protection against the most extreme blast hazard. They also protect explosives and personnel inside from any fragment and debris hazard and reduce the blast over-pressures to levels where damage or injury should not occur.

As PES, buildings made of masonry and concrete will be sources of significant structural debris that present a significant threat to surrounding ES.

5.2 Hazard division 1.2

Ammunition of HD 1.2 will not sustain propagation so normal construction materials such as concrete, brick and earth-covered structures may be used for the construction of ESH for HD 1.2. However, this will render the ESH unsuitable for the storage of HD 1.1. Timber and lightweight steel doors are not resistant to projection effects and should not be used.

HD 1.2 ammunition will, in the event of an explosion, produce a range of fragments and lobbed ammunition which will be projected from a PES. If comprehensive data is available for a particular ammunition nature, then the QD for HD 1.2 may be replaced by this more appropriate data taking into account the vulnerability of the ammunition, explosives and buildings at the other ES.

Munitions which explode during an accident will rarely function as intended i.e. detonate in their design mode. In a fire situation, explosive fillings may melt and expand, breaching their casings and then exploding via cook-off or burning to detonation reactions. These explosions may involve anything from 100% to very little of the fill, dependent on the amount of the filling that has escaped through the breach. The fragmentation produced by such reactions is totally different to that generated in a design detonation. The case splits open producing large (for a 105mm shell, for example, 2 - 3kg) but comparatively few fragments with velocities in the range of 10 - 500 m/s. These are likely to be projected further than the smaller fragments from the full detonation of similar munitions in a HD 1.1 reaction. Quantities of unexploded munitions, sub-assemblies or sub-munitions will be projected to considerable ranges and will, due to thermal or mechanical damage, be in a more hazardous condition than previously. As a result, a Storage sub-Division (SsD) should be created. SsD is applicable only to storage situations. .[9]

SsD 1.2.1 – ammunition of HD 1.2 giving fragments with a considerable range, defined as having a total applicable HE content greater than 0.136kg. These comprise those rounds and ammunition that contain a high explosive charge and may also contain a propelling or pyrotechnic charge. “Total applicable HE content” excludes any propelling or pyrotechnic charges. It is not possible to specify QD that allow for the maximum possible flight ranges of propulsive items but the likely range of packaged items, if involved in an accident during storage, is typical of SsD 1.2.1.

SsD 1.2.2 – ammunition of HD 1.2 giving fragments of moderate range, defined as having a total applicable HE content of less than or equal to 0.136kg. It will also typically comprise ammunition that does not contain H.E. and will include pyrotechnic rounds and articles, plus inert projectile rounds.

Test data can be used to move items from one SsD to another[10].

[9] This is a NATO, not UN classification, which has been, introduced as best practice.

[10] A further NATO classification in HD 1.2 also exists – HD 1.2.3. This is applicable to munitions that exhibit at most an explosion reaction in sympathetic reaction testing as per STANAG 4396 and a burning reaction in bullet impact, slow heating, and liquid fuel / external fire testing as per STANAGs 4241, 4382 and 4240, respectively. It is not included within IATG as few countries (with the exception of NATO members) possess such ammunition.

5.3 Hazard division 1.3

The thermal radiation from the fireball produced by the functioning of explosives in HD 1.3 can cause fire in another ESH and from there lead to an explosion in that ESH. The explosives most likely to produce a mass fire effect are propellants. They produce a fireball with intense radiant heat, fire brands and some fragments. The firebrands may be large pieces of burning propellant. It is possible that the wind could deflect the upper parts of a fireball away from the seat of the fire and towards an ES. This wind effect could increase flame radius by 50%. An asymmetrically constructed building such as an ECM or building with protective roof and walls, but with one relatively weak wall or a door, induces highly directional effects from the flames and the projection of burning packages.

Weak points in a PES structure may cause jetting of the fireball. Normal construction materials such as concrete and brick, and earth-covered structures may be assumed to be impervious to thermal radiation and flame impingement from fires involving HD 1.3. However, timber and lightweight steel doors are not resistant to the effects of fire and should not be used in construction.

As previously discussed in Clause 4.2 above, internal pressure building up in a structure, from the gas by-products generated by the fire, can cause the structure to burst or breech, generating structural debris.

This division includes some items which burn with great violence and intense heat emitting considerable thermal radiation (mass fire hazard), and others which burn sporadically. Items in this division may explode but do not usually form dangerous fragments. Firebrands and burning containers may be projected. For the purpose of determining QDs and defining mixing and aggregations rules, a distinction is made between the more hazardous propellant explosives of HD 1.3 (classified as SsD 1.3.1) and the less hazardous items and substances of HD 1.3 (classified as SsD 1.3.2).

5.4 Hazard divisions 1.4, 1.5 and 1.6

Any secure, weather-proof structure may be used to store explosives of HD 1.4. However, if a construction is being contemplated, then the effects of other PES and future potential storage requirements should be considered.

For HD 1.5[11] and HD 1.6, the national authority should provide storage advice. However, it is recommended to treat HD 1.5 as high value items worthy of a high level of protection at an ES.

6 Physiological effects of an explosion

Human body tolerance to blast is high and the degree of injury sustained by an individual is directly proportional to the amount of over-pressure received. The orientation of a person to the shock front, and the actual shape of the shock front, are significant factors in determining the type and level of injuries sustained. The release of air bubbles from disrupted alveoli of the lungs into the vascular system accounts for most fatalities. Rupturing of eardrums and injury to the body due to being propelled by the shock wave translation are also highly likely.

It is internationally agreed that fragments and debris are potentially lethal if their impact energy is ≥ 80 joules (see Clause 4.1). It is expected that, at the Inhabited Building Distance (IBD), the density of such lethal fragments will not exceed 1 per 56 square metres (m^2) on the ground surface.

6.1 Injuries from hazard division 1.1

Table 3 provides an idea of the effects of blast overpressure at various levels and the potential effect on the human body.

[11] See IATG 02.20 *Quantity and separation distances*.

Injury Level	Maximum Blast Overpressure (kPa)
Eardrum Rupture	
Threshold of Lethality	35
50% Rupture	100
Lung Damage	
Threshold of Lethality	70
50% Lethality	250
Body Translation	
Threshold of Lethality	100 -150
50% Lethality	400 – 750

Table 3: Blast injury levels

The expected injuries to personnel at specific QD from explosions of HD 1.1 are as summarised in Table 4.

QD	QD Type	Injury Summary
$8.0Q^{1/3}$	Process Building Distance (PBD)	▪ Serious injuries and fatalities from debris, firebrands, fragments, or building collapse. ▪ There is only a small chance of serious injury occurring due to direct blast effects.
$14.8Q^{1/3}$	Public Traffic Route Distance (PTRD)	▪ Personnel in the open may not be seriously injured by blast, but some injuries will occur as a result of fragments and debris, the extent of which will depend on the construction of the PES and the type of ammunition involved. ▪ Personnel in a building will have a high degree of protection from death or serious injury. Any injuries that do occur will be caused mainly by fragments from glass breakage and building debris.
$22.2Q^{1/3}$	Inhabited Building Distance (IBD)	▪ Injuries are unlikely as a direct result of blast effects, but could occur due to glazing fragments and flying or falling debris.
$44.4Q^{1/3}$	Vulnerable Building Distance	▪ Injuries are unlikely as a direct result of blast effects. Injuries that do occur will be caused mainly by glass and debris falling from buildings.

Table 4: Estimated injury levels

6.2 Injuries from hazard division 1.2

The total fragment and debris hazard at the IBD would not be expected to exceed one potentially lethal fragment (≥80J) per 56m^2 of ground area. This hazard is generated over a longer time period, generally in excess of one hour (and possibly days) after the initial explosive event. It may not happen immediately as items may continue to react/explode long after the initial event. Because of this long duration effect, individuals have the opportunity to escape or to seek greater protection from the fragment threat.

6.3 Injuries from hazard division 1.3

For explosives of HD 1.3, the IBD is based on a thermal dose of 62.8kJ/m^2. Occupants of reasonably constructed inhabited buildings should not suffer injury unless standing in front of a window. They, and anyone caught in the open, are likely to experience reddening of any exposed skin areas.

7 Damage to buildings

The damage levels likely to occur to an ES of conventional construction from an explosion of HD 1.1 at a PES for different QD are as summarised in Table 5.

QD	QD Type	Injury Summary
$2.4Q^{1/3}$	Inter Magazine Distance (IMD)	▪ Any buildings not designed to resist the blast loading will almost certainly be completely demolished.
$8.0Q^{1/3}$	Process Building Distance (PBD)	▪ Buildings not designed to resist the blast loading will suffer severe damage. ▪ Direct initiation of stored explosives is unlikely but the effects of the explosion could lead to a fire.
$22.2Q^{1/3}$	Inhabited Building Distance (IBD)	▪ Buildings not designed to resist the blast loading will probably only suffer minor damage, mainly to glazing, lightweight cladding, etc.
$44.4Q^{1/3}$	Vulnerable Building Distance	▪ Buildings not designed to resist the blast loading are likely to suffer only superficial damage to large panes of glass and other lightweight cladding.

Table 5: Estimated building damage levels

Vulnerable constructions located between IBD and 2 x IBD (often the vulnerable building distance, VBD) may be damaged by an explosion. A structural assessment of the extent of the damage that would occur, including the possibility of collapse and fragment or debris penetration, should be made. Vulnerable buildings located beyond VBD should not be damaged and therefore do not require any assessment. Vulnerable buildings are dealt with in greater detail at Clause 9.2.

8 Types of buildings at explosives facilities

8.1 Light structured buildings

Light structured buildings are constructed of light frangible materials that should not produce very many dangerous projections when used as a PES. As an ES, this structure could collapse but the debris produced should not initiate explosives. This type of structure is typically a single-storey building, clad with lightweight steel, aluminium or glass reinforced plastic (GRP) sheeting or similar materials. Doors shall comply with Table 8.[12]

A light structure provides little resistance to high velocity fragments, lobbed ammunition or debris from an HD 1.1 and HD 1.2 explosive event, or from the fire hazard of a HD 1.3 event. As an ES, light structures should be barricaded to reduce the IMD but shall be barricaded where used as a Process Building.

8.2 Medium walled building

A medium-walled building is one constructed of a minimum thickness of 215mm solid or 280mm cavity masonry[13] walls or 150mm RC and a 150mm RC roof slab. Doors shall comply with Table 8. As an ES, this type of structure may collapse, and damage ammunition stored inside because it is not normally designed to resist blast over-pressure. The debris produced by a PES, dependent on the quantity of explosives involved, may have a high enough velocity to initiate explosives or seriously injure personnel within the ES. This type of building will not resist the penetration of high velocity fragments at an ES or PES and should be barricaded to reduce the IMD.

A medium walled building is reasonably effective in resisting fragments and lobbed items of HD 1.2 explosives and provides adequate protection against the fire hazard from HD 1.3 explosives. A medium-walled building is to be considered a light structure when determining QD for other than HD 1.2.

[12] This table is extracted from DSA03.OME part 2. UK MOD. November 2020

[13] Or unreinforced concrete block.

8.3 Heavy walled building

A heavy-walled building is one with a minimum of 680mm thick masonry or 450mm thick concrete walls, and a minimum 150mm RC roof. Doors shall comply with Table 8. A receptor barricade is not generally required because the heavy walls fulfil this function. However, if the stocks are vulnerable to attack by debris, a separate barricade should be provided, and consideration given to increasing the strength of the roof to prevent perforation and back-face spalling. If building doors are exposed to fragments from a PES, they should be shielded by a barricade.

As an ES this type of building will:

a) prevent initiation of explosives inside by preventing penetration of high velocity fragments, but it may collapse and damage stocks because it is not normally designed to resist blast;

b) be effective in resisting incoming fragments and lobbed munitions from HD 1.2 explosives, but only when the roof is constructed from RC; and

c) provide adequate protection against the fire hazard from HD 1.3 explosives.

As a PES, the building may intercept some, or all, of the high velocity primary fragments, but the amount of debris is generally increased by the nature of its heavy construction.

8.4 Earth covered magazine

An earth covered magazine (ECM, sometimes referred to as an igloo) is an explosives storehouse with earth cover of minimum thickness 600mm on the roof and earth cover to the sides and rear walls. The slope of the earth against the walls is dependent upon the material used. The structure and doors are designed to resist blast and high velocity fragments so that the contents will not be initiated or seriously damaged at the required IMD. The supporting structure for the earth cover can be constructed of corrugated steel and RC, but is normally an RC box structure. As an ES, this type of building behaves similarly to a heavy-walled building for all hazard divisions, with the additional advantage of having been specifically designed to resist the blast loading and, therefore, giving stored explosives complete protection from initiation at reduced IMD. As an ES, there are several categories of structural strength associated with the headwall and doors, based on their abilities to withstand specific external pressure loading and high velocity fragment threats, as discussed herein.

The doors and headwall do not normally require a barricade provided they have been designed to resist blast loading and high velocity fragment penetration. As a PES, an ECM has reduced QDs to the side and rear due to attenuation of the blast by the earth cover while blast and fragmentation effects may also focus out of the front. In order to gain the most efficient land usage where more than one ECM is used, ECMs should be orientated side-by-side with the headwalls on a common line. Where more than one row of ECMs is used, the front walls in one row should face the rear of the other ECMs in the second row.

8.5 Earth covered building

An earth covered building is any structure which has a minimum thickness of 600mm of earth on the roof and earth cover to the sides and rear walls, and which does not meet the standards of an ECM Doors must comply with Table 8. The slope of the earth against the walls is dependent upon the material used. A barricade should be provided to shield doors and walls that are not earth covered and which face a PES. As an ES, this type of building behaves similarly to a heavy-walled building for all hazard divisions.

8.6 Open bay or site

The floor of such a bay or site is preferably to be of concrete with any required battens firmly attached. Consolidated hard-core or other suitable material may be used, but this form of a base will require constant maintenance to keep vegetation under control. Barricades may be required.

8.7 Process building

An ammunition process building (APB) is a building or site in which explosives are manufactured or worked upon. This includes such facilities as missile test rooms, preparation buildings, explosives workshops and all maintenance and preparation procedure facilities. The use of an appropriate building type shall ensure that the requirements of IATG 02:10 *Introduction to risk management principles and processes* are met and that workers are employed at risk levels which are as low as is reasonably practicable (ALARP).

As an ES, this type of building must either be designed to survive and protect workers from an explosion at a PES, or have a relatively large separation distance from other PES in order to give protection to personnel rather than just to protect against initiation of the explosives contained within.

As a PES, an APB is classified according to its construction and the QDs determined using the total quantity of explosive that may be present at any one time unless effectively unitised. Due to the close proximity of explosives to workers within a PES, it may not be possible (other than for small quantities of explosives) to provide protection, and fatalities should be expected. However, the ALARP principle should be applied wherever reasonable and practicable to lessen the risk.

8.8 Container storage

Any container being used as storage e.g. an ISO or similar container shall be treated as an open stack when being used for storage of explosives. Barricades may be required.

9 Inhabited buildings and PES

Inhabited buildings are those that contain people but not explosives. The term is usually applied to buildings used by the general public outside an explosives area, but is also used for those buildings inside the area owned by the national authority that may be affected by a PES, e.g. soldiers' accommodation, administration areas, etc. All non-explosives inhabited buildings within the IBD of a PES should be designed to resist the expected blast over-pressure and should resist fragments and debris. However, and unusually, where the risk from fragments is low, a light structure that would collapse and produce debris that would not seriously injure personnel within may provide a cost-effective alternative.

The glazing in inhabited buildings is vulnerable to the effects of a blast even at VBD (the purple line) where there is still some risk of injury from flying or falling glass. Construction and glazing of inhabited buildings affected by a PES should comply, as a minimum, with Table 6.[14]

9.1 Structural considerations

Serious structural damage, caused by blast, to traditionally constructed low-rise buildings located between IBD and VBD should not occur. The breakage of glass and frangible cladding may occur, but the risk of serious hazard to occupants should be minimal. However certain types of construction are known to be susceptible to significant damage at and beyond the IBD and may cause injuries and fatalities disproportionate to the scale of the explosive event. This could happen as a result of construction materials used (e.g. extensive glazed areas) or from the risk of total collapse, which could crush and kill occupants who would otherwise be expected to survive in the open or in more traditional forms of construction. The term 'vulnerable construction' is used to describe these types of buildings and they require special attention when planning storehouse construction and calculating QDs.

[14] This table is extracted from DSA03.OME part 2. UK MOD. November 2020.

9.2 Vulnerable construction

Buildings of vulnerable construction should be sited at a minimum of $44.4Q^{1/3}$, but the variation and complexity of modern building materials, construction methods and national legal requirements and usage make it impossible to define universal regulations. A building classified as vulnerable may still be located at the normal IBD if the population is low or measures are taken to protect the population from the potential explosion hazards. Guidance to the types of building that might be described as being of vulnerable construction, and the factors that will influence the need to locate them outside the purple line from a PES, are as follows:

a) Type 1 - glazed or other frangible curtain wall construction. Buildings that are more than three storeys or 12m in height constructed with continuous non-load bearing curtain walling with individual glazed or frangible panels larger than 1.5m^2 and extending over more than 50% or 120m^2 of the surface of any elevation. This construction is typical of high-rise office buildings;

b) Type 2 - glazed wall construction. Buildings that are more than three storeys or 12m in height with solid walls and individual glazing panes or frangible panels larger than 1.5 m^2 and extending over at least 50% or 120 m^2 of any elevation. This construction is typical of that used in high-rise office buildings;

c) Type 3 - glazed or other frangible roof construction. Buildings that are of more than 400 m^2 plan area with continuous or individual glazing panes larger than 1.5 m^2 extending over at least 50% or 120 m^2 of any elevation. Type 3 buildings are typical of those in covered market buildings, shopping complexes and retail warehouses; and

d) Type 4 – sensitive structures. Building structures that may in themselves be susceptible to disproportionate damage (e.g. collapse, partial collapse or progressive collapse), including;

   1) unframed structures with limited continuity utilising non-ductile materials;

   2) large-span, tension or other special structures with critical load bearing elements;

   3) unusually weak structures such as historic or timber framed buildings; and

   4) buildings containing vulnerable elements such as pre-cast panel fixings or large span slender masonry panels which may be particularly susceptible to failure and lead to a falling debris hazard.

As a general guide, buildings that stand out by either size or construction type against a normal background of houses should be closely examined. Those buildings that fall within or near the vulnerable construction guidelines above, or where it is suspected that they may be particularly vulnerable to blast, should be assessed to identify any potential risks.

9.3 Other buildings

Large facilities of special construction or importance should be examined to ascertain if they are to be classed as being of vulnerable construction and a technical assessment must be carried out for each site. Where the facilities are assessed to be of vulnerable construction, the large facilities should be sited at a minimum QD of $44.4Q^{1/3}$. Examples are:

a) large factories;

b) multi-storey office or apartment buildings;

c) public buildings and structures of major value;

d) large educational facilities;

e) hospitals;

f) major transport centres such as ports, railway stations, airports, etc;

g) major public utilities such as water, gas and electric works;

h) facilities of vulnerable construction used for mass meetings such as assembly halls and fairs, exhibition areas and sports stadia; and

i) built-up areas, which are both large and intensely developed.

The construction of buildings in an explosives area which are normally unmanned, such as plant rooms, electrical sub-stations, pump houses and so forth, should be situated and protected to the level of the importance attached to the survival of the facility.

<table>
<tr><th colspan="2">Distance from PES</th><th rowspan="2">Structural Requirements</th><th rowspan="2">Glazing Requirements</th></tr>
<tr><th>QD</th><th>QD Type</th></tr>
<tr><td>>44.4Q$^{1/3}$</td><td>Vulnerable Building Distance (VBD) (Purple Line)</td><td>▪ Conventional design only.</td><td rowspan="6">▪ Single or double glazing acceptable.
▪ Laminated glass or anti-shatter film permitted.</td></tr>
<tr><td><44.4Q$^{1/3}$</td><td>Vulnerable Building Distance (VBD) (Purple Line)</td><td rowspan="3">▪ Conventional design only.
▪ Vulnerable construction not allowed.
▪ Load-bearing brick structures permitted but note the requirements for the limitation of progressive collapse.</td></tr>
<tr><td><22.2Q$^{1/3}$</td><td>Inhabited Building Distance (IBD) (Yellow Line)</td></tr>
<tr><td>>16.0Q$^{1/3}$</td><td rowspan="2">Closest Indirect Support Distance (Unhardened)</td></tr>
<tr><td><16.0Q$^{1/3}$</td><td rowspan="4">▪ Conventional design but must have an RC slab at roof level of at least 150mm.
▪ Load-bearing brick structures permitted but note the requirements for the limitation of progressive collapse.</td></tr>
<tr><td>>14.8Q$^{1/3}$</td><td rowspan="2">Public Traffic Route Distance (PTRD)</td></tr>
<tr><td><14.8Q$^{1/3}$</td><td rowspan="4">▪ Single or double glazing acceptable.
▪ Laminated glass only. The use of anti-shatter film is not acceptable.</td></tr>
<tr><td>>11.1Q$^{1/3}$</td><td rowspan="2">½ Inhabited Building Distance</td></tr>
<tr><td><11.1Q$^{1/3}$</td><td rowspan="2">▪ Conventional design but must have a full structural frame and an RC slab at roof level of at least 150mm.</td></tr>
<tr><td>>9.6Q$^{1/3}$</td><td rowspan="2">Closest Direct Support Distance (Unhardened)</td></tr>
<tr><td><9.6Q$^{1/3}$</td><td rowspan="3">▪ Specially approved designs.</td><td rowspan="3">▪ Specialist advice should be sought.</td></tr>
<tr><td>>8.0Q$^{1/3}$</td><td>Process Building Distance</td></tr>
<tr><td><8.0Q$^{1/3}$</td><td>Special Facilities</td></tr>
</table>

Table 6: Exposed sites construction requirements

10 Design considerations (LEVEL 2)

The following design considerations shall be modified to meet national authority legal requirements. They should, however, be viewed as best practice as they are in line with the highest standards of ammunition storage and safety principles. Explosives facilities should be constructed so as to provide a specified level of protection against the hazards of accidental explosive events in an adjacent facility. The type of structure provided will depend on the protection level required and the type and quantity of explosives stored.

The final structural form of the storage or processing facility will depend upon the anticipated blast loading acting on the structure, and the anticipated fragment and debris distribution will determine if the roof and walls require reinforcing and the need for traversing.

However, there are certain standard design requirements that should be applied to any explosive storage namely:

a) facilities should be designed so that they are easy to keep clean and ensure that dirt and dust is kept to a bare minimum;

b) there must be adequate access to the facility and individual explosives stacks to enable ease of checking and movement of the explosives and to provide the free movement of air between stacks to assist with moisture control;

c) where possible, fixtures and fittings should be located so that they cannot be fouled by MHE or other equipment. If this is not possible, fixtures and fittings should be suitably protected;

d) electrical equipment should be designed for any unique hazards that might exist, explosive dusts, gases or vapours from processes being performed or the material being stored;

e) grounding and bonding for static charge control;

f) lightning protection consideration, especially if in an area where lightning strikes present a threat. Lightning protection can be constructed integral to the design of the structure, such as with an ECM where reinforcing steel in all the walls can be tied together to form a protective barrier;

g) gangways should be provided between stacks and the wall of an ESH. They should be permanently marked on the floor as a sterile area using yellow hatched markings;

h) ESH should be designed and equipped so that the inside temperature does not fall below 5°C or rise above 25°C. If these temperature conditions cannot be met, artificial heating or air conditioning to an approved standard should be installed; and

i) the surrounding area must be free of flammable materials. Undergrowth should be kept close cropped to the ground. Grass should very short to 6m from PES. The rest of the site should be kept in such a condition so as not to present an undue fire risk.[15]

10.1 Protective buildings for personnel (LEVEL 2)

Buildings which are required to provide protection for personnel, such as APBs and other occupied buildings at inside quantity distance (IQD), should be designed to resist blast loadings and penetration by fragments and debris. The following design requirements should be adopted:

a) all design considerations should be based on a 90% confidence level;

b) deflections of main supporting structural elements should be limited to 2° support rotations or deflections of span divided by 60. If mild-steel spall plates of suitable thickness are fixed to the internal face of RC surfaces to retain back-face spalling, a maximum support rotation of 4° or deflections of span divided by 30 may be adopted;

c) high velocity spalling of RC elements or members is unacceptable and should be prevented by the use of spall plates. Low velocity spalling may be accepted if it can be shown that it will not be dangerous to personnel; and

d) the glazing hazard standard shall be of low hazard – see Table 6 and Clause 11.11 for glazing specifications.

10.2 Design of pressure release structures (LEVEL 2)

Designing structures to fully contain the blast and fragments due to an internal explosive event is only practicable when very low quantities (≤10 kg) of explosives of HD 1.1, or larger quantities (≤50kg) of HD 1.3 are stored. Structures designed to store explosives of HD 1.3, or small quantities (≤100kg) of HD 1.1 can be designed to survive with limited damage by incorporating a frangible wall or panel to reduce the magnitude and duration of the internal blast parameters should an internal explosion occur. However, should construction of this type of building be considered then specialist advice should be obtained.

[15] See IATG 02.50 *Fire safety*.

10.3 Frangible materials and their properties (LEVEL 2)

Ideally, frangible materials should have low mass, break up into small harmless fragments at the PES, and be strong enough to resist fragments at an ES. Provision of a barricade to shield a vent panel against fragment attack negates the need for the material to be fragment resistant at an ES. However, the frangible wall or panel should satisfy security requirements.[16] The best method should be the use of a separate and approved security barset inside the vent panel, which does not compromise the vent operation. This system also has the advantage of improving resistance to external blast pressures. Restriction of gas flow through the reduced vent area should be taken into account in the design.

Frangibility of materials is dependent upon the strength and mass of the material used, but it is also affected by the applied blast loading. As the blast loading on the panel in typical storage situations is likely to be very large, the effects of material resistance may be ignored and the frangibility determined by considering only the mass of the panel. However, for smaller quantities of explosives this situation may not be the case and consideration of the material's resistance may be necessary.

To permit adequate venting, a frangible wall or panel should have a mass not exceeding 50kg/m^2 for HD 1.3 and 25kg/m^2 for HD 1.1. There should not be line of sight between frangible walls in an adjacent PES unless the separation distance is sufficient to prevent propagation by fragments, debris or projected burning propellant.

Any fixings used to secure frangible walls and panels to a structure shall be designed such that the frangible portion fails in the required manner. The suitability of materials used for frangible features will depend upon factors such as mass, durability and weather resistance. The following materials are listed in recommended order of preference:

a) glass reinforced plastic (GRP) - a high strength material that produces small lightweight projections of low velocity. The unit mass is dependent upon thickness but is typically 2.2kg/m^2 for a thickness of 1mm;

b) plywood - has a high strength to weight ratio, but if >25 mm thick it may produce heavy, sharp fragments. The unit mass is typically around 0.6kg/m^2 per mm of thickness;

c) fibrous cement sheeting - is lightweight and strong but produces sharp fragments that could be hazardous. The unit mass is between 2.5 - 3.3kg/m^2 per mm of thickness;

d) steel and aluminium sheeting - have low mass and high strength but they tend not to break up. They usually deform and should still be considered a hazardous projection risk. Aluminium has a unit mass of 2.7kg/m^2 per mm of thickness and steel 7.8kg/m^2; and

e) proprietary panels – are sandwiches made from thin metal sheeting with a lightweight insulating core such as styrofoam. They have low mass and are easily removed from fixings by an explosive event. However, they tend not to disintegrate and may pose an unacceptable projection hazard risk. The individual properties of this type of panel should be sought from the prospective manufacturer.

[16] See IATG 09.10 *Security principles and systems.*

10.4 Ammunition requiring special consideration (LEVEL 2)

10.4.1. Rockets and missiles

Unless tests have shown otherwise, rockets and missiles should always be regarded as self-propulsive. Rockets and missiles that are stored in a propulsive state should have walls thick enough to prevent their perforation in the event of accidental initiation. The rockets/missiles should be secured to the structure; alternatively, a structure designed to resist motor thrust such as a vertically faced barricade, located as close to the building as possible, may be provided. This barricade should be thick enough to prevent perforation by the rockets and the barricade length and height should exceed an angle of 10° from the door aperture.

The most suitable type of structure for storage of ammunition of this type is an ECM. The rockets should be positioned pointing towards the rear or sidewalls. However, if the missiles face the door, a door barricade may be required. Rockets in a non-propulsive state should be stored in structures suitable for the quantity and HD of the explosives present.

10.4.2. Storage of HD 1.1 shaped charge warheads

Trials have shown that shaped charge warheads will produce a shaped charge if they are initiated, even in a fire. The jet will be significantly less efficient than the designed effect but will still be capable of penetrating the walls of any storage structure. Therefore, warheads should be pointed towards earth backed walls or towards the floor. It is preferable to have several discrete layers, e.g. cavity walls with a vertical faced and earth backed barricade, between the stored warheads and the free field because this will help to disrupt the jet. The larger the shaped charge, the more penetrative any formed jet will be and the more difficult it will be to provide effective mitigation.

There are no specific QDs recommended to provide protection against the shaped charge effect, even from very large charges, since the jet represents only one fragment. Therefore, provided the above recommendations are followed, HD 1.1 QDs should be applied.

10.5 Construction to contain fragments and prevent lobbing (LEVEL 2)

Designing structures to contain projections or lobbed items of HD 1.1 is an extremely complicated procedure and very costly, so unless special circumstances arise, it should not be considered. It is only feasible to design such a structure when the NEQ is small, or when the NEQ is divided into smaller quantities by dividing walls that prevent the mass explosion of the entire content in the event of an accidental explosion in one of the units. The design of a structure to contain projections and lobbed items represents a more stringent requirement than that for dividing walls to prevent propagation. Where such a design is required, expert advice should be obtained.

10.6 Protection against projected objects (LEVEL 2)

Explosives storage buildings should provide protection against penetration by debris, low velocity fragments and lobbed munitions. This is achieved by a combination of appropriate separation distances and the minimum construction thicknesses listed below:

a) roof - 150mm in-situ reinforced concrete slab;

b) walls - 150mm in-situ reinforced concrete or 215mm solid brickwork; and

c) doors - 16mm mild steel or equivalent;

To give protection against high velocity fragments, a barricade or earth cover should be provided. However, if this is not possible, the following material thicknesses will generally be sufficient to prevent initiation of the explosives at an ES:

a) walls - 450mm in-situ reinforced concrete or 680mm solid brickwork;

b) doors - 50mm mild steel or equivalent; and

c) barricade - 2400mm of earth.

Specially designed structures can be constructed to provide protection from specific threats, but such structures must be designed by a specialist in this area.

11 Construction materials

11.1 Earth

Earth cover for earth covered buildings and ECM are also required to meet the requirements of the materials listed in Table 7.

Material Description *(In preference order)*	**Grading Limits [1] [2]**				**Design Slope [4]** *(Dependant on soil mechanics)*
	Coarse Material		**Fine Material**		
	Maximum Particle Size	**Maximum Content (% by Weight: 20 – 75mm)**	**Maximum Fines Content (% by Weight: <63µm)**	**Maximum Clay Content (% by Weight: <2µm)**	
Well Graded Sand	6.3mm	0%	15% [1]	5% [1]	1:1.5 to 2 (33^0 to 26^0)
Well Graded Gravelly or Clayey or Silty Sand (inorganic)	7.5mm	5% [1]	20% [1]	5% [1]	1:1.3 to 2.5 (37^0 to 21^0)
Inorganic Fill [3]	Other inorganic material meeting the above grading requirements				

Table 7: Construction materials for earth covered buildings[17]

NOTE 1 Coarse and fine particles shall be uniformly distributed throughout the material to provide a homogenous fill.

NOTE 2 The material used should have a Uniformity Coefficient (D_{60} / D_{10}) of 6 or greater.

NOTE 3 Rubble from demolished buildings or any other similar material shall not be used in the construction of barricades due to the risk of enhanced projection hazard.

NOTE 4 Slope stability requirements are defined in this IATG; design slopes tabulated are indicative only and will vary dependent upon:

a. The nature and strength of foundation soil and rock and depth to the water table;
b. The degree of compaction and surface preparation provided to the fill;
c. The fineness of the content and erosion potential of the fill materials;
d. The compaction moisture content where the fill materials are not free draining;
e. The provision of drainage measures to control short/long-term pore water pressures; and
f. The fill being reinforced with geo-synthetics, wire mesh etc.

11.2 Reinforced concrete (LEVEL 3)

In the following technical data, the standards referred to are indicative of the technical specifications the national technical authority may specify.

[17] These are the same requirements as for earth barricades. See IATG 05.30 *Barricades.*

The lowest grade of reinforced concrete (RC) permitted for use in construction of explosives facilities should be C35[18] with a nominal maximum aggregate size of 20mm. For conventional structures used as explosives buildings, the normal national technical authority reinforcement requirements should apply. Where there is a design requirement to consider dynamic loads, the following should also apply:

a) the arrangement, quality and quantity of reinforcement shall ensure satisfactory performance of RC elements subject to plastic deformation under blast loading. The requirements are significantly different and more stringent than for conventional structures;

b) main and secondary reinforcement shall be hot-rolled high-yield (HRHY) deformed steel bars to an equivalent of BS 4449:2005 + Amendment 2 2009 *Specification for carbon steel bars for the reinforcement of concrete*[19] Grade 460; and

c) shear reinforcement shall be hot-rolled mild steel bars (MS) to an equivalent of BS 4449 Grade 250.

Cold worked high yield reinforcing bars shall not be used in explosives structures because of the high strain rates and large deformations expected.

The minimum reinforcement quantities for blast resistant structures shall be:

a) 0.25% HRHY main bars each face;

b) 0.2% HRHY secondary bars each face;

c) 0.1% MS links for designed compression reinforcement; and

d) 0.04% MS links for nominal compression reinforcement.

Reinforcement shall be arranged so as to minimise laps where practical. Where laps in the main tension bars are necessary, they shall be 72 diameters long to allow for the reduced bond strength in cracked concrete. Reinforcement shall have full development lengths at slab/wall and wall/wall junctions.

Blast links shall be provided to enclose all layers of main and secondary steel in order to better contain the core concrete, to improve dynamic response, to increase shear capacity and to limit the size of back face spall fragments. Links shall be ‘U’ shaped, staggered and at maximum spacing of 300mm. Links shall generally be used in preference to diagonal lacing bars for reasons of economy and construction practicability. Links shall be adequately bent around reinforcing bars at corners and the minimum hook length shall be the lesser of 20 bar diameters each or two thirds of the slab thickness.

Open links conforming with shape code 77 to ISO 3766:2003 *Construction drawings - Simplified representation of concrete reinforcement* are acceptable provided that the hook allowance is increased to 40 diameters. The open end should face away from the potential explosion source i.e. in the primary tension face. Closed links conforming with shape code 79 to ISO3766 are acceptable provided that the over-lapping leg is placed through the thickness of the concrete section. The use of shape code 61 to ISO 3766 and shape code 51 to BS 8666:2005 *Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete - Specification* are not permitted for use as blast links.

[18] See ISO 22965:2007 Series *Concrete.*

[19] There are, as yet, no ISO covering this particular subject, although ISO 15630-1 *Steel rod test methods* is referred to in the BS.

Reinforcement should generally utilise moderate sized bars (up to 25mm) at close centres in preference to large bars at large centres in order to better contain the core concrete, to improve dynamic response and to limit the size of back face spall fragments. Main and secondary reinforcement shall be provided equally in both faces of RC elements subject to blast loading in order to allow for reverse loading and rebound forces. Reinforcement in RC elements shall be bonded so as to preclude side flashing. This should include, as a minimum:

a) reinforcement crossovers to be welded at a maximum of 2.5 metre centres in both faces; and

b) any remaining reinforcement crossovers shall be wire-tied at every intersection.

11.3 Structural steel (LEVEL 3)

Structural steel members required to provide resistance to blast loadings shall be able to develop their full plastic capacity during support rotation, and only plastic sections are to be used. Other types are not permitted.[20]

Plastic deformations of structural purlins,[21] within the permissible limits given in Clause 10.1 may be used to produce an economic solution. To avoid brittle modes of failure, member support connections shall be 'over-strong' and designed to withstand the maximum capable support reaction of the section under plastic rotation.

The grade of steel used must remain ductile in the design environment and for the range of permissible deformations given. BS 4449 Grade 43C is generally acceptable.

Welded components, junctions or connections that are load-carrying and that are vital to surviving an accidental explosion should be:

a) subjected to an agreed non-destructive test regime to demonstrate the competence of the welds; and

b) normalised after fabrication by an agreed heat-treatment process to relieve stresses in the heat affected zones.

11.4 Brickwork (LEVEL 2)

Brickwork for use in the construction of explosives facilities is to have a minimum characteristic compressive strength of 27.5N/mm^2 in a 1:1:6 cement/lime/sand mortar mix. Bricks should be solid and frost resistant (e.g. Engineering Class A or B). Where it is impractical to obtain solid bricks, any hollows shall be laid upwards and completely filled with mortar.

The use of concrete blockwork as an alternative to brickwork may be suitable only if solid blocks with a minimum compressive strength of 15.0N/mm^2 are used. Concrete blocks may not necessarily meet security requirements for intruder resistance and may require additional measures. Alternatively, hollow blocks with steel reinforced and concrete-filled voids may be considered. However, if block walls are intended to act in pressure relief such as in HD1.3 storage, then these measures shall not be allowed.

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[20] For multi-storey buildings the risks of progressive collapse after blast loading should be established. In physics and materials science, plasticity, also known as plastic deformation, is the ability of a solid material to undergo permanent deformation, a non-reversible change of shape in response to applied forces. Plasticity theory can be used for some reinforced concrete structures assuming they are under-reinforced, meaning that the steel reinforcement fails before the concrete does.

[21] Defined as *a horizontal structural member spanning between beams or trusses to support a roof deck.*

11.5 General comments on building materials not specified (LEVEL 2)

Generally, flammable materials shall not be used in explosives facilities and only non-combustible materials shall be used for the construction of facilities containing explosives. All construction shall be watertight, and all components shall be moisture resistant. The fixing of equipment to walls and roofs that may be subject to high shock loads should an explosion occur, shall be minimised due to the potential debris hazard that could arise from dislodged equipment, potentially with significant velocity.

11.5.1. Spark resistant materials and equipment fixing (LEVEL 3)

Facilities for the storage of bulk explosives sensitive to sparks or friction shall not have any exposed iron, steel, aluminium or aluminium alloy containing more than 1% of magnesium where it may come into contact with explosive substances. Where facilities are used for the storage of bulk explosives sensitive to sparks or friction, 'spark resistant' aggregates for the floor and walls are to be used in construction.

Where equipment fixings to concrete walls subject to high shock motions are unavoidable, they shall utilise under-reamed anchors, or other suitable types that have been demonstrated to be able to perform adequately in cracked concrete. Parallel expanding anchors shall not be used in such locations.

11.6 Roofs (LEVEL 2)

PES roofs should be either all heavy or all light. A heavy roof is defined as being one of at least 150mm thick RC, or its equivalent. Light roofs, which are normally pitched, shall be covered in a frangible material e.g. glass reinforced polyester or light metal sheeting. Metal trusses should normally be used, but on smaller buildings hardwood trusses may be acceptable. For concrete roofs that are not waterproof, a suitable waterproof finish, such as asphalt, may be fitted. If suitable propriety products are identified they may also be used as long as their fire rating is of the correct standard. Arrangements should be made on all roofs for rainwater discharge into open channels or gullies.[22] The recommended option should be the use of heavy roofs for all buildings but the decision on the type of roof used will depend on the explosives to be stored and local circumstances.

11.6.1. Special functions

Roofs, which are usually designed in combination with the supporting wall, may be designed to have special functions such as:

a) containment of fragments and the prevention of lobbed items. QDs for buildings designed to contain fragments and lobbed items should be dependent on the design specification of the actual building. In many cases, reduced QDs resulting from incorporating such roofs may be permitted;

b) shielding against blast, projections and lobbed items; and

c) exclusion of firebrands, projections and lobbed items with a resulting reduction in QDs. However, this reduction often depends on the provision of a shielding roof.

[22] The impact of snow and ice on ventilation and drainage in extremely cold climates should be considered.

11.7 Floors (LEVEL 2)

Floor design loadings shall be adequate to support the stored explosives and materiel handling equipment (MHE). The load area of a pallet will be of the order 10kN/m^2 of floor area. In some structures such as ECM storage, stacks up to 5 pallets high may be utilised which may give a loading of 50kN/m^2. Gangways and access requirements will reduce the average floor loading.

To make such floors dust free, they should be treated with sodium silicate (ICI Grade P84 or equivalent) or a similar approved substance. The floors of a PES to be used for the storage or processing of bulk explosives sensitive to spark or friction should be surfaced with gritless asphalt or other approved substance as per Clause 11.5. Other substances are also possible but formal approval should be sought from the national authority. Some facilities, particularly process buildings, may require to be fitted with conductive or anti-static floors.

11.8 External and internal walls (LEVEL 2)

PES designed as ESH do not require any internal or external decoration. In hot climates, external walls may be painted white to reflect heat. APB walls should have a smooth finish, free of cracks and crevices and be painted with an oil-based or washable paint. Lead based paint shall not be used. All corners should be rounded off and flat surfaces angled downwards to facilitate cleaning. Cladding and insulation specifications shall be based on those described at Clause 11.5 above. Asbestos shall not be used for this purpose.

11.9 Drainage (LEVEL 2)

Adequate drainage should be provided for all PES. To avoid the ingress of water through door openings, the external slab should fall away from the building. Any drains exiting sites where there are exposed explosives, such as APBs, laboratories etc., should have a suitable and readily accessible trap with removable covers fitted in order to intercept any explosive residues. Traps and drains shall be regularly cleaned to prevent any build-up of residue.

11.10 Doors (LEVEL 2)

Door construction may vary according to the required degree of protection to stocks from fragments and whether a door barricade is present. Door materials shall comply with the requirements set out in Table 8. Locks shall comply with the requirements of IATG 09.10 *Security principles and systems*.

Exposed Site Construction Type	PES Holdings			
	HD1.1 / 1.2	HD1.3 / 1.4	No PES	Notes
Lightweight	As HD1.3/1.4	The main requirement is explosives safety, followed by physical security. Generally to be as approved by IATG 09.10.	Prime requirement is explosives safety, followed by physical security. Generally to be as approved by IATG 09.10.	The national authority shall lay down security standards, however, these should meet the minimum of IATG 09.10. Similarly it should be noted that the door hinges should be suitable for the task.
Medium-walled (150mm RC or 215mm brick)	16mm mild-steel plate. Security requirements to be incorporated into the design.			
Earth-covered ESH	16mm mild-steel plate. Security requirements to be incorporated into the design.			
Heavy-walled (450mm RC or 680mm brick)	50mm mild-steel plate. Security requirements to be incorporated into the design.			

Table 8: Minimum construction requirements for exposed site doors

11.10.1. Fire doors (LEVEL 2)

Emergency escape doors for evacuation in fire, explosion or other emergency shall be located to satisfy national authority laws and regulations. These should also satisfy the requirements of IATG 02.50 *Fire safety*. It is suggested that there is a maximum escape distance of 9m where travel is possible in one direction only and 18m for more than one permissible direction. In storehouses where the provision of alternative means of escape is not possible, such as earth-covered storehouses and ECM, approval may be given to increasing the maximum single-direction travel distance to 18m.

Escape doors should not be fitted with locks but should have approved bolts on the inside and be provided with 'Ball'[23] type catches that will operate by pressure on any part of the door. Panic bolts or latches may be provided instead of 'Ball' catches if security or other considerations warrant it. One escape door may also be used for access and may be fitted with an approved lock in place of the bolts, however, this lock must only be operable from the inside of the building.

Door openings shall be of dimensions suitable for their required usage and should open outwards. Sliding, folding and up-and-over types are acceptable. These types of door shall be provided with, or have adjacent to them, an outwards opening personnel escape door.

An entrance step may be provided to protect stocks against ingress of dirt or water. The height of this step should not be excessive, and ramps should be fitted to protect MHE.

11.11 Windows and other glazing (LEVEL 2)

Flying glass is the main cause of injuries in explosive events. It should be a requirement to design all inhabited buildings inside the IBD to resist blast pressures, fragments and debris, so it is logical to design any glazing to minimise the risks posed. A summary of the glazing required within IQD is included in Table 6.[24] Windows shall not face a PES, or if they do, they shall be effectively barricaded.

Windows shall not normally be permitted in explosives buildings. Where this is unavoidable, they should be as small as possible and (for security) should be non-opening. Where opening windows exist, they shall be fitted with approved security grilles. Windows should be positioned where they will not admit direct sunlight, which could fall on explosives. If this is not possible, they should be covered or shaded.

To reduce and/or mitigate the risk from fragments from a PES and from glass fragments clerestory[25] glazing should be used. In occupied explosives buildings, low level glazing should be designed to survive the blast overpressures in order to offer reasonable levels of protection to the occupants.

Glazing materials shall be chosen to reduce injuries to the occupants of inhabited buildings. The materials most suitable for this purpose are:

a) laminated glass. Laminated glass with a minimum thickness of 7.5mm consisting of annealed glass with a 1.5mm thick polyvinylbutyral (PVB) interlayer has a high blast resistance and does not produce such hazardous fragments as annealed or toughened glass. Such glazing should be UV resistant. Deep rebates with polysulphide or silicon sealant should be used when fitting the window frames;

[23] A spring-loaded ball held within a cylinder attached to a flange.

[24] More detailed information on glazing resistance to blast loading is contained within the UK Home Office Scientific Development Branch (HOSDB) Glazing Hazard Guide 1997.

[25] Defined as a high wall with a band of narrow windows along the very top.

b) polycarbonate. Polycarbonate with a minimum thickness of 6mm, fitted into robust frames, is a tough flexible material with a high blast resistance. In comparison with other types of glazing, it is more expensive, less scratch resistant, degrades with time and exposure to solvents such as cleaning materials, and can produce sharp fragments when it fails. It is difficult for X-rays to detect such fragments in the human body and this should be addressed in the risk assessment before it is adopted for use. Such glazing should be UV resistant. It is more useful as a secondary glazing material: and

c) toughened glass (full heat tempered). This glass is 4 to 5 times stronger than annealed glass and can therefore resist higher blast loading if fitted in a strong rigid frame. The fragments produced when it breaks are small, cuboid and less injurious than those from annealed glass.

Untreated plain glass or wired glass shall not be used within IQD. Should these exist in current buildings they should be enhanced with anti-shatter film (ASF) and bomb-blast net curtains (BBNC). Where plain or wired glass is used internally, the side remote from the PES shall be filmed. Where the primary blast can come from either side from multiple PES, both sides shall be filmed. Inside $14.8Q^{1/3}$ only laminated or toughened glass solutions shall be used.

11.12 Ventilation and air conditioning (LEVEL 2/3)

Ammunition storage and process buildings should be kept as dry and temperate as possible. To assist in the reduction of condensation they should be provided with natural ventilation and, if required, dehumidification equipment. To optimise the life of explosives, it is desirable to limit the humidity and temperature in a storehouse or process building. The ideal conditions are that:

a) the relative humidity should be maintained between 50 and 60%. Humidity levels higher than this may lead to deterioration of the explosives and lower levels may give rise to problems with static electricity for some types of ammunition; and

b) the temperature should generally be maintained between 5°C and 25°C. Temperatures higher than this could cause damage to propellants and other explosive material.

High- and low-level ventilators should be provided in all buildings and compartments that are not air conditioned. However, in very small compartments, this may not be necessary. If ventilators or air conditioning is not fitted, careful checking for dampness and stock deterioration must take place regularly.[26]

Ventilators may be either controllable from the exterior of the building or be of a permanent open type such as air-brick. They shall comply with all security requirements including the fitting of suitable metal shields to prevent the ingress of rain or snow. Fire shutters with fusible links may be required for certain types of ventilators.

To prevent penetration by fragments, airbricks provided in cavity masonry walls shall be staggered horizontally, and those provided in solid masonry or reinforced concrete walls shall be protected by 6mm thick mild-steel cover-plates giving line-of-sight protection. Overlaps should be provided to ensure secure fitting.

If forced air ventilation is required and exhaust fans are necessary, these should be fitted on the leeward side of the building. Suitable automatic shutter systems fitted with small mesh metal grilles, where necessary, should be provided to ensure that there is no ingress of air when the fans are not running.

[26] See IATG 06.70 *Inspection of explosives facilities.*

In hot climates, special arrangements should be made to keep the contents of a PES as cool as possible by providing an interior ceiling or double roof and extending the width of the roof to protect the walls from the direct rays of the sun. In some PES where the temperature range is critical, it may be necessary to provide insulating materials or air-conditioning. Alternatively, earth covered above ground or semi-underground buildings may be a suitable alternative. It may also be necessary to provide metal grille doors in addition to the normal doors to enable the PES to be adequately ventilated during the night. The grille doors should be fitted with approved locks.

Where it is necessary to provide air conditioning to meet specified restricted humidity conditions, the plant provided shall comply with national requirements and IATG 05.40 *Safety standards for electrical installations*.

Certain processes may have the potential for generating hazardous environments, such as explosives dust, gases or vapours, and, in those cases, ventilation and associated electrical equipment shall be designed to prevent inadvertent initiation of those environments. Such designs should be in accordance with IATG 05.40 *Safety standards for electrical installations*.

11.13 Heating and utilities (LEVEL 2)

Suitable protective shields should be provided to prevent explosives, stores containing explosives, or their packages from coming into contact with any heated surface, pipes or radiators. The protective shields should be designed such that items cannot be placed on them, for example with sloping tops.

Utilities to APBs such as compressed air, and any associated plant, water supplies, drainage etc, should have pipelines or conduits carrying services that are colour coded to show the nature of their contents, and bonded at the entry and exit to/from the building or compartment. This colour coding should be shown at the building entrance and at such other points as is necessary to avoid confusion. The colour code should be approved by the national technical authority.

11.14 Lifting equipment (LEVEL 2)

Buildings intended to contain heavy or bulk stores should either be provided with an approved overhead hand operated or electric crane, or the construction of the PES should be such that it will allow for the use of mobile handling, lifting and stacking equipment.

11.15 Lightning protection

See IATG 05.40 *Safety standards for electrical installations.*

12 Electrical requirements (LEVEL 2)

These are covered in depth at IATG 05.40 *Safety standards for electrical installations.*

13 Blast design and survivability

The design of buildings to be subjected to blast and shock loadings shall be carried out by competent persons such as chartered civil or structural engineers with appropriate experience in blast design. It is not intended to lay down any firm regulations as these will of necessity be modified by the national technical authority to meet local requirements and laws including design approval. It is suggested that the survivability criteria in this document should be the minimum standard required.

Annex A
(normative)
References

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

a) BS 4449:2005[E] and Amendment 2:2009 *Specification for carbon steel bars for the reinforcement of concrete.* BSI. 2009;

b) IATG 01.40 *Glossary of terms, definitions, and abbreviations*. UNODA;

c) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

d) IATG 02.20 *Quantity and separation distances.* UNODA;

e) IATG 02.40 *Safeguarding of explosive facilities*. UNODA;

f) IATG 02.50 *Fire safety*. UNODA;

g) IATG 05.30 *Barricades*. UNODA;

h) IATG 06.70 *Inspection of explosives facilities*. UNODA;

i) IATG 02.40 *Safeguarding of explosive facilities*. UNODA;

j) IATG 09.10 *Security principles and systems*. UNODA;

k) ISO 22965:2007[E] Series *Concrete.* ISO. 2007; and

l) ISO 3766:2003[E] *Construction drawings - Simplified representation of concrete reinforcement.* ISO. 2003.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[27] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[27] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[28]

a) AASTP-1, Edition B Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

b) *Handbook of Best Practices on Conventional Ammunition*, Chapter 2. Decision 6/08. OSCE. 2008;

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020;

d) Technical Paper 15*, Approved Protective Construction*, Revision 3. US Department of Defense Explosives Safety Board (DDESB). May 2010. www.wbdg.org/building-types/ammunition-explosive-magazines; and

e) UFC-3-340-02, *Structures to Resist the Effects of Accidental Explosions*. US Department of Defense. 05 December 2008; Change 2, 01 September 2014. www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-3-340-02.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[29] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[28] Data from many of these publications has been used to develop this IATG.

[29] Where copyright permits.

Annex C
(informative)
List of ammunition storage building types

This Annex is not intended to provide a definitive list of ammunition storage building types. Rather it is intended to identify the various types of buildings and the functions they carry out to provide information to the national technical authority in order that it can make valued judgements on the type of facility required.

C.1 ECM (LEVEL 3) and storage buildings (LEVEL 2)

Standard ECM are fully pre-designed structures. They only require the design of their foundations and other elements that depend on individual site conditions. ECM should be designed to a 90% level of confidence that, as an ES, collapse or door failure will not occur when exposed to the blast loading from an explosion at a nearby PES at the appropriate IMD. Significant changes to the design may require complete re-validation of the structure. Drawings of these structures are readily available and in the event of a building programme, expert help should be sought. A source for current '7 Bar' ECM structural designs is the Whole Building Design Guide website at www.wbdg.org/building-types/ammunition-explosive-magazines.

Deflections have been limited to maintain structural integrity. They will not be larger than the width of the air gap around the explosives within, such that the structure will not strike the explosives. The support rotations of all the RC elements and the doors shall be limited to 4° and 12° respectively.

To avoid major spalling, the spall velocities shall be limited to:

a) spall velocities >50 ms and with a kinetic energy ≤2500J; and

b) spall velocities <50 ms and with a momentum ≤100Ns.

Standard ECM construction should prevent major spalling of RC members occurring; however, the limits above may not prevent initiation of sensitive primary explosives.

C.1.1 Design Loads for ECM as an Exposed Site

The blast parameters that standard ECM have been designed to resist are as follows:

a) 3 Bar ECM. When ECM are constructed with their axes parallel, account shall be taken of the explosion effects from another ECM in a side by side situation. The separation distance (IMD) D3 is given by $0.5Q^{1/3}$. The blast parameters for the dynamic design of the ECM structure are as follows:

Location on ECM	Peak Positive Overpressure (kPa)	Positive Impulse (kPa.ms)	Positive Duration (ms)
Head Wall, Doors, Rear and Side Walls	300	$100Q^{1/3}$	$1Q^{1/3}$
Roof	600	$100Q^{1/3}$	$1Q^{1/3}$

Table C.1: 3 Bar ECM design parameters

b) 7 Bar ECM. When ECM have the same longitudinal axis and the head wall and doors of one are exposed face-on to the rear wall of another or vice-versa, the separation distance (IMD) D4, front to back, is given by $0.8Q^{1/3}$. ECM should not be sited with their doors facing each other. The blast parameters for the dynamic design of the ECM structure are as follows:

Location on ECM	Peak Positive Overpressure (kPa)	Positive Impulse (kPa.ms)	Positive Duration (ms)
Head Wall, Doors and Rear Wall (if the position is reversed)	700	$200Q^{1/3}$	$1Q^{1/3}$
Side Walls	300	$100Q^{1/3}$	$1Q^{1/3}$
Roof	600	$100Q^{1/3}$	$1Q^{1/3}$

Table C.2: 7 Bar ECM design parameters

c) An ECM that is not a true arch, such as a portal type or "flat arch" structure, should be designed for the likely blast loading on the earth-cover. Each structural element (roof, sidewall or rear-wall) may require consideration depending upon the type and orientation of the structure. Owing to the dearth of data on the loading beneath the earth-cover, it may be necessary to design for the anticipated worst case, similar to the design loads for head-walls and doors. Design authorities should base their work upon applicable blast parameters from test references cited in NATO publication AASTP-1, Part 2, Annex IIB taking into account the maximum NEQ expected for the proposed facility and consulting at the earliest practicable date with national explosives safety authorities.

C.1.2 Design loads for ECM doors as an Exposed Site

As well as positive phase blast effects, ECM doors should be designed to resist the loads that may occur during the negative phase of the blast loading. An equivalent static pressure of 0.5 Bar over the surface area of the doors should be taken for support restraint design. The doors are not required to remain in position under full rebound loads. Fragment attack on the door and head wall is not of particular significance provided that end-on conditions[30] apply. Typical fragments have less than 1 kg mass and velocity up to 300 m/s. A mild steel door with plate thickness of 20mm will resist the perforation of all fragments within these limits. A 16mm plate thickness will reduce the residual velocity such that sympathetic detonation should not occur.

C.1.3 Single bay box ECM

Many designs exist but, in essence, this is an RC portal type structure with a minimum of 600mm of earth cover on the roof and earth cover against the side and rear walls. The slope of the earth against the walls is dependent on the material type used but should have a maximum slope of 1:2 (approximately 26°). Access is through a top-hung sliding steel door and a steel personnel door, both located in the headwall. The foundations are RC strip footings with a separate ground-bearing floor slab. The internal dimensions are 16m long, 9.12 m wide and a minimum of 4.6m high. The structure has been dynamically designed to resist the blast effects as an ES from an explosion in a nearby PES.

This particular ECM has been designed at the relevant QDs as a PES and an ES for a nominal maximum NEQ stored of 75,000 kg of HD 1.1 and up to 250,000 kg of HD 1.2 or HD 1.3. Greater NEQ's may be stored, but a design check must be carried out to determine any structural alterations required. An example of this design is illustrated at Annex D.

C.1.4 Double bay box ECM

Again, different designs are possible. It is an RC structure as described above but the roof slab is supported at midpoint by a longitudinal RC beam spanning on to RC columns at ~4 metre intervals. The internal dimensions are 16m long, 18.64m wide and a minimum of 4.6m high. NEQ limits are as for a single bay ECM. An example of this design is illustrated at Annex D.

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[30] Those scenarios where the ends of each ECM face each other.

C.1.5 Steel arch ECM

This ECM is formed of corrugated steel sheeting with RC front and rear walls and base slab with earth cover and NEQs as for other forms of ECM. Access is generally through a top-hung sliding steel door, but some designs use double, hinged doors. An example of this design is illustrated at Annex D.

C.1.6 Steel framed medium wall storehouse

This is a single-storey steel framed building with mono-pitched RC roof and masonry cavity perimeter walls. This structure is not generally designed to resist blast loading. Access is through doors located in the side. An example of this design is illustrated at Annex D.

C.1.7 Storehouse for HD 1.3 ammunition

This is an RC single storey box structure with a part frangible front wall. Overall dimensions are approximately 37m x 16m x 6.2m. This structure is not generally designed to resist blast loading. Access to the building is through two top-hung sliding steel doors located in the front elevation. An example of this storehouse is illustrated at Annex D.

C.1.8 Storehouse for unit ammunition holdings

This may be a single storey, compartmentalised and flat roofed building. The roof and floor slab are RC, supported on the external cavity and solid masonry cross-walls. Access into each compartment is through double doors in the front. For security reasons, the inner wall should be constructed of bricks not blocks, unless approval is given by the national technical authority. An example of this storehouse is illustrated at Annex D.

C.2 Ammunition process buildings (LEVEL 2)

Many different types of APB exist that cover the requirements for ammunition manufacture, maintenance and testing. The design of new buildings should take into account the design principles contained in this IATG. Unfortunately, older buildings of this type were not generally designed to resist blast loading, and protection against high velocity missiles was provided by barricades or heavy walls acting as barricades, together with a protective roof. However, these types of buildings are not satisfactory because the weight of debris from the structure at collapse would cause serious injury to the occupants. An example of these buildings is illustrated at Annex D.

C.2.1 General purpose ammunition process buildings

This building is used for the assembly and maintenance of explosives. The arrangement of the plant room, changing room, office and so forth should be altered to suit the specific requirements of the individual building. The construction consists of an RC frame and slabs with clerestory glazing and masonry cavity external walls. APBs should be designed to promote flexibility in use. However, a specific process building may be necessary to meet a specific requirement such as large missile surveillance. APBs should always be completely barricaded. As an ES, or where personnel who are not directly involved in the processing activity are exposed to risk of injury, the design shall give them reasonable and practicable protection.

C.2.2 Special purpose ammunition process buildings

C.2.2.1 Integrated weapons complex (LEVEL 3)

These facilities are designed to be used for the assembly, maintenance and testing of missiles, torpedoes and other complex weapons systems.

The example shown at Annex D consists of four Weapon Assembly and Check Rooms (WACR) positioned in a cruciform shape around a central Test Equipment House (TEH) and two independent plant rooms. The actual construction should be determined by the blast parameters from a given amount of explosives in a WACR and should be designed to give reasonable levels of protection to workers in an adjacent WACR and higher levels of protection to personnel in the TEH. This particular design has been verified by trials.

The TEH is a RC box construction, separated from the WACR construction to reduce shock transfer in the event of an explosion. Heavy blast doors, which are mechanically actuated and interlocked, protect the TEH and there are no windows. This design affords protection both to the occupants and test equipment.

Each WACR has three thick reinforced concrete walls, which serve as container barricades. Internal dimensions are approximately 24.5m long x 10.5m wide x 6.6m high. The roof and front wall are designed to be lightweight frangible vents with the front wall additionally provided with a vertical RC barricade. Efflux vent holes are provided in two side walls. A personnel escape door is provided at the rear of each WACR with an external door barricade.

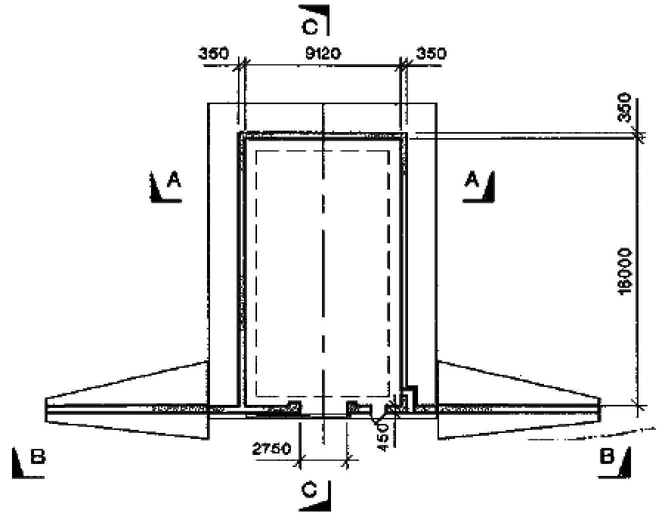
C.2.2.2 Guided weapons store and workshop (LEVEL 2)

This is a single storey RC framed building with a flat RC roof slab, cavity masonry panel walls and overall dimensions of 19.0m x 9.7m x 3.7m. It permits the storage and processing of high value guided weapons and their associated test equipment in a building specially designed to process them and negates the need for modifying normal process buildings for a missile task and then re-modifying it to carry out conventional ammunition tasks. This building is illustrated at Annex D.

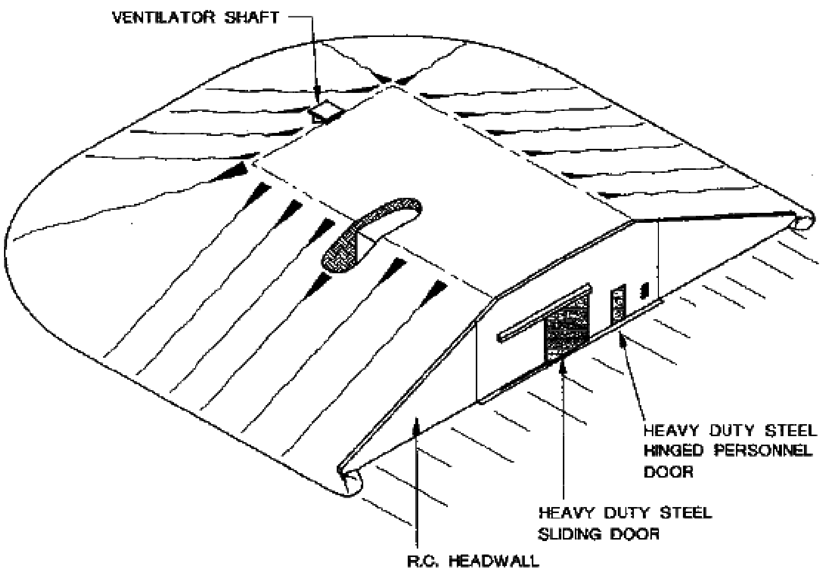
Annex D
(informative)
Diagrams of ammunition storage building types

All diagrams are courtesy of the UK Joint Service Publication 482, Chapter 6, *Buildings Associated with Military Explosives*.

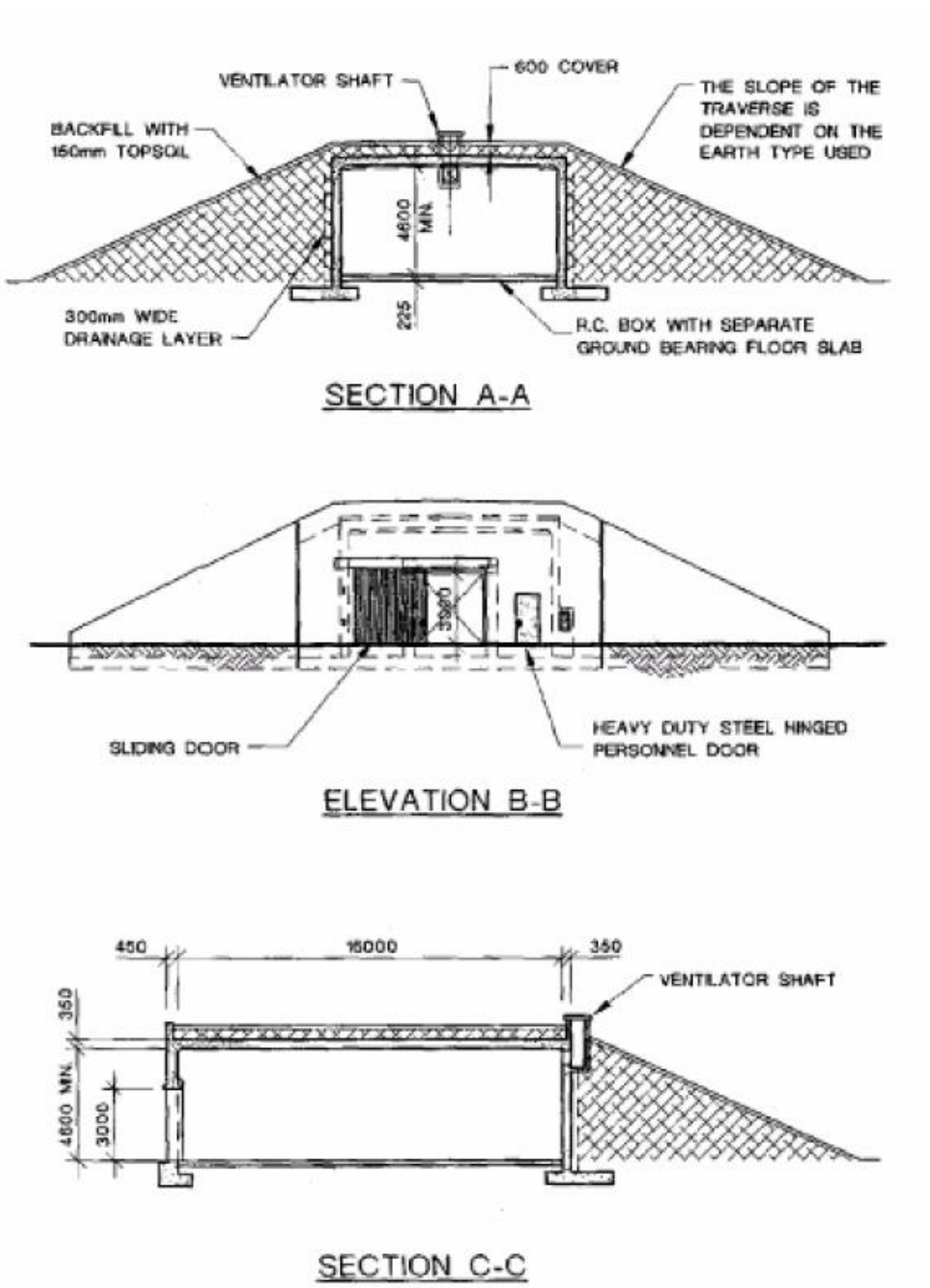
D.1 Box ECM single bay



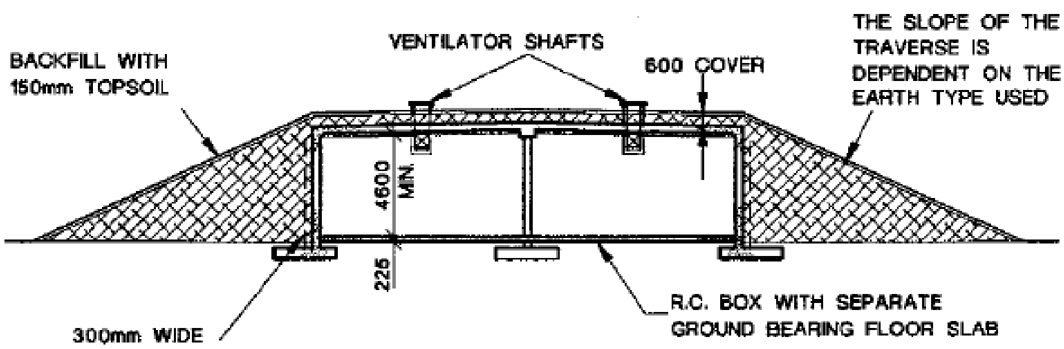
FLOOR PLAN



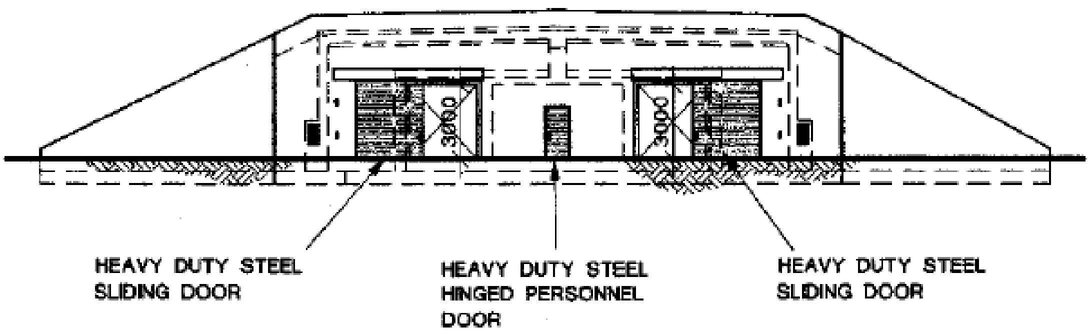
STORAGE CAPACITY: 4 x 10 x 3 HIGH = 120 STANDARD NATO PALLETS
EXPLOSIVE LIMIT: 75.000 kg. TNT EQUIVALENT
INTERNAL DIMENSIONS = 9120x16000x4600 = 6.0 m^3 VOLUME


VENTILATOR SHAFT
600 COVER
BACKFILL WITH
150mm TOPSOIL
THE SLOPE OF THE
TRAVERSE IS
DEPENDENT ON THE
EARTH TYPE USED
4600
MIN.
225
300mm WIDE
DRAINAGE LAYER
R.C. BOX WITH SEPARATE
GROUND BEARING FLOOR SLAB
SECTION A-A
SLIDING DOOR
HEAVY DUTY STEEL HINGED
PERSONNEL DOOR
ELEVATION B-B
450
16000
350
VENTILATOR SHAFT
350
4600 MIN.
3000
SECTION C-C

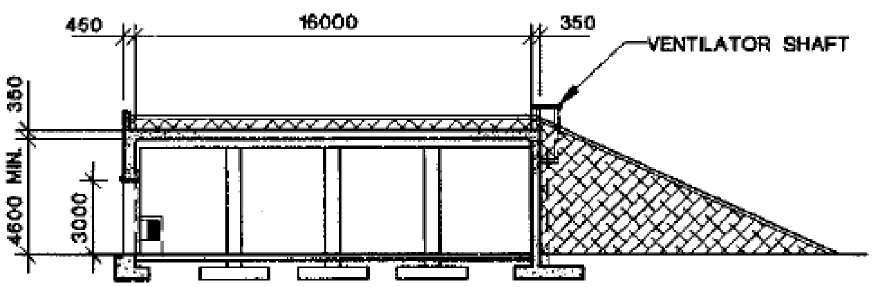
D.2 Box ECM double bay



SECTION A-A

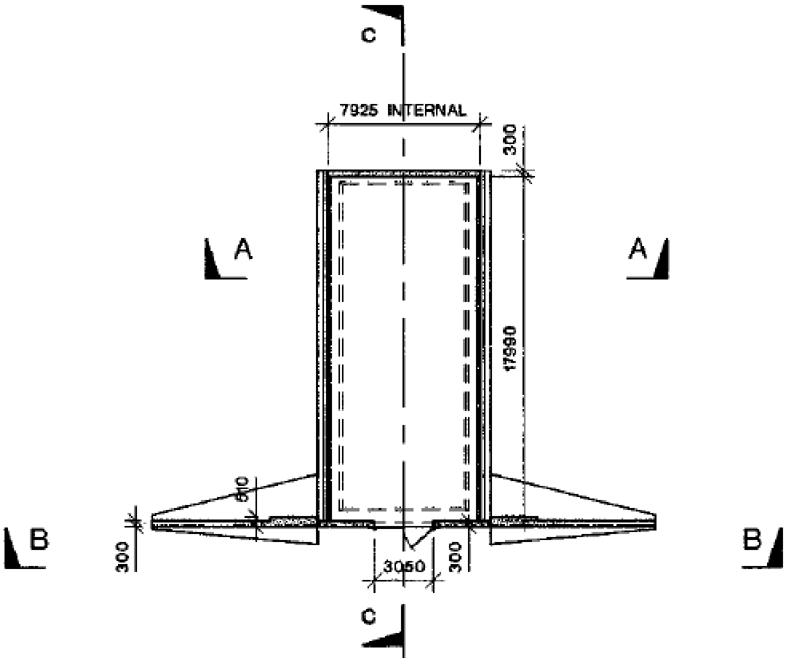


ELEVATION B-B

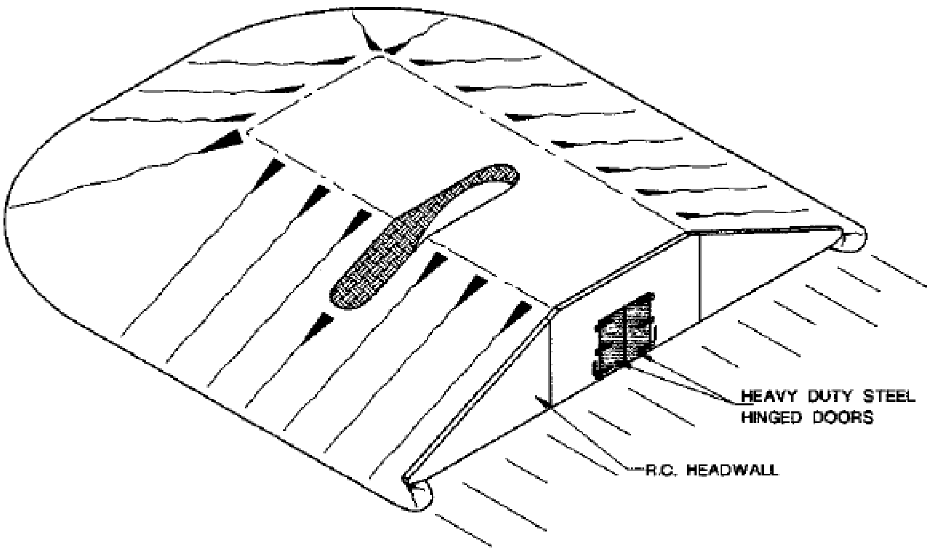


SECTION C-C

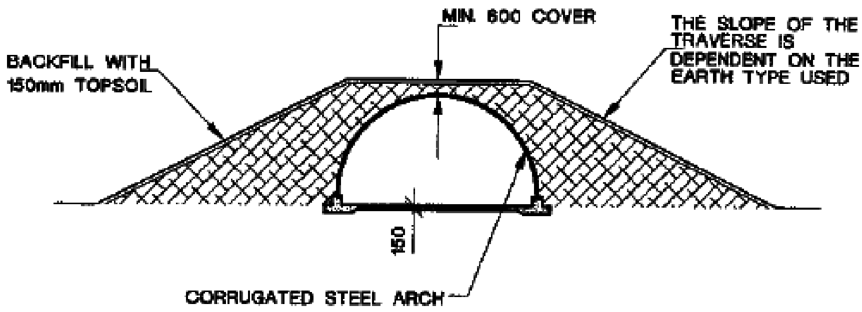
D.3 Steel arch earth mounded ECM



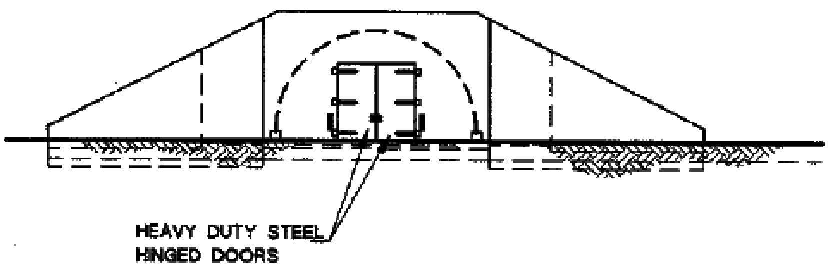
FLOOR PLAN



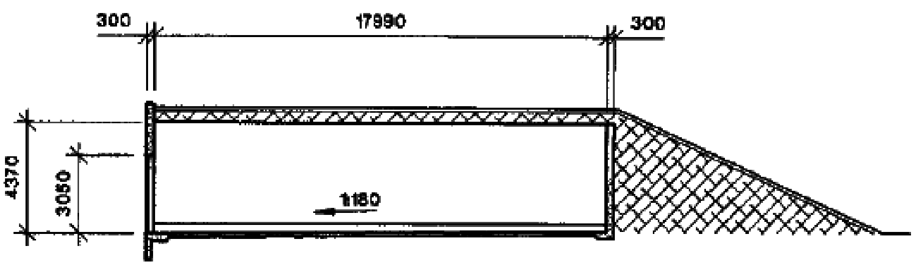
INTERNAL DIMENSIONS = 7925x17990x4370 MAX. = 501 m^3 VOLUME



SECTION A-A

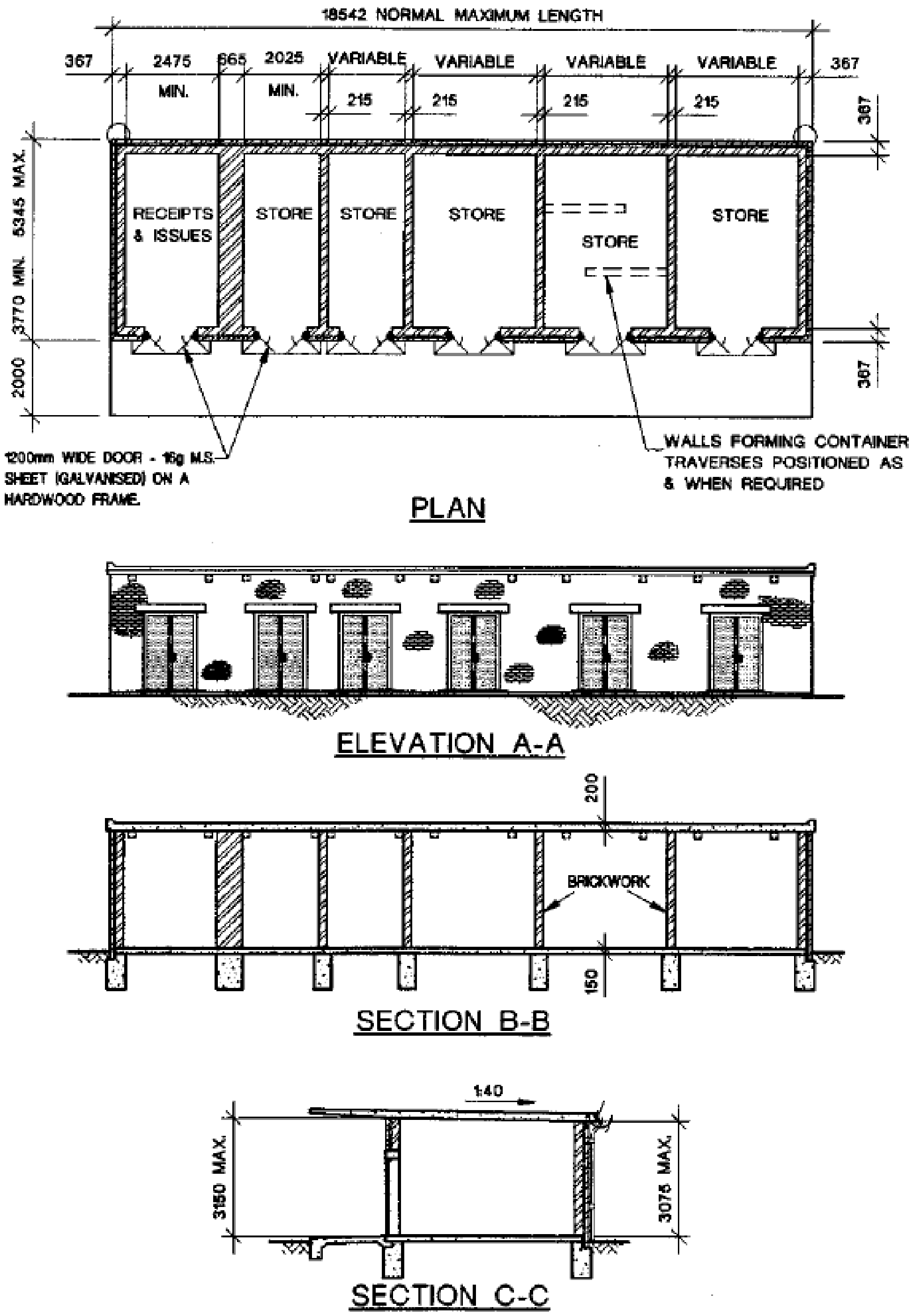


ELEVATION B-B

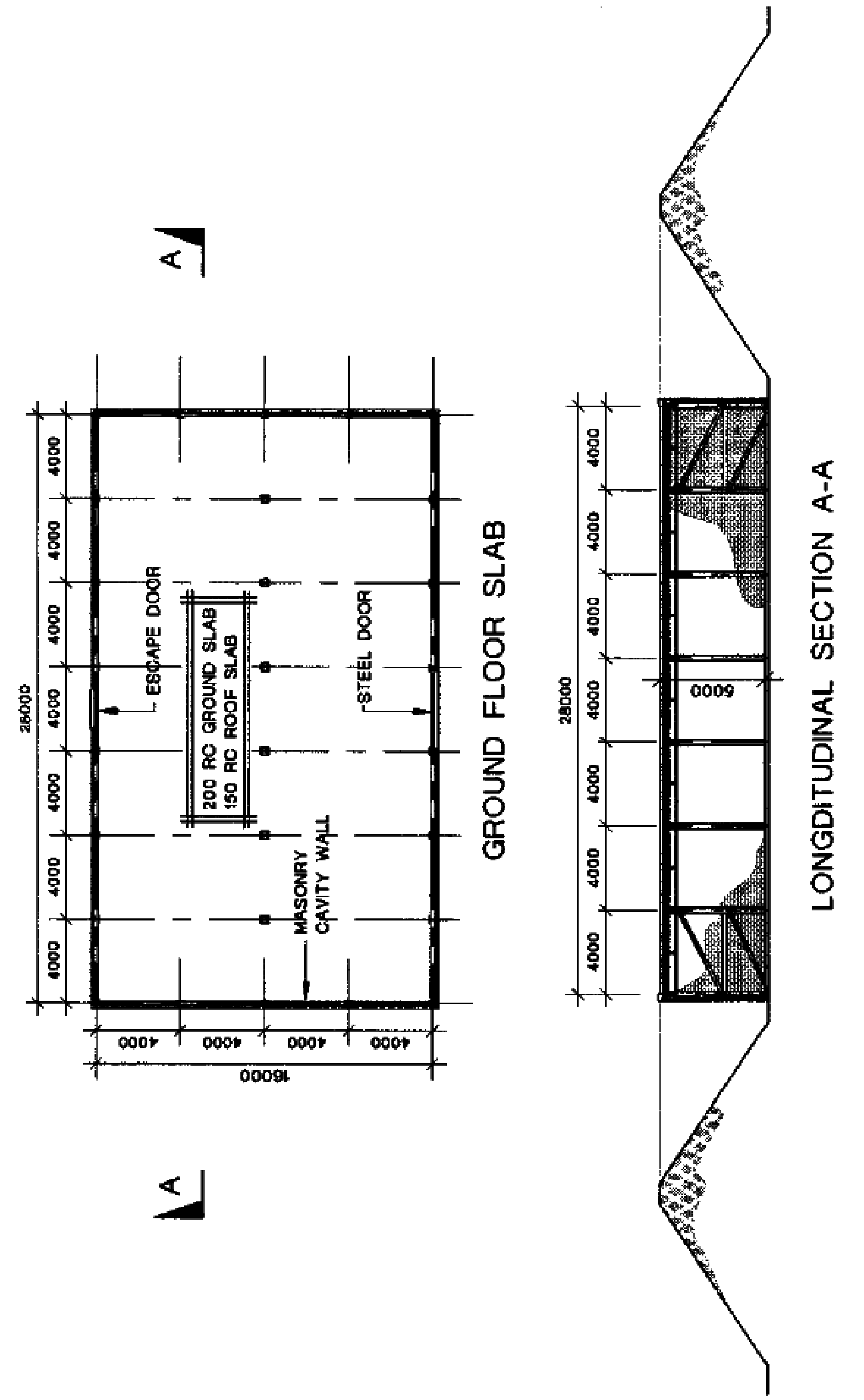


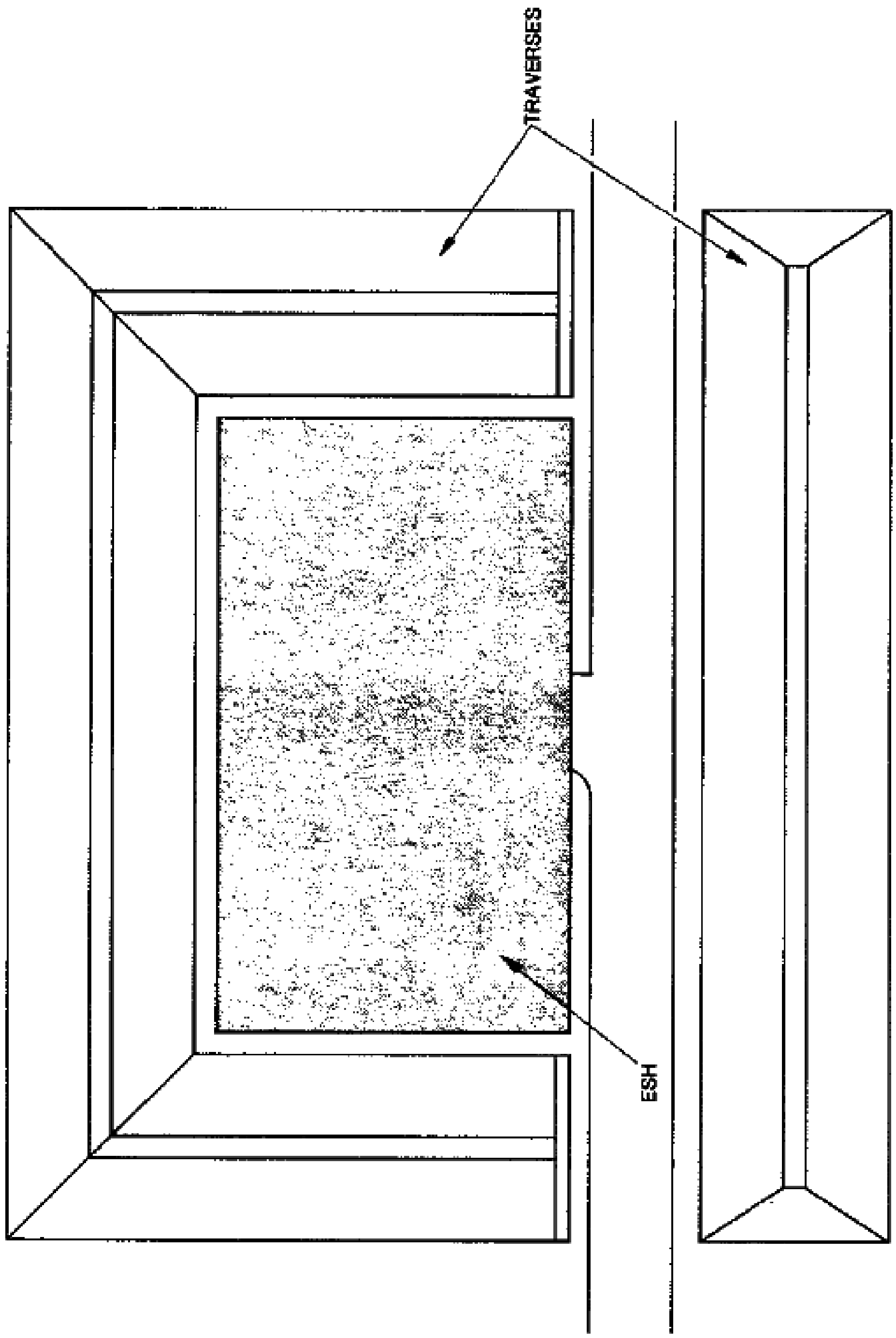
SECTION C-C

D.4 Small storehouse for unit holdings



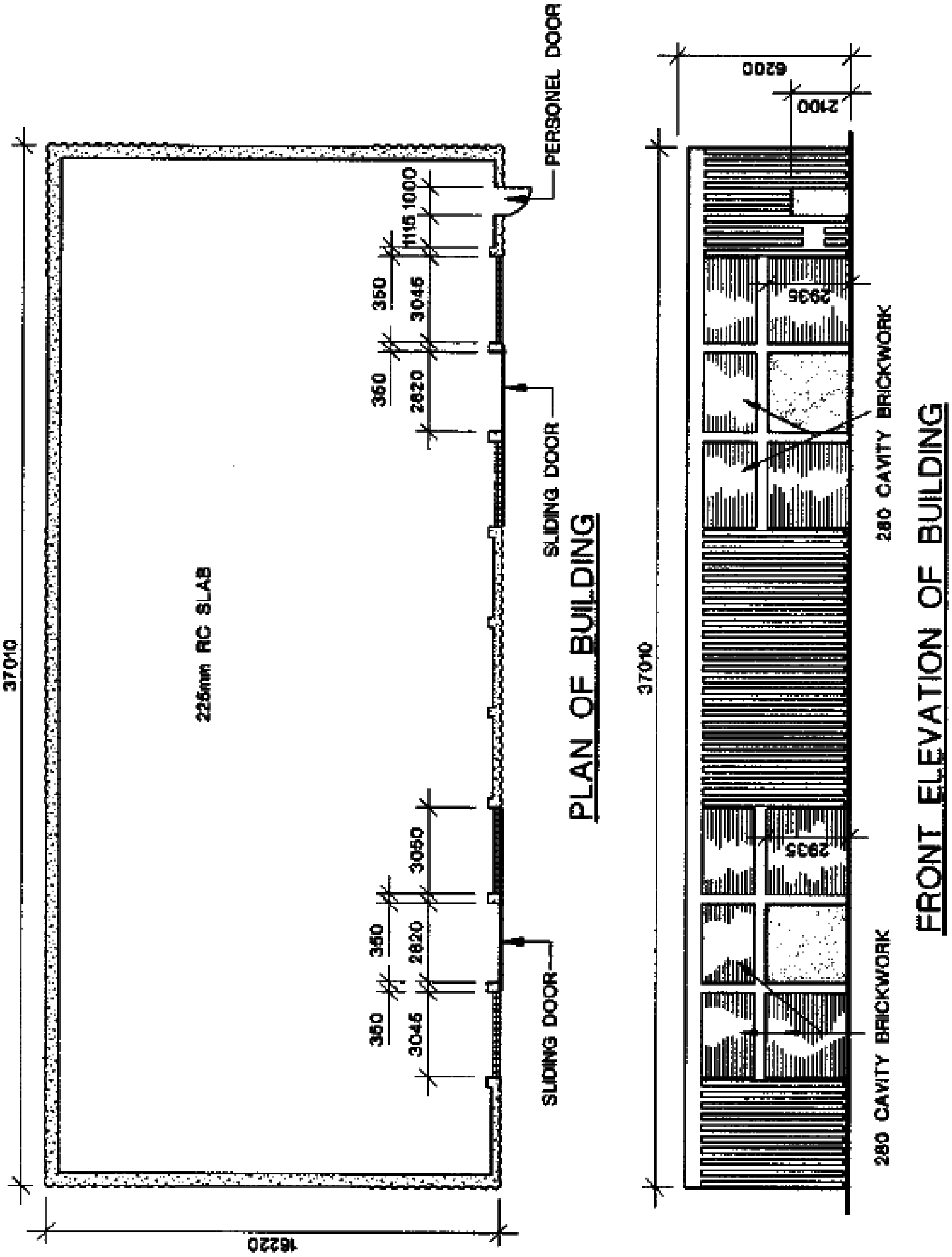
D.5 Steel framed medium wall storehouse

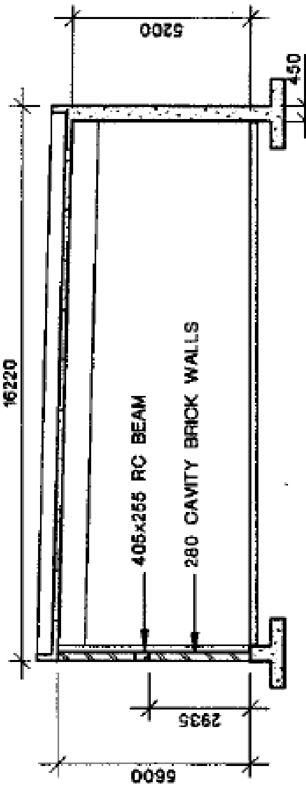




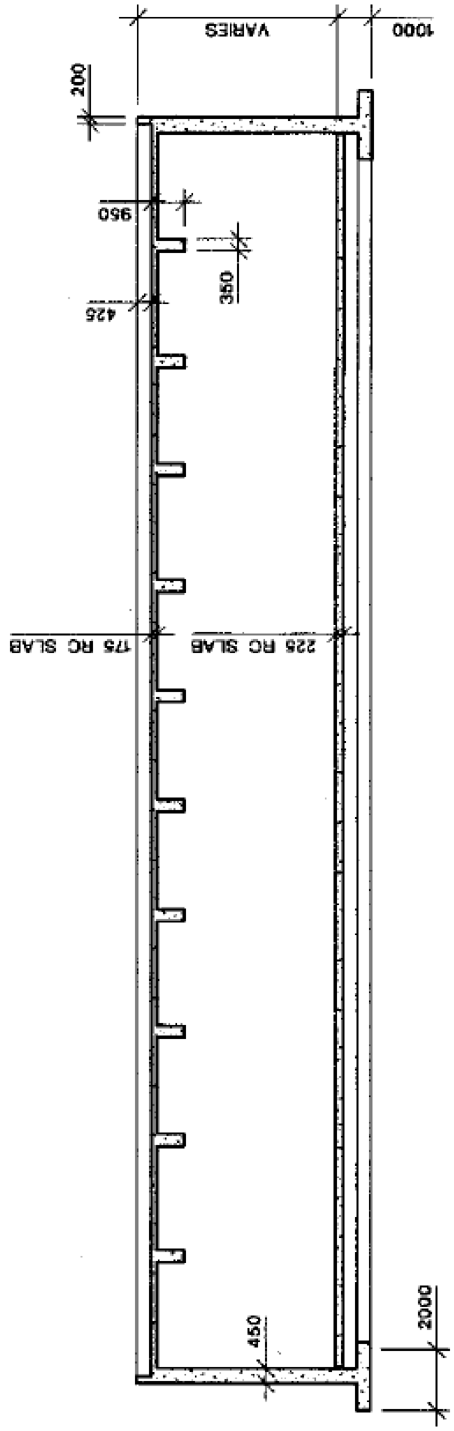
LAYOUT OF STOREHOUSE

D.6 Storehouse for HD 1.3 explosives



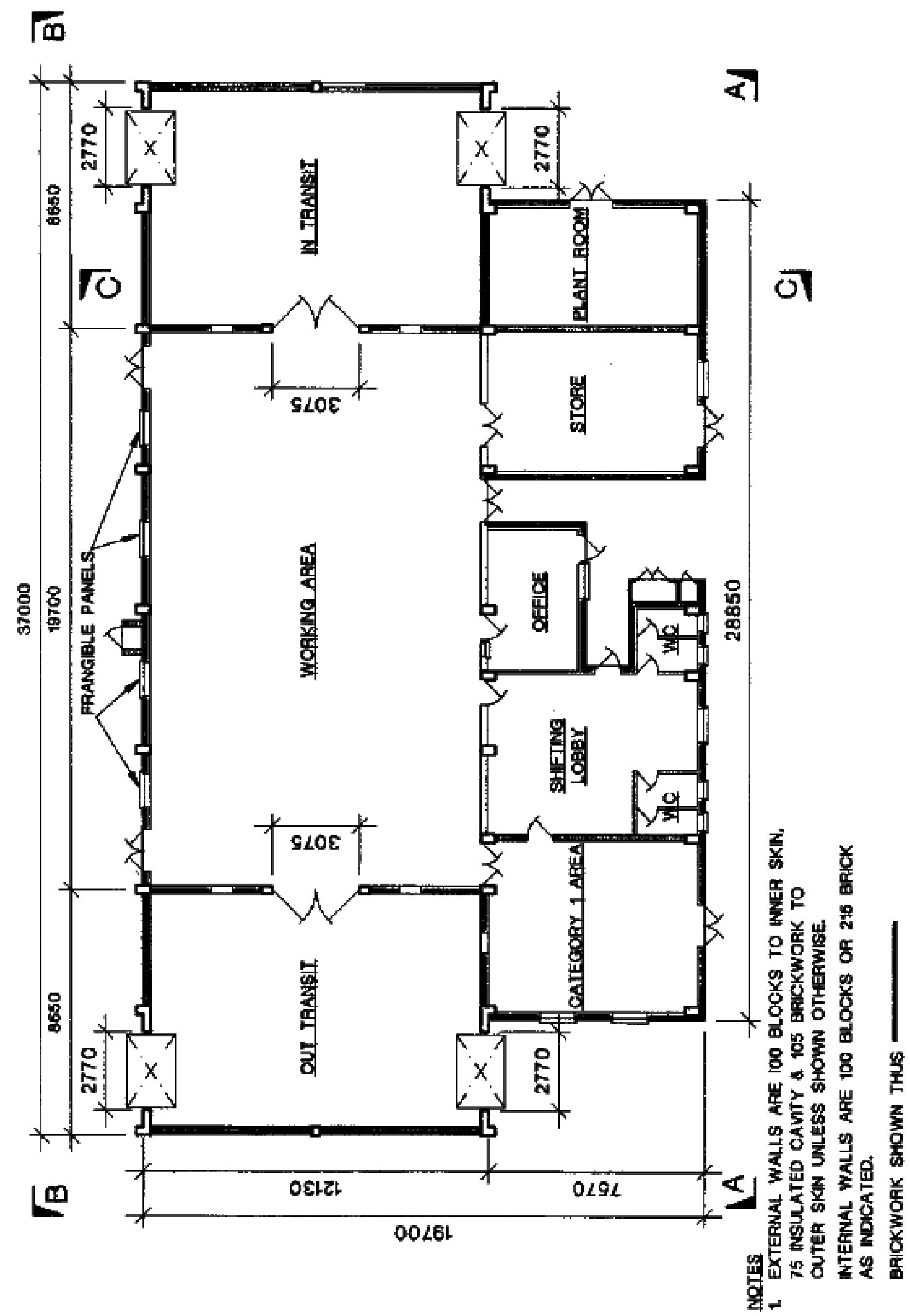


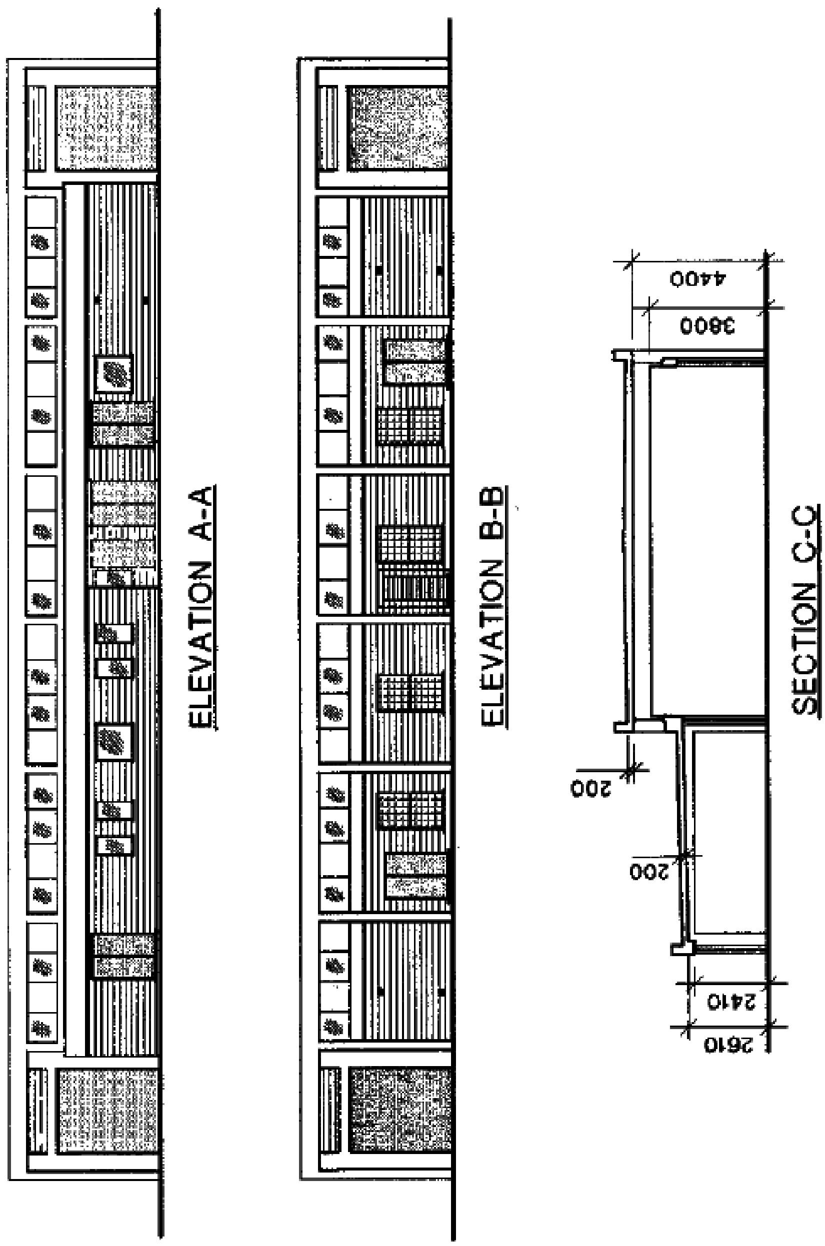
CROSS SECTION THRO' BUILDING

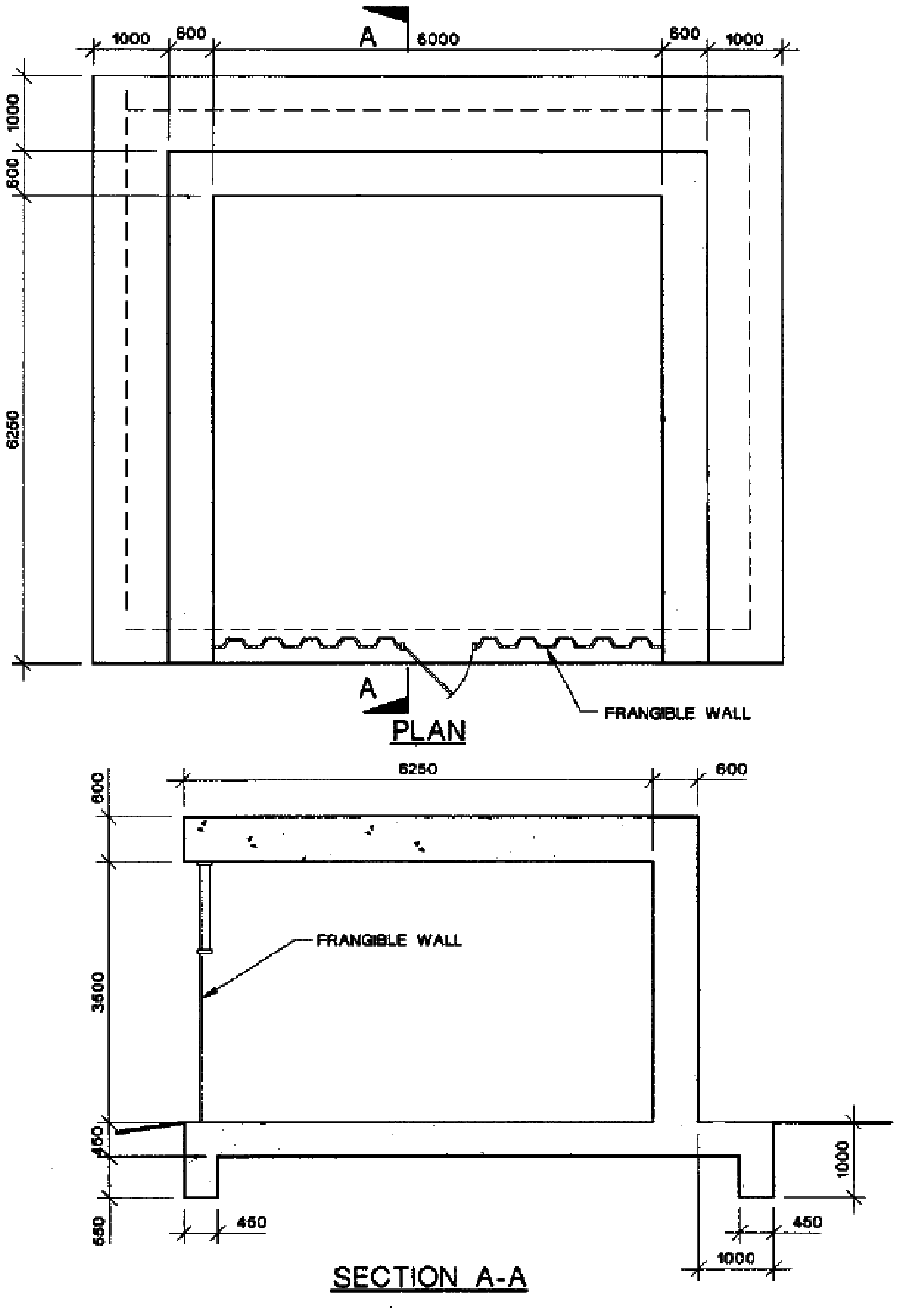


LONGDITUDINAL SECTION THRO' BUILDING

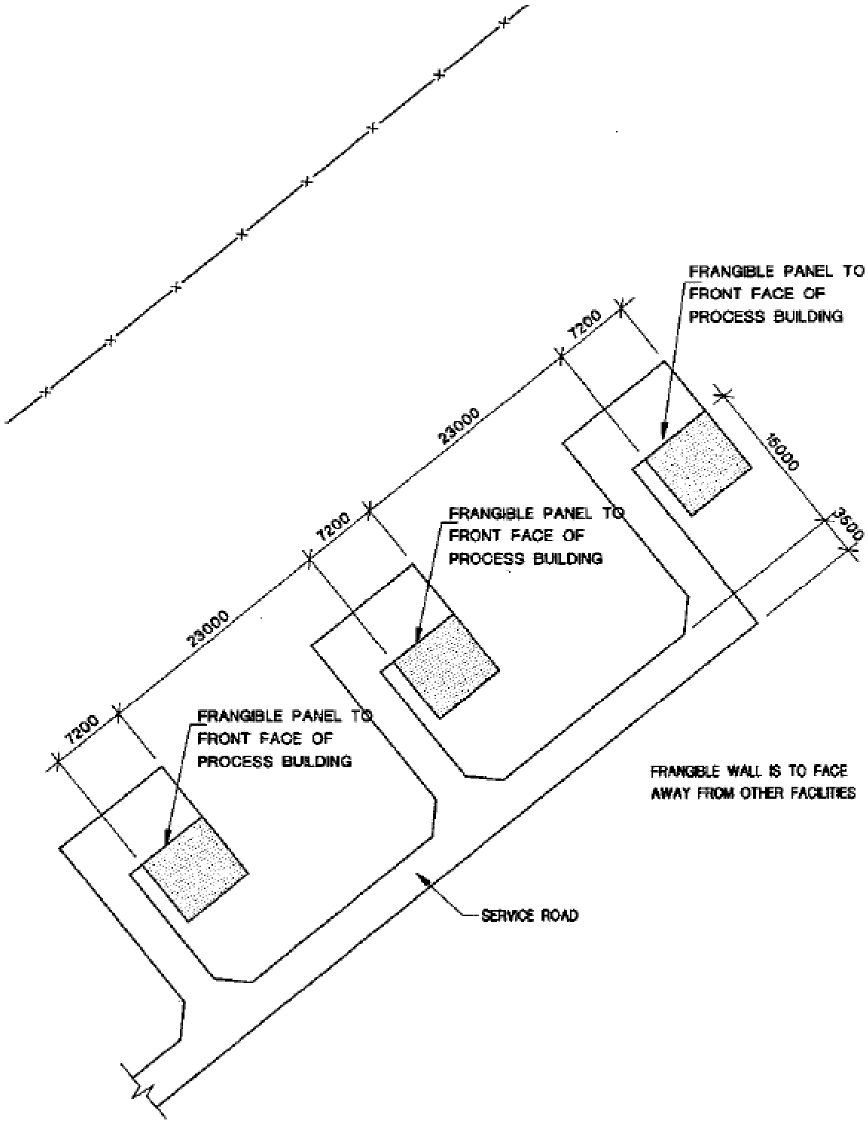
D.7 Typical ammunition process building




ELEVATION A-A
ELEVATION B-B
SECTION C-C
4400
3800
200
200
2410
2610

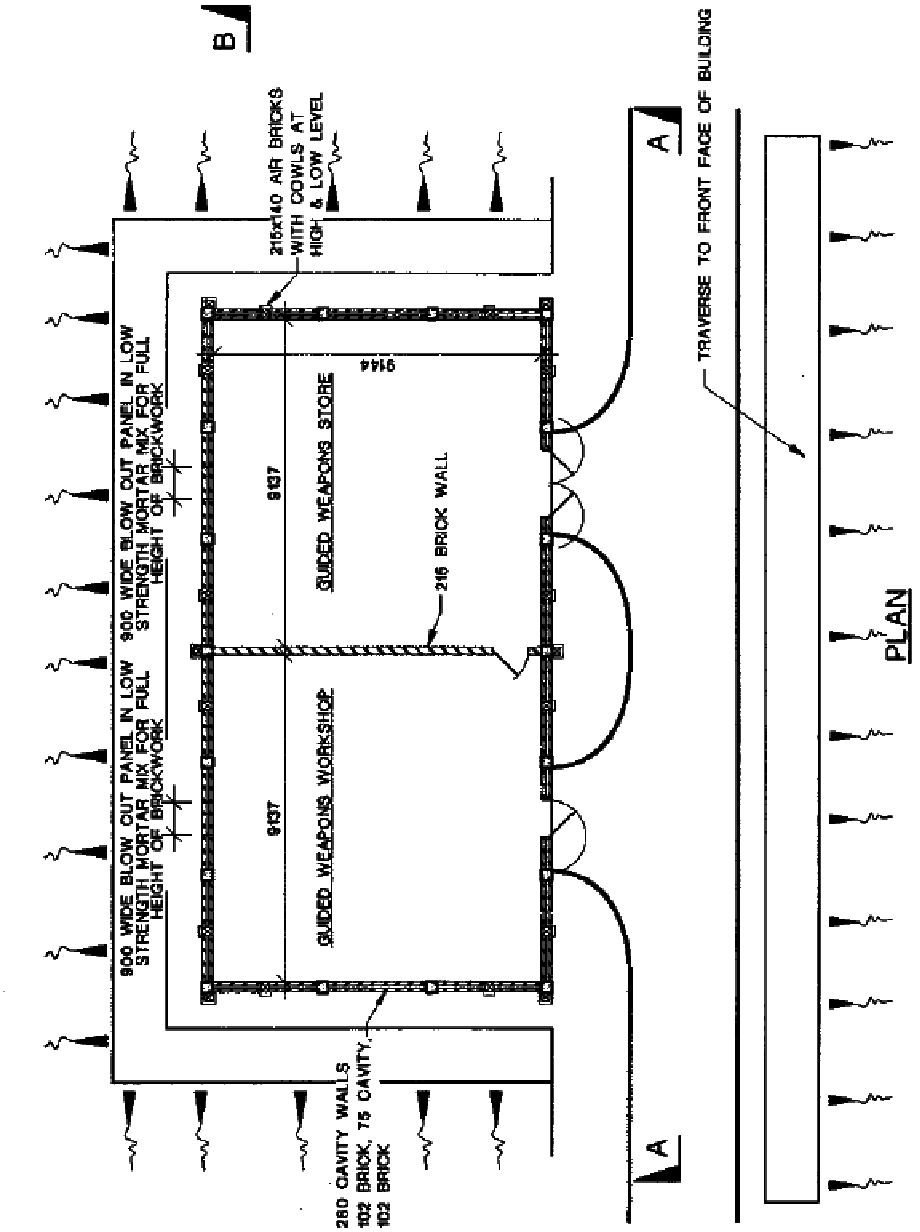

A
1000
600
6000
600
1000
1000
600
6250
A
FRANGIBLE WALL
PLAN
6250
600
600
FRANGIBLE WALL
3500
450
1000
550
450
450
1000
SECTION A-A

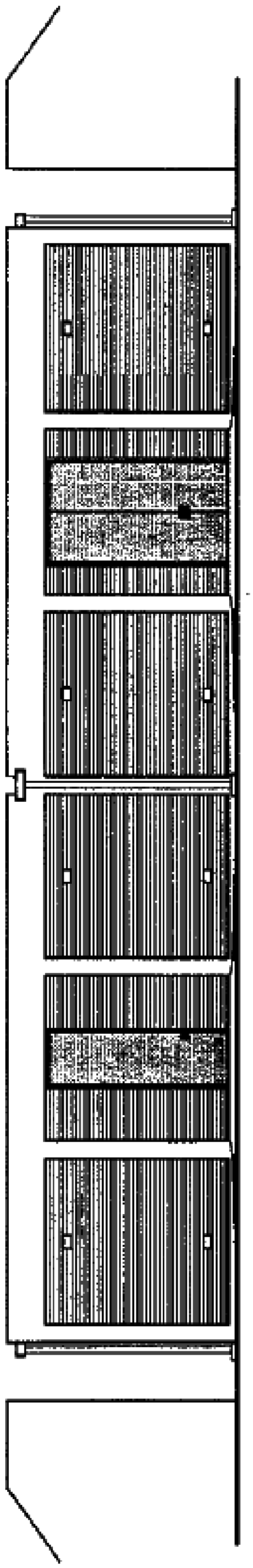
D.8 Ammunition test building



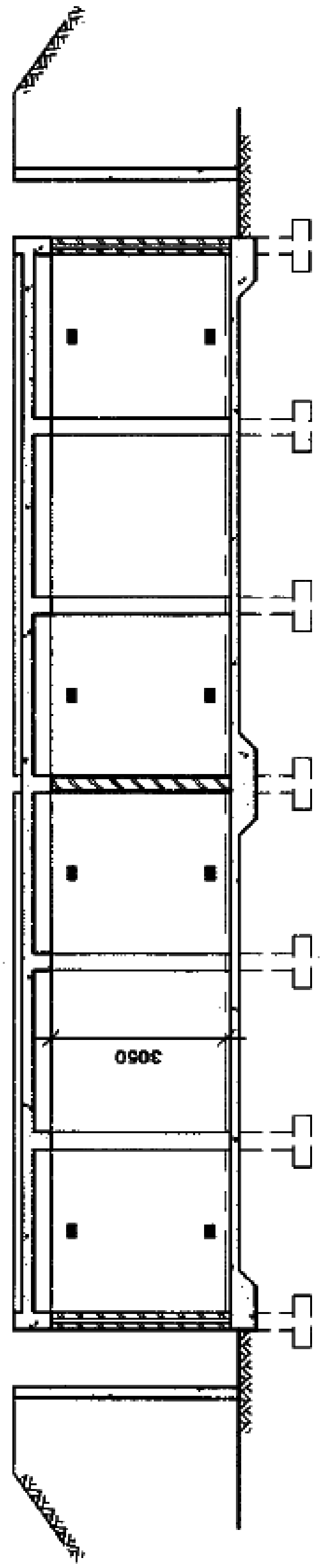
LAYOUT OF A TYPICAL FACILITY

D.9 Guided weapons store and workshop



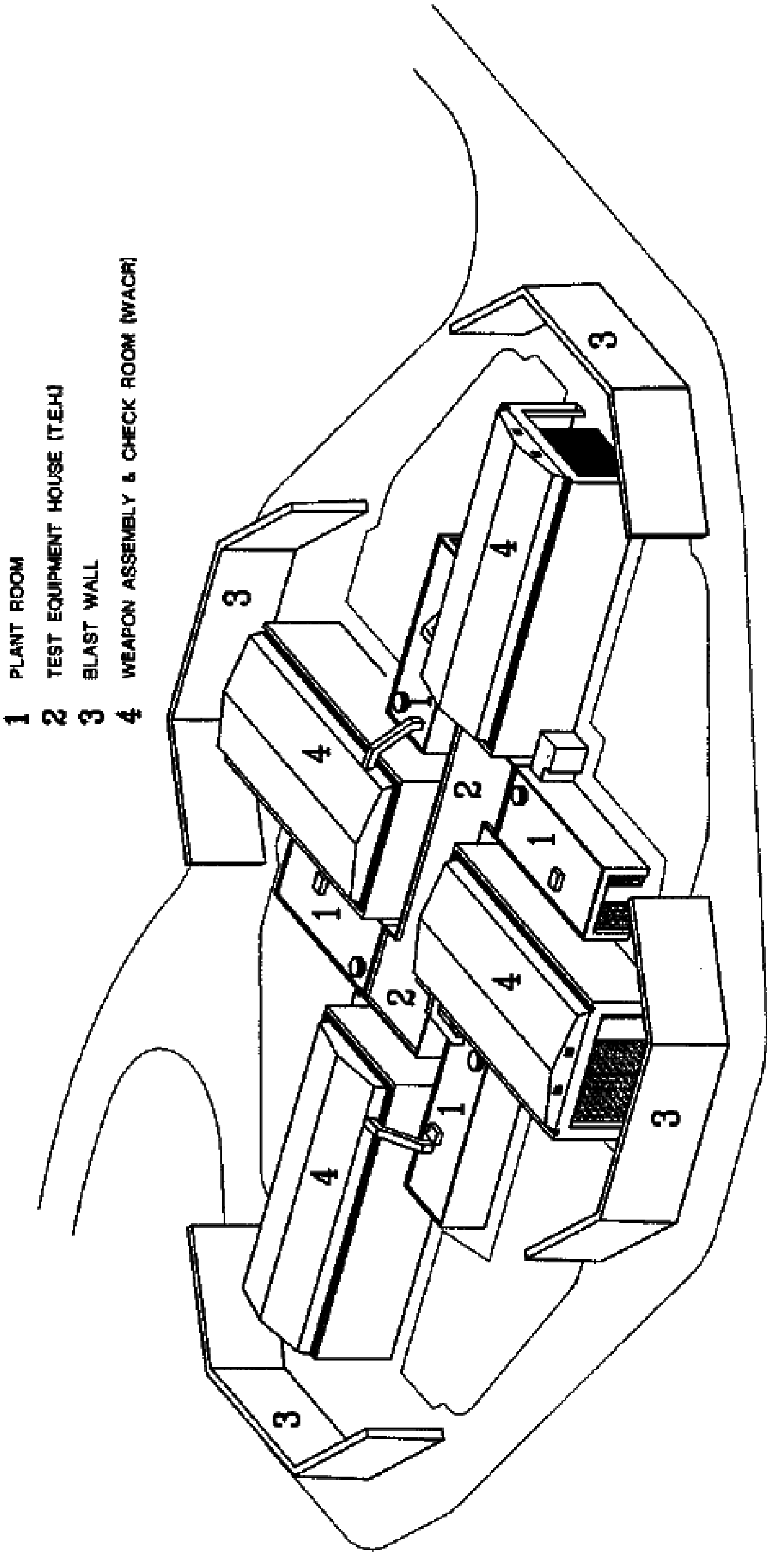


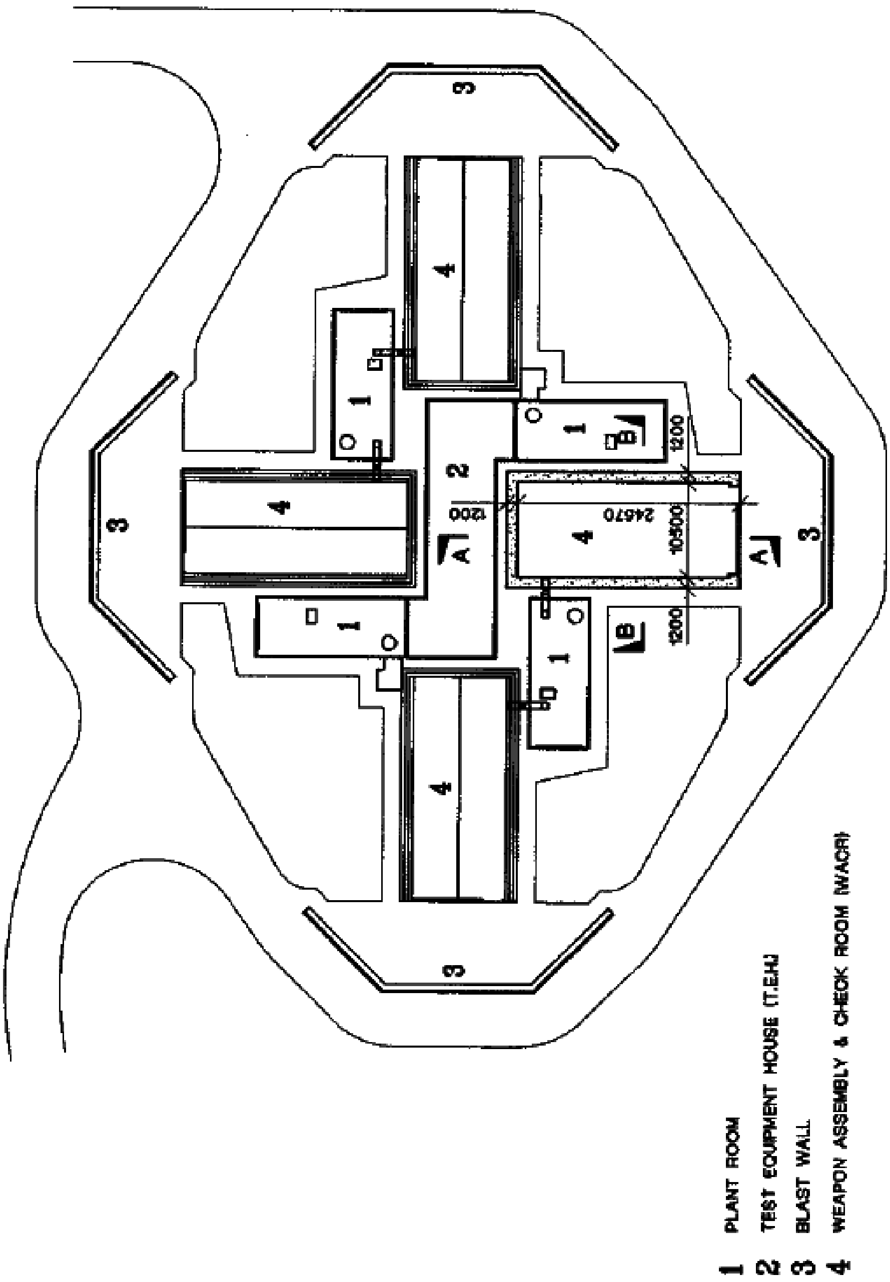
ELEVATION A-A



SECTION B-B

D.10 Integrated weapons complex




1 PLANT ROOM
2 TEST EQUIPMENT HOUSE (T.E.H.)
3 BLAST WALL
4 WEAPON ASSEMBLY & CHECK ROOM (WACR)
1200
24670
10500
1200
A
B

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date under the edition number and date of the .

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted onwww.un.org/disarmament/ammunition~~www.un.org/disarmament/un-saferguard/~~.

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 05.30

Third edition
March 2021

Barricades

UN SaferGuard
Securing ammunition, protecting lives

IATG 05.30:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition.

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module details how barricades[3] may be used to intercept low angle, high velocity fragments from an explosive event on one side of the barricade to prevent the prompt initiation of explosives on the other side. Such fragments are the predominant threat leading to such an occurrence. Barricades can also protect personnel from low angle fragments, debris, and provide some protection at an Exposed Site (ES) from blast and flame. Correct design, construction and siting are essential in order to make effective use of the Quantity Distances (QDs) calculated.[4]

This IATG module only refers to barricades used in the design and construction of permanent explosive storage facilities.

Natural ground features may be used for this purpose, but the most common forms are artificial earth mounds, reinforced concrete and masonry walls, or a combination of these types. A barricade may be completely destroyed in an explosion, but its design should be such that it will stop or sufficiently slow down low angle, high velocity fragments before it collapses or is dispersed. If personnel protection is being afforded by a barricade, then its design will need to ensure that it does not present an additional hazard.

To be effective, a barricade shall be constructed of properly specified materials to a minimum effective thickness.

[3] The term 'traverse' is also used by some nations to describe a barricade.

[4] See IATG 02.20 *Quantity and separation distances*.

Barricades

1 Scope

This IATG module introduces different types of barricades, explains the function they perform and recommends how they should be sited and constructed.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term ‘barricade’ refers to *a natural ground feature, artificial mound, or wall which is capable of intercepting high velocity low angle projections from a potential explosion site and preventing initiation of explosives stocks stored nearby.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Barricades

A barricade is a barrier whose role is to intercept the low angle, high velocity fragments from an explosion. In doing so, it will prevent the initiation of explosives stored behind the barricade. Natural ground features may be used for this purpose, but in the event of this not being possible, then some construction will be necessary.

The most common barricades are earth mounds, reinforced concrete (RC) and masonry walls, or a combination of these types. A barricade may be completely destroyed in an explosion, but its design should enable it to stop or sufficiently slow down high velocity fragments before it collapses or is dispersed.

To be effective, a barricade must be constructed of properly specified materials to a minimum effective thickness. This IATG module will provide construction details and diagrams, which the national technical authority should modify in line with its own national regulations, but it is suggested that the module provided here should be the minimum required.

It should be noted that although barricades will also protect personnel from low angle, high velocity missiles and fragments, and can provide some protection at an Exposed Site (ES) from blast and flame, its primary function is the prevention of initiation of explosives by low angle, high velocity fragments, which are the predominant threat leading to such an occurrence.

A barricade is not considered to stop high angle fragments and debris, which travel over the barricade and are generally the basis for minimum inhabited building distances. However, for smaller quantities of net explosive quantity (NEQ), a building and barricade concept can be designed to reduce inhabited building distances. A full-scale test shall be conducted to validate the design.

5 Functional types of barricade (LEVEL 2)

Barricades may be divided into four functional areas and are defined by the type of protection provided. However, it is not always possible to distinguish clearly between barricade types because their functions change and merge according to their position relative to an ES or a Potential Explosion Site (PES). Yet classification by function is still useful because it indicates a measure of the barricade strength required.

The four types of barricade are:

a) A receptor barricade. This protects the explosives within the ES. It surrounds from direct attack by low angle, high velocity fragments and debris from an explosion in an adjacent PES. This type should be used for ES where the explosive quantities are too large for an interceptor barricade at the PES to be effective at a specified quantity distance , which cannot be changed. A receptor barricade should be as close as possible to the ES it is protecting;

b) An interceptor barricade. An interceptor barricade is positioned close to the PES and is designed to protect explosives at the ES from direct attack by low angle, high velocity fragments. The barricade may be undermined by the crater created by the explosion and destroyed by the blast loading. However, it must remain in position long enough to intercept and retard fragments before it collapses;

c) A container barricade. This type is designed to contain the high velocity fragments projected from an explosion within. It protects personnel and ES in the vicinity from the effects of an internal explosion. Therefore, it must remain substantially intact after an explosion. In real terms, a container barricade is only practical for small quantities of explosives (<1000 kg) and is only of value around process buildings or relatively small ammunition stacks; and

d) A screening barricade. As its name suggests, this is a barricade designed to act as a screen between a PES and an ES. It is designed to intercept fragmentation at a higher angle than is normal for a barricade. It may be situated at the ES but is usually more effective if situated at the PES. If it is located at a PES it should be high enough to intercept all fragments projected at 40° or less and remain substantially intact after an explosion. The 40° line shall be measured from the centre of the top of the explosives stack if the roof is lightweight and from the centre of the roof if it is not of lightweight construction.[5] The effects of potential blast overpressure loading should also be considered in the design phase to ensure that the barricade would not collapse on the structure it was protecting.

6 Location of barricades (LEVEL 2)

The barricade should be as close as possible to either the PES or the ES, depending on its purpose. The barricade toe or face should be a minimum of 1m from the stack of explosives or wall of any building it protects. However, access for stock, mechanical handling equipment (MHE), building maintenance etc may require a greater distance. This may in turn require a larger barricade.

Where a barricade may be undermined by the potential crater, or the NEQ exceeds 75,000kg of Hazard Division (HD) 1.1, the barricade should be moved outwards to avoid undermining. As an alternative, the thickness of the barricade may be increased in proportion to the quantity of explosives so that at least 2/3 of its base is outside of the potential crater. The approximate crater diameter (D) in metres is given by the formula $D = Q^{1/3}$ where Q is the NEQ in kg.

For a more accurate prediction of crater size, particularly where undermining may occur, appropriate design methods shall be employed. These take into consideration the depth of burst, the soil or other material type in which the crater is formed including any concrete slab effects. Specialist ammunition technical advice should be sought.

7 Barricade materials (LEVEL 2)

An explosion may disperse the material used for a barricade, especially if it is vertically or near vertically faced. The resulting debris hazard may initiate explosives in adjacent buildings and present a hazard to personnel. In order to minimise these effects, materials to one of the specifications in Table 1 should be used in the construction. The materials are listed in order of preference.

The stability of the barricade slope should be checked on a case by case basis. The required factor of safety against rotational slip will depend on: 1) the function of the barricade, 2) the consequences of failure to safe use of the facility and 3) the degree of disruption caused while repairs are being carried out if failure occurs[6]. However, the factor of safety should be ≥1.2 in the long term.

In the case of a reinforced fill slope, information from the manufacturer shall be required to determine the number and type of reinforcements, embedded lengths and vertical spacing.[7] The early involvement of the manufacturers of these materials in the design process is essential. Where a vertical, or near vertical i.e. >70° face using a wrap-around detail or pre-cast concrete facing element is envisaged for the reinforced fill, the fill material shall be free-draining and shall comply with the requirements of the manufacturer of the reinforcement. Since such a configuration constitutes a 'wall', the factor of safety against sliding should not be less than 2.0 and that against rotational slip not less than 1.5.

[5] See IATG 05.20 *Types of buildings for explosive storage*.

[6] See IATG 02.10 *Introduction to risk management principles and processes.*

[7] See IATG 05.20 *Types of building for explosives storage.*

Measures should be taken to prevent the burrowing of rabbits, termites or other burrowing animals into a barricade. Advice and typical details of protection from burrowing animals may be obtained from specialist agencies.[8] This is important because if a barricade subsides, even by a small amount, it will reduce the amount of explosive that may be legally held at the PES.

If a barricade is unlikely to be dispersed by an explosion, then it need not be constructed of special materials. However, this severely limits storage flexibility and it would be better to construct the barricade of the material specifications listed in Table 1. Earth cover for earth covered buildings ECMs are also required to meet the requirements of the materials listed in Table 1.

<table>
<tr><th rowspan="3">Material Description
(In preference order)</th><th colspan="4">Grading Limits (1) (2)</th><th rowspan="3">Design Slope (4)
(Dependant on soil mechanics)</th></tr>
<tr><th colspan="2">Coarse Material</th><th colspan="2">Fine Material</th></tr>
<tr><th>Maximum Particle Size</th><th>Maximum Content
(% by Weight: 20 – 75mm)</th><th>Maximum Fines Content
(% by Weight: <63µm)</th><th>Maximum Clay Content
(% by Weight: <2µm)</th></tr>
<tr><td>Well Graded Sand</td><td>6.3mm</td><td>0%</td><td>15% (1)</td><td>5% (1)</td><td>1:1.5 to 2
(33^0 to 26^0)</td></tr>
<tr><td>Well Graded Gravelly or Clayey or Silty Sand (inorganic)</td><td>7.5mm</td><td>5% (1)</td><td>20% (1)</td><td>5% (1)</td><td rowspan="2">1:1.3 to 2.5
(37^0 to 21^0)</td></tr>
<tr><td>Inorganic Fill (3)</td><td colspan="4">Other inorganic material meeting the above grading requirements</td></tr>
</table>

Table 1: Construction materials for barricades

NOTE 1 Coarse and fine particles shall be uniformly distributed throughout the material to provide a homogenous fill.

NOTE 2 The material used should have a Uniformity Coefficient (D_{60} / D_{10}) of 6 or greater.

NOTE 3 Rubble from demolished buildings or any other similar material shall not be used in the construction of barricades due to the risk of enhanced projection hazard.

NOTE 4 Slope stability requirements are defined in this IATG module; design slopes tabulated are indicative only and will vary dependent upon:

a. The nature and strength of foundation soil and rock and depth to the water table;
b. The degree of compaction and surface preparation provided to the fill;
c. The fines content and erosion potential of the fill materials;
d. The compaction moisture content where the fill materials are not free draining;
e. The provision of drainage measures to control short/long-term pore water pressures; and
f. The fill being reinforced with geo-synthetics, wire mesh etc.

8 Earth barricades (LEVEL 1)

It is essential that barricades have the correct geometry. It mitigates against the risk of high velocity fragments or debris escaping above or around the ends of the barricade. Generous margins in barricade dimensions should be provided so that lines of sight are totally blocked.

8.1 Barricade height

To eliminate height line of sight problems, the dimensions for an earth barricade should be controlled by the 2-degree rule. This is illustrated at Annex C. This rule does not apply to separation distances less than PES $<5Q^{1/3}$. Where PES are separated by a distance of $>5Q,^{1/3}$ barricades should be assessed individually. An alternative to the 2-degree rule is to ensure that there is at least 0.6m of additional barricade height along the line of sight from one PES to another.

[8] Some experience suggests that the use of appropriate insecticides mixed in with the earth during barricade construction has a good effect.

A barricade may be constructed with a minimum width of 2.4m at a level equal to the maximum height of the stored explosives, plus an extra 600mm. A barricade may also be erected to the height of the eaves of the building, which the barricade protects. These requirements are illustrated at Annex D.

Should low stacks of explosives be stored in a PES and the 2-degree rule leads to barricades being lower than the eaves of the building, consideration shall be given to increasing the barricade height up to the building eaves. This will assist in limiting building debris throw. However, this may lead to unusually high barricades.

8.2 Barricade length

Ideally, a barricade should surround the PES it protects as this allows flexibility in further development. However, should this not be the case then it should extend, without any reduction in overall height, beyond the sides of the PES to eliminate any potential lines of sight to other PES and ES. This length shall be not less than 1 metre at each end of the barricade on all barricaded sides of the PES. Annex C provides a diagrammatic of this situation.

8.3 Slopes

Barricade shall be sloped such that they are stable. This slope will vary with the construction materials used but should normally be no steeper than 1:2 or 26° from the horizontal. The flatter the slope, the less erosion and hence less maintenance required.

9 Other materials compared to earth (LEVEL 1)

Should brick, concrete or steel be used to support the vertical face of a type 2 or a type 3 barricade (see Clause 10), their effectiveness in stopping high velocity fragments is increased when compared with a pure earth barricade. These effectiveness figures are at Table 2.

Material	Effectiveness compared to soil (nominal value of 1)
Brick	x 4
Concrete	x 6
Steel	x 24

Table 2: Effectiveness of materials compared to soil

This effectiveness means that barricade thickness may be reduced accordingly. However, the equivalent mass of an interceptor barricade should not be reduced below 2.4 m of earth at the top level of the stack or eaves of the PES to prevent dispersion of the barricade occurring.

9.1 Wall barricades (LEVEL 2)

Concrete or masonry walls of buildings may be used as barricades. However, they must be designed with this role in mind. Existing walls will probably not be suitable for the task. Where explosives or personnel are to be protected, the walls should be designed to resist collapse. For small NEQs such as those to be found in process buildings, Table 3 lists the thickness required for cantilever container barricades of 3m maximum height at 1m stand off from the explosives in order to prevent collapse. For larger NEQs, specialist advice should be obtained.

NEQ (kg)	RC Wall Thickness Buttressed at 3 m Centres, with 0.2% Tension Reinforcement. (mm)	Nominal Brick Wall Thickness (mm)
2.5	225	340
5	225	340
7	225	450
12	225	570
18	300	680
35	450	**Not permitted**
50	600	**Not permitted**
68	750	**Not permitted**

Table 3: Thickness required for cantilever container barricades.

9.2 Other barricade types (LEVEL 1)

There may be occasions, such as field storage of ammunition, when the use of improvised barricades will be required.

Full scale testing is often the basis for validating the effectiveness of use of other non-traditional barricade designs. New tests should be conducted for situations where the limitations or conditions associated with the initial approval for use of the barricade involved are exceeded or the impacts unknown.

9.2.1. Use of HD 1.4 ammunition as a barricade

Ammunition of HD 1.4 may be stacked so as to provide buffered storage protection between stacks of other HD. However, these stocks of HD 1.4 may be destroyed in the event of the explosion of an adjacent stack. This use of HD 1.4 should only be considered in an emergency.

9.2.2. Water barriers

Several propriety water barriers are available . They are effective but should only ever be considered as temporary due to long term survivability and maintenance issues. Water is an effective medium for slowing down high velocity fragments. Maintenance of the water tanks in extremes of temperature is also problematic.

9.2.3. Soil barriers

Several propriety soil-filled barriers are also available. The filling of these should meet the requirements of the materials listed in Table 1.

9.2.4. Unitization[9] (LEVEL 2)

Unitization is the partitioning of explosives in individual compartments using dividing walls or by using internal barricades. In some cases, this allows reduced QDs to be used. The subject of unitization is a complex one and specialist ammunition technical advice should be obtained before its application and subsequent reduction in QDs is authorised.[10] This concept is generally only applicable to small NEQ < 200 kg.

10 Design of barricades and their variable functions (LEVEL 2)

There are six constructional designs of barricades:

a) Type I. This is a double slope earth mound construction;

b) Type II. A single slope vertical face earth mound, or partial vertical face mound;

c) Type III. A steep double slope earth mound sometimes referred to as a 'Chilver' type;

d) Type IV. Often described as a bunker building or combined barricade. This type includes fully buried buildings not more than 600 mm below ground level; [11]

e) Type V. These are wall barricades constructed of brick, reinforced concrete and composite construction; and

f) Type VI. Natural features of a site such as mounds, hillocks and so forth. As a minimum, they are to be the same size as a type I.

It would be unwise to tightly define the use of each type of barricade because the functions and protective features often overlap. However, in general, Types I, II and III, comprising sloping barricades, are the most used for storage purposes. They are the most functional because they can function in all four protective roles (see paragraph 5). Type IV barricades make use of the PES structure to support the earth and Type V barricades are primarily used as receptor barricades or are designed as container barricades. Diagrams of these barricades are at Annex C.

11 Barricade protection against blast overpressure

General procedures to predict pressure mitigation versus general barricade design types and their location have to date not been developed. Yet based on direct-experimental work, the overpressure loading on a surface area shielded by a barricade is reduced by approximately 50 percent when the following conditions are met:

a) location. The barricade's stand-off is within two barricade heights of the protected area;

b) height. The top of the barricade is at least as high as the top of the protected area; and

c) length. The length of the barricade is at least two times the length of the protected area.

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[9] See IATG 02.20 *Quantity and separation distances.*

[10] As an example, one national requirement for the use of internal barricades is that they should be constructed using autoclaved aerated concrete blocks or an approved equivalent as barriers. The barrier thickness shall be a minimum of 300 mm. Autoclaved aerated concrete blocks are designed to be sacrificial and shall have a density of 550 - 750 kg/m^3 and a compressive strength of 4 - 5 N/mm^2. The blocks need not be mortared together thus enabling cells to be readily adjustable in size to suit storage requirements.

[11] If deeper than 0.6m the building may have to be considered as underground storage.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.10 *Introduction to risk management principles and processes*. UNODA;

d) IATG 02.20 *Quantity and separation distances.* UNODA; and

e) IATG 05.20 *Types of buildings for explosive storage.* UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[12] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[12] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[13]

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

b) *Handbook of Best Practices on Conventional Ammunition*, Chapter 2. Decision 6/08. OSCE. 2008;

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020;

d) Technical Paper 15, Revision 3, *Approved Protective Constructions*. US Department of Defense Explosive Safety Board (DDESB). May 2010. www.wbdg.org/building-types/ammunition-explosive-magazines; and

e) UFC-3-340-02, *Structures to Resist the Effects of Accidental Explosions*. US Department of Defense. 05 December 2008; Change 2, 01 September 2014. www.wbdg.org/building-types/ammunition-explosive-magazines

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[14] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

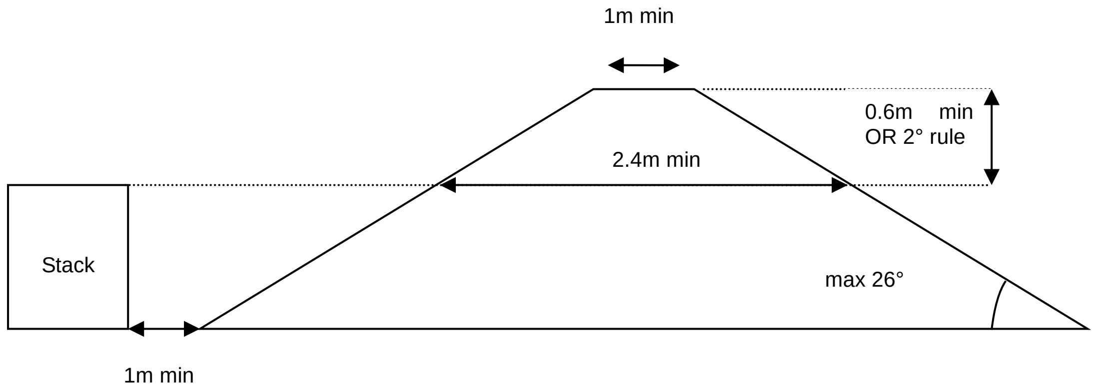
[13] Data from many of these publications has been used to develop this IATG.

[14] Where copyright permits.

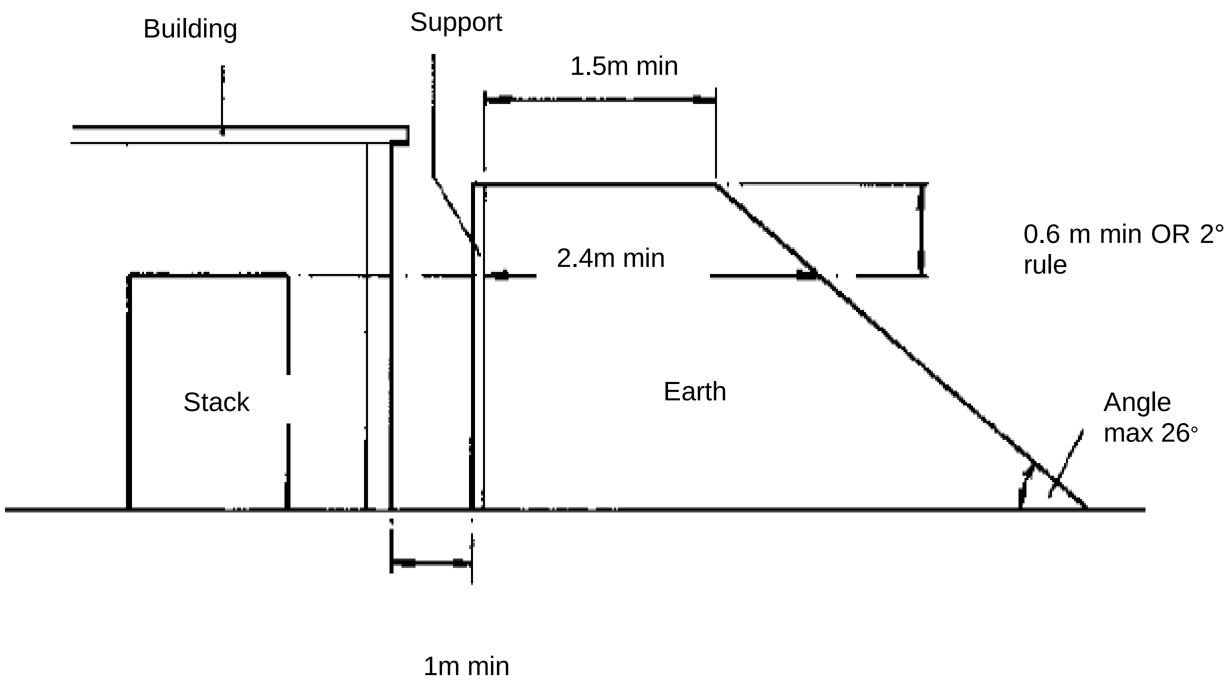
Annex C
(informative)
Types of barricades

This annex provides a definitive list of barricade types. It is intended to identify the various types of barricades and their design. All diagrams that follow in this IATG are courtesy of the UK Joint Service Publication 482, Volume 1, Chapter 7, *Barricades*.

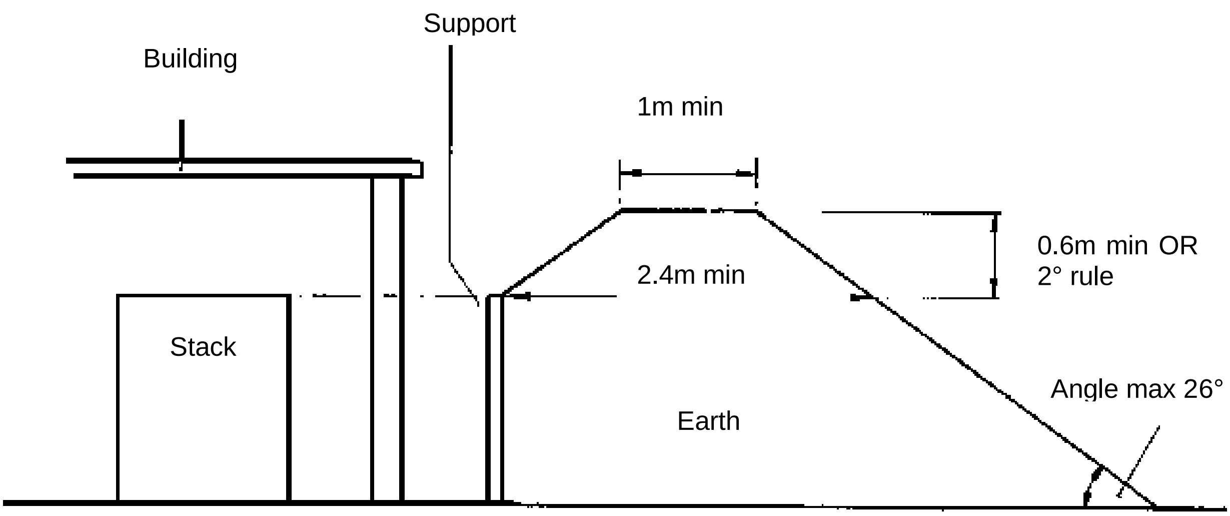
C.1 Type I – standard double slope



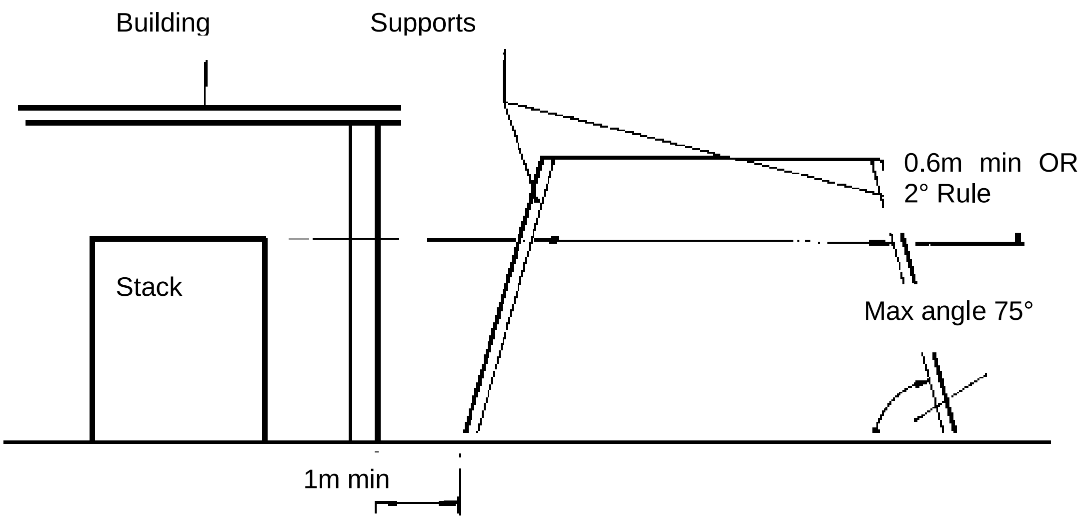
C.2 Type II – single slope vertical face type



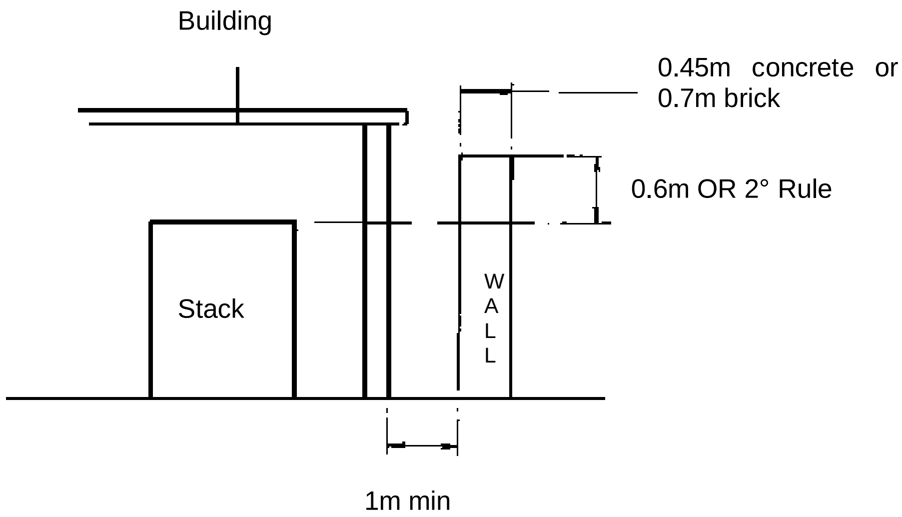
C.3 Type II – partly vertical partly sloped face type



C.4 Type III – steep double slope (Chilver) barricade



C.5. Type V – wall barricade



Annex D
(informative)
Height of barricades – determination

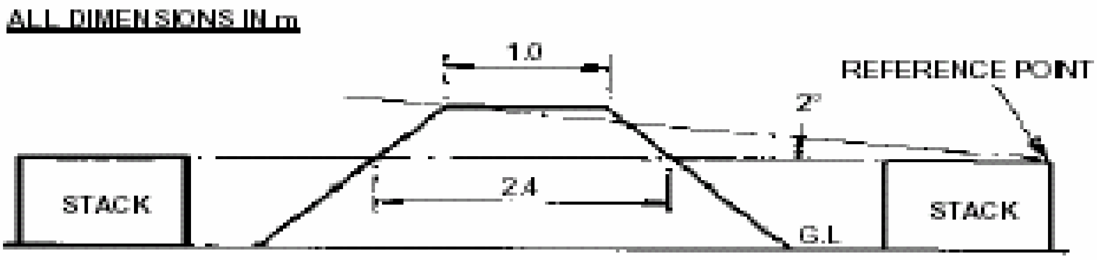


Fig 1 Determination of Traverse Height on Level Terrain

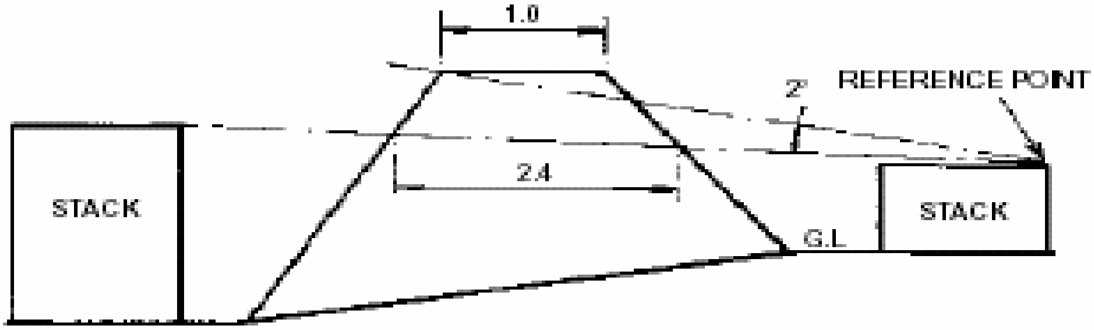


Fig 2 Determination of Traverse Height on Sloping Terrain

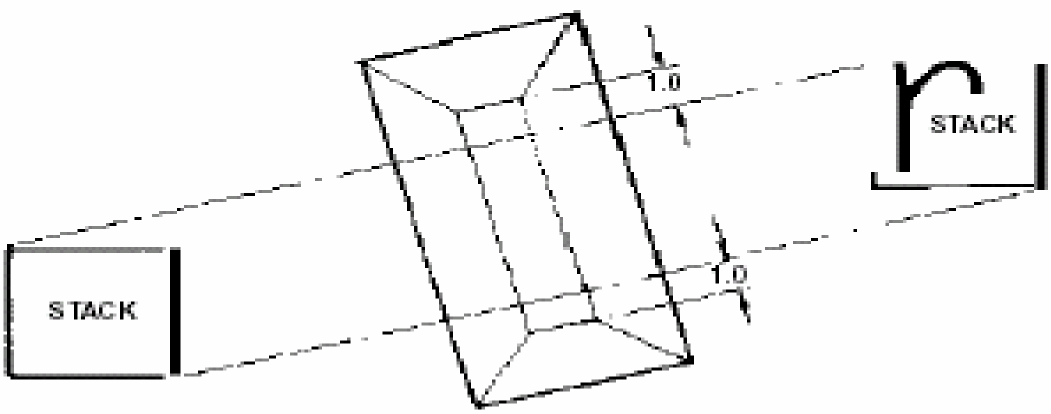


Fig 3 Determination of Traverse Length

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date under the edition number and date of the .

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted onwww.un.org/disarmament/ammunition~~www.un.org/disarmament/un-saferguard/~~.

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 05.40

Third edition
March 2021

Safety standards for electrical installations

Securing ammunition, protecting lives

IATG 05.40:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction (LEVEL 2)

This IATG module[3] describes the requirements and standards for electrical installations, lightning protection, electrostatic protection and electrical/electronic equipment in above ground and underground sites containing or likely to contain explosives. These sites include ammunition storage, processing and handling buildings as well as related facilities and airfields.

[3] Due to the complexity of this issue and the depth of information required this IATG has been primarily adapted from UK JSP 482 (replaced by DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020).

Safety standards for electrical installations

1 Scope

This IATG module describes the electrical safety standards that should be used in explosives facilities of various types. This module does not apply to non-explosives facilities even if they are in an explosives area. However, the electrical installation and any equipment used in these buildings should comply with national technical authority statutory requirements and specifications to ensure that they are not a risk to explosives facilities. These regulations should be read in conjunction with relevant national technical authority laws and regulations and with international standards.

This IATG module has been written using European standards, against which national standards can be compared to produce equivalent national guidelines. A list of the European Union regulations is provided for reference at Annex D.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'electrical category' refers *to the standard of electrical installations and equipment required in an explosive building. The electrical category is the same as the category allocated to the building or area.*

The term 'explosives facility' refers to *an area containing one or more potential explosion sites.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Electrical categories (LEVEL 2)

Areas within buildings or facilities should be divided into categories according to the type of explosives that are stored or handled and the processes to be undertaken. Electrical installations and equipment should be of the same category as the area in which they are installed or used. The category of an area or building shall be displayed at the entrance (see example sign at appendix 1 to annex E).

4.1 Mixed category areas (LEVEL 2)

As a result of the processes carried out, some facilities may have rooms, cells or areas that require different explosive categories. A physical barrier should be used to define the different categories. As a minimum, the barrier should be a door and possess sufficient measures to control the migration of dusts or vapours.

4.2 Sublimating explosives (LEVEL 3)

Special measures are necessary when explosives are liable to sublimation. Electrical equipment should not be installed in the building unless it is absolutely essential. In such circumstances, suitable standards shall be specified in conjunction with an explosives chemist who will need to advise on the properties of the explosive in the process.

4.3 Selection of electrical category (LEVEL 2)

Annex E provides an example of a selection algorithm, which may be employed in the selection of the most suitable electrical category. The algorithm should be matched to national legislation and regulations covering explosives atmospheres, degrees of protection against ingression and maximum surface temperatures.

4.4 Category A and associated electrical standards (LEVEL 3)

Category A areas are explosives buildings in which explosives gases and vapours may be present. There may also be a dust hazard and this is covered at Clause 4.8. Category A areas may be further sub-divided into three zones that codify the differing degrees of probability with which explosive concentrations of gases and vapours may arise in terms of both the frequency of occurrence and the probable duration of their existence. These zones are shown in Table 1:

Category A Zones	Definition
Category A Zone 0	An area in which an explosive gas/vapour atmosphere is continuously present or is present for long periods.
Category A Zone 1	An area in which a flammable atmosphere is likely to occur during normal operation.
Category A Zone 2	An area in which a flammable atmosphere is not likely to occur in normal operation but, if one does occur, it will exist for a short time only.

Table 1: Category A electrical zones

4.4.1. Buildings and installations near to Category A areas

Electrical installations and equipment located on the outside of the building or in an adjacent and separate room should be of Category A standard if the gas or vapour hazard extends outside the building. The zone allocated should address the risk of the type of flammable atmosphere occurring. A degree of protection giving additional weather proofing may be necessary.

4.5 Category B (LEVEL 2)

Category B areas exist where the processing and handling of explosives gives rise to an explosives dust atmosphere and/or hazard created by accumulation or settling. Category B areas may not encompass a whole room or building if the extent of any atmosphere created is limited to a local area, for example within a fume cupboard.

Exposed explosives that do not give rise to a flammable or explosive atmosphere or hazard created by dust accumulating or settling during normal use may be processed within Category C explosives buildings.

Only explosives items and explosives processes assessed as capable of generating a flammable or explosive atmosphere or hazard created by dust accumulating or settling during normal service need to be processed in Category B facilities. All explosives, even rubbery propellant, may generate dust. Explosives such as nitro-glycerine may give rise to vapour that can condense to liquid or crystalline explosive. Sublimation may occur during manufacturing processes.

During the decision-making process on the categorisation of an explosive device, it is important to address the packaging/enclosure of the device and its capacity for preventing the egress of dust during the full spectrum of its service environment. Accidental spillage of dust in a Category B environment shall be immediately and safely removed.

Category B zones are summarised in Table 2:

Category B Zones	Definition	Dust Tightness to EN 60528
Category B Zone 20	An area in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods, or frequently.	IP6X
Category B Zone 21	An area in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.	IP6X
Category B Zone 22	An area in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, it will persist for a short time only.	IP5X

Table 2: Category B electrical zones

4.5.1. Buildings and installations near to Category B areas

Machinery rooms associated with Category B buildings, but with no direct access to the explosives area and with no risk of dust and vapour migration, should not be classified as explosives areas. Electrical equipment installed in such areas should be to explosives Category D standard as specified at Annex G. Weather proofing may be required for outdoor installations.

4.6 Category C (LEVEL 2)

Category C is the standard for all explosives buildings in which explosives do not give rise to flammable vapour or explosive dust at normal storage temperature. Electrical equipment and installations should comply with the specifications at Annex F.

4.6.1. Buildings and installations near to Category C areas

Machinery rooms associated with Category C buildings, but with no direct access to the explosives area and with no risk of dust and vapour migration, should not be classified as explosives areas. Electrical equipment installed in such areas should be to explosives Category D standard as specified at Annex G. Weather proofing may be required for outdoor installations.

4.7 Category D (LEVEL 2)

This standard applies to buildings, rooms, etc. where small quantities of explosives, except Hazard Division (HD) 1.1, are stored as agreed with the head of establishment and/or national technical authority. The explosives shall not be exposed and shall not give rise to flammable vapour or explosives dust. The Category D standard also applies to some plant rooms but it is not intended to allow storage of explosives in these rooms. Electrical equipment standards are at Annex G.

4.8 Combined Category A and B areas (LEVEL 3)

Should it be necessary to classify areas as having both flammable vapour/gas and dust atmospheres, the areas concerned shall meet the requirements for both Category A and Category B facilities. National technical authority standards (or if necessary international standards) can provide for gas and dust risks to be accommodated in a single equipment design and electrical equipment providing both gas and dust protection is widely available.

4.9 Surface temperature of equipment (LEVEL 3)

National technical authorities may develop their own temperature classifications, but Table 3 below shows commonly used standard maximum surface temperature levels.

Class	Maximum Surface Temperature Level (^{0}C)
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Table 3: Surface temperature classification levels

The design surface temperature limitations for electrical equipment under normal conditions should not exceed the following:

a) for Category A facilities: the appropriate T Class, or 135°C whichever is the lower;

b) for Category B facilities: 135°C;

c) for Category C facilities: 135°C, with the exception of water or oil filled radiators which should be 85°C; and

d) for Category D facilities: there is no specified number but may follow the limits for Category C.

4.10 Electrical protection specific to Category A zones (LEVEL 3)

The national technical authority regulations concerning electrical protection in Category A should meet and apply the protective requirements as set out below at Table 4. The appropriate European (EN) standards are shown to enable comparison with national standards.

Type of Protection	Symbol	Description	Use in Category A Zones	EN Standard
Intrinsic Safety	Ex ia	Limits the energy of sparks and limits the temperature but includes specified fault conditions.	0,1 and 2	EN 60079-25:2004 EN 50020:2002
Intrinsic Safety	Ex ib	Limits both the energy of sparks and the temperature.	1 and 2	EN 60079-25:2004 EN 50020:2002

Type of Protection	Symbol	Description	Use in Category A Zones	EN Standard
Increased Safety	Ex e	No arcs, sparks or hot surfaces.	1 and 2	EN 60079-7:2003 EN 50019:2000
Oil Immersion	Ex o	Keeps flammable gas away from any hot surfaces and ignition-capable equipment.	1 and 2	EN 50015:1998
Encapsulation	Ex m	Keeps flammable gas away from any hot surfaces and ignition-capable equipment.	1 and 2	EN 60079-18:2004 EN 50028
Powder (Quartz / Sand Filled)	Ex q	Contains an explosion and quenches flames.	1 and 2	EN 50017:1998
Pressurised Apparatus	Ex p	Keeps flammable gas away from any hot surfaces and ignition-capable equipment.	1 and 2	EN 60079-2:2004 EN 50016:2002
Flameproof	Ex d	Contains an explosion and quenches flames.	1 and 2	EN 50018:2000 EN 6079-1:2004
'n' Type Protection Non Sparking Enclosed Break Energy Limitation Simplified Pressurisation Restricted Breathing	Ex n Ex nA Ex nW Ex nL Ex nP Ex nR	A type of protection applied to electrical apparatus such that, in normal operation, it is not capable of igniting a surrounding explosive atmosphere and a fault capable of causing ignition is not likely to occur.	2	EN 60079-15:2003 EN 50021:1999

Table 4: Category A electrical requirements

4.11 Electro-magnetic compatibility (EMC) (LEVEL 2)

Electromagnetic emissions from electrical equipment used in explosives buildings should be controlled to ensure the protection of: 1) any electrically initiated devices (EID), including electro-explosive devices (EED) in ammunition; 2) electronic equipment and radio receivers associated with weapons; and/or 3) control systems in the explosives buildings or in the near vicinity of these buildings.

Ammunition should have its electronic circuitry assessed against a national technical authority specified radio frequency (RF) environment. Such assessments are required, as part of the introduction into service process, for the ammunition in all modes of packaging, operation and testing. When packed in its approved container, stores are normally considered to be protected against the Electro-magnetic (EM) environment; but when unpacked, under test or during processing operations, their EM vulnerability susceptibility may be considerably increased.

To prevent radiation hazard (RADHAZ) problems, deliberate RF transmitters should in general be prohibited in explosive storage areas (ESA) and buildings. This includes low power transmitters such as those found in wireless LAN and Wi-Fi systems and personal radio transmitters. However, it is recognised that some of these may be required in ESA and buildings and they may therefore be allowed on a case by case basis.[4]

4.11.1. Compatibility levels in storage buildings (LEVEL 2)

EMC performance levels of electrical equipment in explosive storage buildings should meet national technical authority requirements. As a guideline, EU norms (EN) are shown below at the level necessary to ensure as low as reasonably practicable (ALARP) protection:

a) in storage buildings, installed and portable equipment should meet the specifications contained in EN61000-6-1 and EN61000-6-3; and

[4] See IATG 05.60 *Hazards of electromagnetic radiation*.

b) mechanical handling equipment (MHE) should meet the EMC requirements of EN12895.

4.11.2. EMC in process buildings – ammunition not connected to electrical equipment

EMC performance levels of electrical equipment in explosive processing buildings should meet national technical authority requirements. As above, the following EN standards are included to provide a guideline:

c) equipment permanently installed in process buildings but not electrically connected to ammunition items should meet the levels specified in EN 61000-6-1 and EN61000-6-3;

d) MHE should meet the EMC requirements of EN 12895; and

e) portable equipment should meet the EMC requirements of EN 61000-6-1 and EN 61000-6-3.

4.11.3. EMC in process buildings – ammunition connected to electrical equipment

Fixed or portable electrical equipment directly connected to a weapon[5] under test should be EMC tested by the manufacturer and the susceptibility to radiated and conducted emission levels provided with the weapon. The relevant tests and limits to be used shall be those applicable to the weapon being tested and relevant to the approved test layout.

For power supply lines that interface only with the facility domestic supplies, the tests and limits applied may be taken from EN61000-6-1 and EN61000-6-3 but with the addition of transient tests. It is suggested that the radiated susceptibility test for all equipment directly connected to weapon systems in explosive buildings shall, as a minimum, use a field strength of 20V/m from 1MHz to 1GHz.

5 Electrical equipment design, construction and use restrictions

The provision and maintenance of electrical installations and equipment to the standards outlined in this module is integral to the safety requirement for explosives buildings. Adherence to national technical authority standards is essential. Should these require amplification then international standards may be applied. The following points should be noted as being of particular importance:

a) suitable overload, short circuit and earth fault protection shall be provided to ensure the clearance of any fault condition;

b) the containment of overheating or sparking within equipment enclosures during normal use. This is in addition to any special provisions required by Category A, B, C or D electrical standards;

c) the use of certain materials such as light alloys in the construction of equipment intended for use in Category A and B buildings is prohibited. Specialist advice should be obtained before proceeding with the installation or alteration of electrical equipment in such buildings;

d) no electrical equipment should be installed, taken into or used in buildings containing explosives unless the national technical authority specifically permits it. If such equipment is not vital to the operation of the facility it should be sited elsewhere;

e) the protection level of any electrical equipment installed shall be that of the electrical category of the area in the building in which it will be used;

f) explosives should not be stored within 0.5m of any electrical equipment; and

g) areas from which explosives are specifically excluded shall be clearly demarcated.

[5] For example, a guided missile, which is both a weapon and item of ammunition.

5.1 Index of protection (IP) (LEVEL 3)

An index of protection (IP) requirement appropriate to the electrical hazard identified from Annex E should be identified. National technical authorities may have their own IP regulations or may apply the IP system shown at Table 5.

First Digit	Degree of protection	Second Digit	Degree of Protection
0	No protection of persons against contact with live or moving parts inside the enclosure. No protection of equipment against ingress of solid foreign bodies.	0	No protection.
1	Protection against accidental or inadvertent contact with live or moving parts inside the enclosure by a large surface of the human body e.g. hand, but no protection against deliberate access to such parts. Protection against solid objects greater than 50mm.	1	Protection against drops of condensed water. Drops of condensed water falling on the enclosure should have no harmful effect.
2	Protection against contact with live or moving parts inside the enclosure by fingers. Protection against solid objects greater than 12mm.	2	Protection against drops of liquid. Drops of falling liquid should have no harmful effect when the enclosure is tilted at any angle up to 15° from the vertical.
3	Protection against contact with live or moving parts inside the enclosure by tools, wires or such objects of a thickness greater than 2.5mm. Protection against ingress of small solid bodies.	3	Protection against rain. Water falling in rain at an angle up to 60° to the vertical should have no harmful effect.
4	Protection against contact with live or moving parts inside the enclosure by tools, wires or such objects of a thickness greater than 1mm. Protection against the ingress of small solid foreign bodies.	4	Protection against splashing. Liquid splashed from any direction should have no harmful effect.
5	Complete protection against contact with live or moving parts inside the enclosure. Protection against harmful deposits of dust. The ingress of dust is not totally prevented, but dust cannot enter in an amount sufficient to interfere with satisfactory operation of the equipment enclosed.	5	Protection against water jets. Water projected by a nozzle from the direction under stated conditions should have no harmful effect.
6	Complete protection against contact with live or moving parts inside the enclosure. Protection against ingress of dust.	6	Protection against conditions on ships decks (decks watertight equipment). Water from heavy seas should not enter the enclosure under prescribed conditions.
		7	Protection against immersion in water. It must not be possible for water to enter the enclosure under stated conditions of pressure and time.
		8	Protection against indefinite immersion in water under specified pressure. It must not be possible for water to enter the enclosure.

Table 5: Electrical hazard Index of protection (IP) levels

When selecting equipment, care should be given to the requirement for environmental protection against the weather, the ingress of solid or liquid particles, and the protection of persons against contact with live or moving parts inside the enclosure.

Any electrical supply that will exceed the energy limits of electro-explosive device (EED) test equipment should be contained by a compliant enclosure with a minimum of IP44 or national equivalent protection.

5.2 Fixed and portable electrical equipment (LEVEL 2)

The precise definition of fixed and portable electrical equipment should be an integral part of the appropriate regulations of the national technical authority. However, useful, and widely accepted, definitions are provided below:

a) fixed electrical equipment is that equipment supplied by one or more permanently wired outlets. This means that electricity is supplied without the use of plugs and sockets; and

b) portable electrical equipment is that equipment supplied from one or more plug or socket outlets. Additionally, all battery-operated equipment is defined as portable.

5.3 Fixed electrical equipment

5.3.1. Air conditioning, heating, and humidity control equipment (LEVEL 2)

Heating and air conditioning equipment should be permanently installed; portable equipment is not permitted in explosives buildings. All heating equipment shall comply with the electrical category of the area it is installed in and meet the maximum temperature requirements specified at Clause 4.9.

The heater should be fitted with a guard or positioned so as to prevent physical contact with the heater. The positioning of the heater and/or the guard fitting should not allow explosives to be laid on the heater by having an angled top surface. The following should also apply to heating equipment:

a) a thermal cut-out, which is not self-resetting with temperature drop, should be fitted to the hottest part of each heater to ensure compliance with the maximum surface temperature limits;

b) water and oil filled-electrically-heated radiators should have a high temperature cut-out set to T6 i.e. 85°C; and

c) heating equipment used for heating explosives should be fitted with an additional thermostatic regulator that will override all other controls and limit the temperature to a safe level, normally not exceeding 100°C. The setting device should be tamperproof, and its operation should be frequently tested. This heating equipment should be fitted with an indicator light to show when the heater is energised.

Electrically heated air re-circulating systems shall not be fitted in Category A or B facilities or in any heating appliances containing exposed explosives e.g. conditioning chambers.

Electrically heated floors and ceilings are not permitted in any explosives building.

5.3.2. Light fittings (LEVEL 2)

Light fittings and individual lighting units (also known as luminaires) shall be of the same standards as the category of the facility in which they are fitted. Lamps of the correct power rating as shown on the installation drawings should be used. Lighting installations should be designed to provide the levels, and quality, of illumination as laid down by the national technical authority.

Any keys held for access to light fittings shall be held in the office of the person responsible for maintenance of the installation and issued only to authorised personnel. Before opening any fitting, the circuit serving it shall be isolated from the supply and shall remain so until all work has been completed.

Emergency lighting fitted with internal power sources should not normally be permitted in explosives buildings as battery condition cannot easily be determined by a visual examination of the fitting from ground level. Also, battery condition will decrease with time and chemical breakdown within the battery may result in corrosion, a short circuit, overheating or fire. However, in Category C areas only, emergency lighting with an internal power source may be installed provided that:

a) the total assembly shall be constructed and installed to Category C levels;

b) maintenance procedures should be implemented that ensure any deterioration of the emergency lighting unit is detected in its early stages and the risks controlled as far as is reasonably practicable;

c) it should be possible to safely isolate the emergency lighting from both the alternating current (AC) and direct current (DC) supplies before the exterior case is opened or it is worked on within an explosives building; and

d) the emergency lighting unit should be removed from the explosives building for repair, major maintenance, re-lamping, and cyclic testing of the battery pack. The enclosure standard of the equipment should not be compromised whilst it remains within the explosives building.

If an uninterruptible power supply (UPS) is specified to power emergency lighting units for Category A and B buildings, it shall be sited in an external plant room.

Emergency lighting units with internal power sources may be fitted in Category D areas.

5.3.3. CCTV, communications equipment and alarm systems (LEVEL 2)

All equipment shall comply with the enclosure standard required by the facility in which it is to be installed and is also to meet both the general and EMC requirements described in this module.

In addition, communications and alarm systems wiring should be separated from power wiring.

5.3.4. Heat sealing equipment (LEVEL 2)

It may be necessary to install heat sealing machines in process buildings to assist in the provision of environmental protection to ammunition items. The equipment should comply with the enclosure standard required by the facility in which it is installed, and also meet both the general and EMC requirements of this module. Inductive heat-sealing machines should not be used in any category of explosives facility.

Heat sealing equipment with external surface temperatures exceeding the maximum temperature limitations for the facility (Category B, 135°C and Category C, 135°C) may not be installed or used unless approved by the national technical authority.

Heat sealing machines should not be used in a Category A facility.

5.4 Portable electrical equipment

5.4.1. Items which emit radio frequency (RF) radiation (LEVEL 2)

Currently, electrical and electronic devices are being introduced that employ RF transmissions in the normal usage e.g. laptop computers, data loggers, communication and location devices for security staff and mobile phones. These need to be strictly controlled and should normally be prohibited inside explosives buildings. Use of such systems outside buildings but in the ESA should only be permitted if the guidelines in IATG 05.60 *Hazards of electromagnetic radiation* are complied with. In addition, the following restrictions should apply:

a) equipment shall conform to the electrical safety requirements of Category A, B or C area as relevant to the facility concerned;

b) access to batteries and charging connections shall require the use of special tools not available to the user;

c) any external aerials on portable equipment shall be insulated; and

d) equipment carried by personnel shall be securely attached to the user.

5.4.2. Mains operated portable equipment (LEVEL 2)

In general, the use of mains operated portable equipment should be avoided in Category A and B areas. If the use of such equipment is necessary, it should meet the requirements of this module and national technical authority standards for use of such equipment in hazardous areas. Authorising the use of portable equipment is the responsibility of the head of the establishment. He or she should carry out a risk assessment and provide the users of the equipment with the relevant safety precautions considered necessary.

Mains operated portable equipment used in Category C and D buildings should also meet the requirements of this module and national technical authority standards for use of such equipment in hazardous areas.

Any flexible cable or cord serving portable equipment should comply with national technical authority legislation for its use in a hazardous area. It should be sheathed with rubber, PVC[6] or PCP[7], tinned copper braided and then sheathed overall with PVC or PCP. A separate core should be provided for the protective earth conductor. The screening should be electrically bonded to the earth conductor unless the equipment is double insulated.

Specialist electrical engineering should be sought if the head of the establishment is considering the installation of this type of equipment, particularly if portable mains equipment is to be permanently switched on and/or left unattended.

5.4.3. Equipment containing batteries (LEVEL 2)

All equipment should comply with the standards laid out in this module and with national technical authority legislation. In addition, the following principles should be implemented:

a) only dry batteries shall be used and shall be of the type recommended by the equipment manufacturer;

b) batteries shall not be changed or charged in explosives facilities;

c) no battery powered equipment shall be left unattended or energised inside an explosives building unless written authorisation is given by the head of the establishment;

d) battery enclosures shall be sealed to the explosives category standards required; and

e) battery enclosures shall be held in place using tamperproof fasteners.

Specialist electrical engineering should be sought if the head of the establishment is considering the installation of this type of equipment, particularly if portable mains equipment is to be permanently switched on and/or left unattended.

5.4.4. Environmental monitoring equipment (LEVEL 3)

Electronic environmental monitoring equipment to be used should meet the requirements of this module and the national technical authority. It shall be compliant with the category of explosives area or building it is to be used in. Maintenance and data download should be carried out in an explosives process facility.

5.4.5. Equipment for testing electro-explosive devices (EED) (LEVEL 3)

This equipment should not be used unless it is approved in writing by the head of the establishment. The head of the establishment should seek specialist ammunition technical advice before authorising the use of such equipment.

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[6] Poly Vinyl Chloride.

[7] Polychloroprence.

5.4.6. Personal medical equipment

These do not need to comply with the electrical standards described within this module but their use in explosives buildings should be approved in writing by the head of the establishment. They shall be firmly attached to the wearer and should be properly maintained.

5.5 Computers, computerised equipment, and data logging equipment

These may be used within explosives areas provided they meet the requirements of the explosives building category. Category A and B area compliance requirements will require specialist products with appropriate certification, including EMC testing. Specialist containers may provide a compliant solution to “overwrap” equipment that fails to meet some aspects of compliance. In addition, they should meet the requirements as laid out in this module and of the national technical authority. They shall not be used in any explosives facility without the authority of the head of establishment.

5.5.1. Cathode ray tube (CRT) displays (LEVEL 2)

CRT displays shall not be permitted in explosives buildings because of the hazards associated with high voltages and static electricity.

5.5.2. Printers, display screen and other peripherals (LEVEL 2)

These may be used within explosives areas provided they meet the requirements of the explosives building category.

5.5.3. Asset tracking devices (LEVEL 3)

These shall not be taken into an explosives area unless specifically approved by the head of establishment who should seek specialist ammunition technical advice. Full compliance of the equipment for the building electrical category shall be required. Asset tracking system components will only be compliant with explosives area standards if those standards are specified prior to system design.

5.6 Vehicles and MHE (LEVEL 2)

Electrical systems on handling equipment permanently installed in explosives buildings shall comply with the specifications appropriate to the building in which they are installed. Safety requirements for electrical systems on vehicles and mobile mechanical handling equipment operated in explosives areas shall also meet these requirements.[8]

6 Commissioning, testing and inspection of electrical equipment

6.1 Safety precautions (LEVEL 1)

It shall be the responsibility of the head of the establishment to ensure that a safe system of work is in place and that any nominated representatives are qualified and possess written authority to carry out their tasks.[9] The protection and control of personnel working in explosives areas shall be in accordance with IATG 06.60 *Works services (construction and repair)* and be agreed in conjunction with the head of the establishment or a nominated representative. The number of operatives on site and the period of their exposure may be limited.

[8] See IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*.

[9] See IATG 02.10 *Introduction to risk management principles and processes*.

No testing or inspections shall be made on an installation in an explosives building without prior approval and written permission from the head of the establishment or his or her nominated representative. Additionally, a nominated person shall first check the facility to ensure that it is safe for testing to proceed.

Unless approved by the national technical authority, testing shall not be permitted unless the facility is certified free from explosives (CFFE). This will be dependent on the category of the facility being tested and the type of electrical test to be carried out. If, for any reason, it is necessary to test when explosive stores are present in the building, special permission shall be obtained from the head of the establishment.

It is of note that this may be an ideal time to carry out other inspections and testing when a building is free from explosives.

As a minimum, the following shall be necessary before any work commences. The list is indicative only and is not exhaustive:

a) ventilation of inspection spaces shall have taken place;

b) gas free certificates will be issued as appropriate;

c) personal protective equipment will be appropriate to the risk and be as per the risk assessment and shall be in date;

d) safety harnesses and fall arrest devices will be appropriate to the risk and be as per the risk assessment and shall be in date;

e) minimum occupation rules will be in force with normally a minimum of 2 people, (maximum occupation will be in accordance with the published person limits for each task);

f) the workplace will be obstruction free and will afford safe access and egress; and

g) all personnel will have been made aware of their escape routes and other health and fire safety requirements.[10]

Under no circumstances shall stacks of explosives or ammunition be used a work platform or to gain access.

6.1.1. Electrical safety (LEVEL 2)

The earth protective conductor shall be visually inspected before any electrical tests are carried out. All joints and conductive paths connected to the protective conductor shall be verified for their continuity in accordance with national technical authority standards. Confirmation of the protective earth conductor shall then be tested using heavy current earth loop tests in accordance with the requirements of the national technical authority.

All instruments used shall be certified to be intrinsically safe if they are to be used for testing installations in explosives buildings if explosives are present. Other test instruments may be used with the written permission of the head of the establishment.

The head of the establishment shall ensure that the following safety precautions are taken:

a) the distance between explosives and electrical conductors and equipment shall be kept to a maximum during the testing and never less than 0.5m, including where wiring is run overhead;

b) testing points for connecting instruments shall be well removed from explosives. No unsealed or exposed explosives shall be permitted in the area under test;

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[10] See IATG 06.60 *Works services (construction and repair)*.

c) the installation shall be under continuous observation during testing and fire prevention measures approved by the head of the establishment or his or her representative shall be in force;

d) when all testing is complete, shorting resistors shall be connected to the network under test to dissipate any residual charge that may have built up. Shorting resistors shall be connected for a period of 30 seconds before disconnecting the test equipment; and

e) test equipment shall be removed from the explosives building upon completion of task or at the end of the working day.

6.2 Inspection and testing

6.2.1. Qualified personnel (LEVEL 2)

Inspection and testing in explosives facilities shall only be carried out by competent personnel. They shall have adequate knowledge of the relevant parts of the establishment's safety rules and procedures. In addition, they should have special competency in the inspection and testing of electrical equipment within explosives facilities and of any special requirements of the national technical authority.

6.2.2. Frequency and test requirements (LEVEL 2)

Table 6 below lists the frequency recommended for the various tests required and which are explained in this Clause.

6.2.3. Visual inspections

Visual inspections and physical checking shall take place as specified in Table 6. This shall also include the checking of safety signs and notices.

6.2.4. Continuity testing

Continuity testing of protective conductors and of main and supplementary bonding shall be carried out at the intervals specified in Table 6. The resistance between all parts of the earth conductor and the earth bar at the main intake switch for the building shall not exceed 0.5Ω.

Testing of the continuity of ring final circuit conductors shall also be carried out at the intervals specified in Table 6.

6.2.5. Insulation testing

Insulation tests including site applied insulation tests, if applicable, shall be carried out at the intervals specified in Table 6 and shall comprise:

a) testing the insulation resistance between live conductors. The result shall be not less than 2MΩ; and

b) testing the insulation resistance to earth. Each conductor shall be separately tested to earth and the result shall not be less than 2MΩ.

6.2.6. Lightning protection systems (LPS)

Two levels of lightning protection systems may be considered for ammunition storage and processing buildings. The first level of the lightning protection may be on the ammunition storage (of a faraday cage type), and the second level of the lighting protection should be near the ammunition storage. Examples are given at Annex C. A single type of lightning protection should be installed regardless of type.

Annex C lists the various requirements of an LPS and additionally the national technical authority shall specify testing regimes, in particular the required standards applicable to earth termination networks. The frequency of testing shall be as per Table 6. This will allow the build-up of a database of test results taking into account all seasonal variations.

6.2.7. Anti-static flooring

Anti-static flooring shall be tested at the intervals specified in Table 6 and in accordance with national technical authority requirements and the specifications laid out in Annex H. New anti-static floors shall be tested on installation and then at the three and nine month points. Thereafter tests should be made at intervals of eleven months. However, if there is evidence of wear and deterioration, the interval between tests should be reduced.

6.2.8. Conductive flooring

Conducting flooring shall be tested at the intervals specified in Table 6 and in accordance with national technical authority requirements and the specifications laid out in Annex H. New conductive floors shall be tested on installation and then at the three and nine month points. Thereafter tests should be made at intervals of eleven months. However, if there is evidence of wear and deterioration, the interval between tests should be reduced. When accepting new conductive floors, the head of the establishment shall ensure that the initial measurements of floor resistance made are well below the maximum of 50kΩ to allow for progressive degradation through life. A suggested limit at installation is below 30kΩ.

6.2.9. Residual current devices (RCD)

The use of external test equipment may induce large fault currents into the earthing system and caution shall be exercised when testing earth circuits using high test currents.

6.2.10. Communications, fire and intruder alarms and electrical installations

These shall be tested as per the requirements of Table 6.

6.2.11. Other electrical tests

The following additional electrical tests shall be carried out as per the intervals specified in Table 6:

a) separation of circuits if applicable;

b) barriers and enclosures if applicable;

c) protection by a non–conducting location;

d) correct polarity tests;

e) earth electrode testing excluding lightning protection;

f) earth fault loop impedance; and

g) measurement of the earth electrode and earth loop impedance and confirmation that the measurements obtained are within acceptable limits as defined by the national technical authority.

Test Requirement Clause	Cat A and Cat B	Cat C	Cat D	Non-explosives Buildings in an ESA
6.2.2.1	6 months	12 months	12 months	12 months
6.2.2.2 6.2.2.3 6.2.2.9	12 months	24 months	24 months	5 years
6.2.2.5 6.2.2.6	11 months	11 months	Not applicable	Not applicable
RCD 6.2.2.7	12 months	12 months	12 months	12 months

Test Requirement Clause	Cat A and Cat B	Cat C	Cat D	Non-explosives Buildings in an ESA
LPS 6.2.2.4	11 months	11 months	11 months	11 months

Table 6: Inspection frequency of electrical equipment

6.2.12. Flexible power cables

Flexible cables shall be inspected and tested as follows:

a) on portable, plug-in type electrical appliances they shall be inspected monthly or prior to use. A portable appliance test (PAT) shall be carried out every six months;

b) on fixed electrical appliances fitted with an electrical interface plug in an explosives building, they shall be inspected prior to use and inspected monthly with a PAT test every six months; and

c) on fixed electrical appliances in an explosives building they shall be inspected prior to use with a full electrical inspection and test every six months.

6.2.13. Cranes and lifting appliances

Cranes and other electrical lifting appliances shall be tested in accordance with national technical authority legislation.

6.2.14. Testing of conducting footwear

Conducting footwear should be tested when new and subsequently at intervals of not more than twelve months. As conductive footwear is checked before use with a hazardous area personal test meter (HAPTM), there is no need for an annual resistance test. Conducting footwear shall also be tested for impact protection to the standards laid down by the national technical authority. The test voltage shall not exceed 100 volts because this is the maximum voltage permissible on personnel that will avoid an ignition hazard to the most sensitive explosives substances and articles.

6.2.15. Testing of anti-static footwear

Conducting footwear should be tested when new and subsequently at intervals of not more than twelve months. It shall be tested against the standards, including impact protection, laid down by the national technical authority.

6.2.16. Testing of conveyor belts

Each surface of any conveyor belting used for the movement of static sensitive explosives substances or articles shall be tested in accordance with the standards laid down by the national technical authority. The electrodes shall be placed on the belting with one electrode on each surface. The maximum acceptable resistance should be 100kΩ.

6.2.17. Record keeping

All test results shall be recorded in accordance with the national technical authority requirements. However, it is strongly recommended that the minimum requirement should be that a log book be maintained. A record of tests, with the findings and any recommendations, shall be kept for comparison purposes with future results for a minimum period of eleven years to aid the detection of deterioration. Should any deterioration be detected a written report shall be made to the head of the establishment.

Equipment should be labelled to show when the next tests are due.

7 Power supply

7.1 External supply and overhead power lines (LEVEL 3)

Power supply overhead systems and any associated network and installations shall not be permitted in, or be allowed to pass over, an explosives area or building. They shall be sited at a safe distance from the perimeter of such areas. Although the breaking of an overhead conductor is a rare occurrence, the operation of circuit protection devices should not be accepted as a total safeguard. Safe distances shall be determined as below and the greater distance determined shall be observed.

7.1.1. Hazard to the power line from explosives

The distance between an explosives building and an overhead power line operating at 11kV or above should be the public traffic route distance,[11] subject to a minimum of 60m. The distance to particularly important lines, for example very high voltage lines, shall be at least the Inhabited Building Distance, subject to a minimum of 120m.

7.1.2. Hazard to the explosives from the power line

No overhead power line shall approach nearer to an explosives building than a distance equivalent to 1.5 times the height of the nearest conductor measured at the line supports, subject to a minimum distance of 15m.

7.1.3. Supply of electricity to explosives areas and cabling

Underground cables should be preferred means of supplying electrical power in explosives areas and should be provided wherever practicable. Cables should not be laid below buildings. Any overhead lines to buildings shall terminate at not less than 15m from the building and the remaining distance completed using underground cable.

Surge protective devices shall be fitted between live conductors and earth and between live and neutral conductors at the junctions of overhead lines and underground cables.

The head of the establishment shall hold and maintain plans showing the location and size of all underground cables, including the location of all joints in cables, cable pits, etc. within explosives areas.

No explosives facility should be within a minimum of 15m of underground cable runs whose working voltage exceeds 650V root mean square (RMS). Underground high voltage (HV) and communication cables, unless directly serving a potential explosion site (PES), are unlikely to be damaged outside the crater distance for the explosives building or stack. Therefore, for HD 1.1 the D5 distance[12] should provide adequate protection and should be used wherever possible. However, to prevent induced currents in either the structure or electrical equipment of a PES, underground cables should not be laid underneath a PES and should not be closer than 15 m to a PES containing any ammunition

7.1.4. Overhead lines and lightning columns

Supports for overhead lines shall not be fixed to buildings containing explosives. Poles or other forms of support for overhead lines, or lighting columns, shall be sited so as to ensure that in the event of failure no support or live conductor is able to fall onto an explosives building. A minimum distance of 1.5 times the height of the support shall be required.

[11] See IATG 02.20 *Quantity and separation distances*.

[12] Ibid.

7.1.5. Overhead lines crossing road and rail

Ideally, public supply and explosives area electrical distribution overhead power lines should not cross roads and railways. Where there are crossovers, precautions shall be taken to reduce to a minimum the length of time vehicles loaded with explosives are below the power lines. Power line crossings of roads and railways should be clearly marked as such by painting yellow box markings on roads.

Overhead power lines at road and rail crossings and the immediately adjacent spans should be inspected annually. Internal power lines spanning roads and rail crossing in explosive storage areas shall be visually inspected for signs of mechanical damage, corrosion, overheating, loose fastening and general deterioration. The inspection of the power line spanning the road/rail crossing is limited to the distance between the poles or pylons immediately adjacent to the crossing. Public supply authorities shall be requested to carry out a similar inspection of their overhead power lines.

7.2 Location of power generation and distribution equipment (LEVEL 2)

Electrical generating plant and distribution equipment with a working voltage of more than 650V RMS shall be sited not less than 45m from any explosives building. Generating plant and distribution equipment working at 650V RMS, or less, may be sited not less than 10m from any building containing explosives, provided that any plant is completely housed in a building or structure which provides complete containment in relation to the buildings containing explosives.

Electrical generating plant and distribution equipment whose working voltage is between 650V RMS and 11kV RMS and which does not contain any flammable insulation fluids may be sited not less than 20m from an explosives building provided the loss of the equipment can be tolerated by the whole establishment.

Notwithstanding the above distance limitations, it may be necessary to increase distances to comply with the explosives quantity distances from adjacent explosives buildings or to provide protection by traversing, in order to protect the electrical installation from the explosives risk.

Electrical installations that contain flammable insulation fluids in sufficient quantity to constitute a significant fire risk shall have drains to allow any fluids to flow into a shingle filled sump of adequate size to contain all leakage. An area clear of all combustible material for 5m shall be maintained around the sump.

7.3 Internal power supply in explosives buildings (LEVEL 2)

This section deals with the standards required for electrical safety inside explosives buildings. It is vital that expert advice is always obtained before work commences on the installation and/or repair of any electrical equipment or fittings. The recommended guidance below is based on various EU standards and are included to act as a reference against which national standards may be compared.

7.3.1. Earthing of explosives facilities (LEVEL 3)

The voltage to earth shall be defined by the national technical authority. As an example of the type of specification required, some systems state that it should not exceed 400V RMS, (+10% -6%) 50Hz, 230V RMS (+10% -6%) 50Hz. However, notwithstanding the specifications laid down, the source shall be directly connected to earth at one point of the system.

7.3.2. Switches

7.3.2.1. Master switches

The electrical supply to any explosives building shall be controlled by one or more master switches positioned outside the building. Master switches shall not be placed within a plant room if one is present. If there is more than one master switch, they should be situated close together and their purpose clearly marked.

Master switches shall be of a design capable of immediately isolating every live and neutral conductor entering the building and disabling the output of any uninterruptible power supplies (UPS).

7.3.2.2. Other switches

Switches and distribution boards controlling the electricity supply to an explosive building shall be located outside the building, or in a plant room that has a minimum half-hour fire resistance and does not open directly into the building or rooms containing explosives.[13] Pilot indicator lights, visible from a distance of at least 10m and preferably duplicated shall be fitted adjacent to the master switches to show when the supply is energised.

The provision of remotely controlled switchgear, with fail-safe configuration, may be considered. The remote control station should be sited outside the building concerned and in a clearly visible position. It should be suitably protected from the environment and provided with pilot light indication.

7.3.2.3. Uninhabited buildings

When an explosives building is vacated, all power shall be switched off. This however does not apply to supplies for services that are either completely located in the plant room or to heating appliances, emergency or security services and others permitted by the head of the establishment.

7.3.3. Final circuits

These shall be controlled by switches that ensure complete isolation of both live and neutral conductors from the supply. These switches may be located inside the building if they are the same category as the building. However, switches controlling heating systems shall always be located outside the explosives building or they shall be in the plant room. All circuits shall be provided with protection against over-current and earth faults. Re-wireable fuses shall not be used. Over-current protection shall be by fuses or circuit breakers complying with national technical authority regulations.

7.3.4. Residual current devices (RCD)

Where conducting or antistatic floors are used, RCDs shall be fitted. Portable devices and devices integral with socket outlets shall be tested daily before use. The test shall operate the integral test device fitted to the RCD. Fixed devices providing dedicated or multi-circuit RCD protection shall be tested at three monthly intervals. Fixed RCDs, including devices integral with socket outlets, should be tested using an approved test instrument in accordance with the times detailed at Table 6.

Portable devices failing a test shall be taken out of service until they are repaired or replaced. Fixed RCDs, including devices integral with socket outlets, that fail integral or instrument testing shall have their associated circuits isolated until defective devices are replaced or repaired.

Although RCDs provide a high degree of protection from electric shock, total protection cannot be guaranteed in a highly conductive environment. Electrical equipment used in conductive environments shall comply with the recommendations of this module and should be constructed to at least double insulated Class II standard.

7.3.5. Electrical sockets

If the installation of electrical socket outlets is necessary, then the classification and standard of sockets used shall meet the recommendations of this module and match the explosive category of the building in which they shall be used. Sockets of a distinctive pattern shall be used for non-standard electricity supplies.

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[13] See IATG 02.50 *Fire safety.*

Multi-plug adapters shall not be used unless there is a specific operational need such as for electronic equipment and in this case a risk assessment should be undertaken before the head of the establishment or his or her appointed representative approves the use of these items.

7.3.6. Surge and transient protection and protection levels

Dependent upon the work being undertaken, equipment in use, the ammunition being stored, the age of the building and its associated electrical cabling and circuitry, it may be necessary to carry out a risk assessment to establish if, and where indicated, transient overvoltage and over-current protection needs to be provided to all primary circuits feeding the final circuits in explosive category areas of explosives buildings. The risk assessment should also include the need for transient protection to all communications and instrumentation circuits that enter and exit the designated explosives area.

In explosives processing facilities two or more levels of protection may be necessary for the power systems and these levels shall be dictated by the national technical authority. The protection shall be required for:

a) incoming mains power (for example waveform 10/350µs with 100kA lightning current arrestors); and

b) internal electrical distribution (for example waveform 8/20µs with 3kA surge arrestors).

Other systems such as CCTV, telephone or control circuits require separate consideration and specialist advice should be obtained.

7.3.6.1. Protection in explosives buildings

In general, processing facilities should be fitted with transient protection. While storage facilities may not, all electrical cabling and wiring entering an explosive facility may conduct dangerous surges of voltage and current. The surge size is normally governed by the gauge or size of the cable, but all cables should be treated as potentially dangerous and therefore protected by surge protection devices.

Surge protection devices shall be provided to protect explosives assemblies when they are connected in any way to the electrical supply system. These protection devices should be installed on each cable or wiring entering the lightning protected area of an explosives processing buildings, between the respective conductor and the building earth and/or Faraday cage, at the conductor’s penetration point.

7.3.6.2. Protection during explosives operations, thunderstorms, and silent hours

Surge protection devices designed for specific equipment may not provide protection for explosives operations and additional surge protection and/or transient protection for sensitive test equipment located in the protected volume of the building may be required. Specialist ammunition technical advice should be sought.

Explosives assemblies shall be disconnected from any test equipment during silent hours and when under a thunderstorm threat. Correctly rated and installed transient over-voltage and over-current devices provide effective protection against sparking but cannot guarantee that sensitive electronics will not be damaged or that sensitive electro-explosive devices will not be ignited.

7.3.6.3. Earthing of surge protection devices

Earth conductors leading from the surge protection devices shall be kept separated from the protected conductors. All earth leads shall be as short as possible to minimise the inductance. As a guide the earth leads should be no longer than 300mm of 6mm diameter cable. If longer cables are unavoidable consideration should be given to adding extra down-stream surge protection.

All metallic utility lines and pipes shall be electrically bonded to the LPS or the structural steel of the facility at, or just before, they enter the facility.

When electrical test equipment is being used, it is essential that surge protection devices be installed to protect all up ammunition rounds (AUR) or explosives components from lightning effects which may occur during the period that the test equipment is connected.

7.3.7. Wiring and cable systems and their use in explosives areas

7.3.7.1. Chemical compatibility

Compatibility with chemicals and/or explosives in the area should be considered when selecting the type of cable to be used. The following wiring types should be used in explosives buildings and should be of fire retardant, low smoke and fume emission plastic materials.

7.3.7.2. Types of wiring and cable systems and their use in categorised areas

Cables for use within Category A and B facilities shall comply with national technical authority regulations concerning these areas. Specialist electrical engineering advice should be sought before the installation of any wiring or cabling in these areas. The following are the minimum recommended materials to be used:

a) synthetic rubber or PVC insulated cables in screwed steel conduit may be used in Category A, B, C and D facilities;

b) synthetic rubber or PVC insulated cables in trunking or non-metallic conduits should only be used in Category C and D facilities;

c) heavy-duty (750 volt) mineral insulated metal covered (MIMC) cables. The outer covering shall be made of low smoke and low acid gas emission material. Cables shall be fitted with terminations compliant with national technical authority regulations. Installation of MIMC cables in Category A and B facilities shall only be installed by appropriately qualified personnel. It is important that the cable, glands and termination are all supplied by the same manufacturer;

d) cross linked polyethylene (XLPE) or PVC insulated multi-core armoured cables shall be compatible with any explosives or chemicals used in the vicinity of the installation. Additional protection against mechanical damage may be necessary;

e) thermo-plastic insulated lead sheathed cables with a protective covering of thermo-plastic material;

f) thermosetting insulated cables in screwed steel conduit may be used in Category A, B, C and D buildings;

g) communications and instrumentation cables, including IT systems, contained in screwed steel conduits may be used in category A, B, C and D buildings; and

h) all cables with single core conductors are prohibited as are cables with a single layer of insulation, with the exception of MIMC.

7.3.7.3. Cable used in conduit and trunking systems

Power cables should be of synthetic rubber, PVC, low smoke and fume (LSF) or XLPE insulated to 450/750V grade or to a specification as laid down by the national technical authority. The cross-sectional area of a conductor shall be appropriate for the current loading and should be not less than 1.5mm^2. Cables for communication and alarm systems may be insulated flexible cords. The cross-sectional area of a conductor should be not less than 0.35mm^2.

7.3.8. Conduit standards

All metal conduits shall comply with national technical authority regulations. For Category A and B facilities specialist electrical engineering advice should be sought. However, in general the following standards should apply:

a) metal conduits shall be heavy gauge solid drawn or continuously seam welded and galvanised. Black enamel may only be used in Category C and D areas;

b) metal conduits shall be screwed tightly into all fittings and equipment with the minimum of exposed thread;

c) running couplers shall not be permitted in Category A or B areas; and

d) conduit boxes shall be of the correct type for the category of the area and zone concerned.

7.3.8.1. Category B area requirements

The following specific requirements should be applied to conduits in Category B areas:

a) joints in straight runs in conduits shall be made by means of a flameproof coupler with sealed or dust tight union;

b) conduits shall be fixed with a minimum of 12mm clearance from walls and be supported by solid backed-splayed saddles;

c) all conduit entries into equipment and fittings shall be made-off with glands certified to the appropriate zone as per Clause 4.5.1; and

d) the use of flexible conduit shall be kept to a minimum, but, if essential, then its use should be specifically authorised by the national technical authority.

7.3.8.2. Category C and D area requirements

Non-metallic conduits should only be used in Category C and D facilities but with the following restrictions:

a) any rigid PVC conduit system shall comply with national technical authority regulations for use in this area category;

b) protection against mechanical damage shall be provided;

c) if slip joints or sliding couplers are used, joints should be made using a suitable adhesive; and

d) separate and adequately rated earth continuity conductors shall be installed throughout the systems.

8 Lightning protection systems (LPS) (LEVEL 2)

It is essential that effective lightning protection measures are provided for facilities involved in the manufacture, processing, handling, or storing of ammunition. Although statistically the probability of a structure or building being struck by lightning is relatively low, it is of the utmost importance to provide lightning protection to facilities containing ammunition.

8.1 External protection

8.1.1. Probability of lightning strike

The probability of an explosives facility being struck by lightning is dependent upon the geographic location of the facility and the atmospheric and weather conditions prevalent at the time. Measured over a long period of time, it is the product of the lightning cloud-to-ground strike density and the effective collection area of the structure or building. Many sources of global lightning data exist that may provide the national technical authority with the relevant data.

8.1.2. Risk of explosion

Ammunition is at risk from lightning as a strike could cause an explosive event by direct or indirect means such as by:

a) causing a surface flashover or electrical arcing between conducting surfaces. This in turn could initiate the explosives or any associated explosive devices directly by heat, sparking and molten metal created by the arc;

b) arcing causing fires in electrical circuits and equipment;

c) lightning strikes starting fires; or

d) spalling generated by the heat of the current flowing through the structural components of the facility impacting on and initiating unprotected exposed explosives and explosive devices.

8.1.3. Facilities which may not require protection (LEVEL 2)

The national technical authority may choose to provide some exemptions to the types of facilities requiring protection. Yet there shall be no exemptions for facilities used for the manufacture, processing, or out-of-container handling of explosives. The following list is based on internationally accepted best practice:

a) underground storage or storage buried and subsequently constructed by excavation and with a minimum of 600mm of earth cover;

b) explosives stores that contain and are properly licensed to store a maximum of 25kg of HD 1.1 and where the explosives are packed in approved containers;

c) buildings containing only HD 1.4 small arms ammunition or other explosives assets that cannot be ignited by lightning or its indirect effects and are packed in their approved containers;

d) earth covered explosives stores with more than 600mm of earth cover and where structural steel or reinforcing bars are bonded to earth. Ventilation stacks and all metallic penetrations shall be bonded to earth. All electrical circuits shall be protected by transient over-voltage and over-current barrier devices.[14] The ammunition shall be in approved containers;

e) ISO containers containing explosives which are of an all welded construction, or where the frame and all panels are electrically bonded using heavy duty bonding straps, may be stored in the open without any specific lightning protection provided that the containers have at least two earthing points at opposite corners to connect to driven earth rods. The direct current (DC) resistance to earth at any point on the ISO container should be less than 10 ohms. ISO containers not designed to this standard shall require further lightning protection preferably via an overhead catenary system; and

f) storage structures and facilities where personnel are not expected to sustain injury and the economic loss of the facility, surrounding facilities and the ammunition would be negligible.

8.2 Types of external lightning protection

Various methods of external protection against lightning exist. However, international best practice may be achieved by enclosing the explosive in an interconnected network of electrical conductors. This in turn ensures that all exterior fields, currents, and voltages are shielded against and that ingression of these is prevented. An LPS is designed to intercept a lightning strike to the building and carry the current safely to earth without causing damage to the building or its contents.

A description of a complete system and its requirements are at Annex C. Appendix 1 to Annex C provides figurative descriptions of differing types of LPS systems

[14] It is difficult and expensive to establish the adequacy of earth bonding of reinforced concrete structures post-construction.

8.2.1. Faraday cage

A typical protection model may be one of reinforcing bars of a cast in-situ RC structure where the bars are fully bonded in a roof to walls to floor configuration and have deliberate earth connections. The use of widely spaced steel stanchions to provide the shield is effective at protecting the building structure but does not prevent magnetic fields penetrating the building. This method of protection imitates a Faraday cage and is called a Faraday cage LPS. It requires a minimum separation distance from the boundaries of the structure to the explosives assets. This should be determined by an electrical specialist.

8.2.2. Other models

Although other LPS such as early streamer emission (ESE) and charge dissipation systems exist they should not be used as preference.

8.3 Internal protection (LEVEL 2)

Buildings and any other structure used for storing or processing explosives should have an internal lightning protection installation. This should consist of equipotential bonding tape and bonds to metallic structures and components. This system is required in order to avoid dangerous flashover or sparking within the structure from any current flowing in the external LPS or structural steel components because this sparking is very dangerous. Sparking should be avoided by the use of equipotential bonding and/or insulation between the various components of the LPS system both internal and external.

8.3.1. Bonding and insulation

All internal equipment and structures such as weapon stands with dimensions exceeding 2m in any direction and within 2m of the walls or building structure should be bonded to earth. Earth bonding should be by the use of an equipotential bonding (EPB) strip running inside the building. The EPB strip should be as low as possible on the walls and should be bonded to the conductive/anti-static floor if one is in use and if it is practicable. Bonding strips or wires higher than 2m above floor level should not be used.

The EPB strip should be connected at one point only to the facility main earth bus bar. It should not be deliberately connected to the LPS down conductors at any other point and it should be in as straight a line as possible with the minimum of bends and corners.

When the strip approaches doors or other openings to buildings the strip should preferably be taken under the floor. However, if the door frame is metallic this may be used for continuity. If a strip has to be run over an opening, no bonding connections to it should be made above the opening.

8.3.1.1. Ammunition under test, assembly or repair

Ammunition shall not be directly connected to the EPB strip. They should be bonded to the stand or other equipment on which they are placed. This in turn should be bonded to the EPB by a single connection from the lowest part of the stand. If an item is not on a stand and its size or positioning requires an equipotential bond, a single connection to the EPB should be made with the connecting cable run as shown at Figure 1.

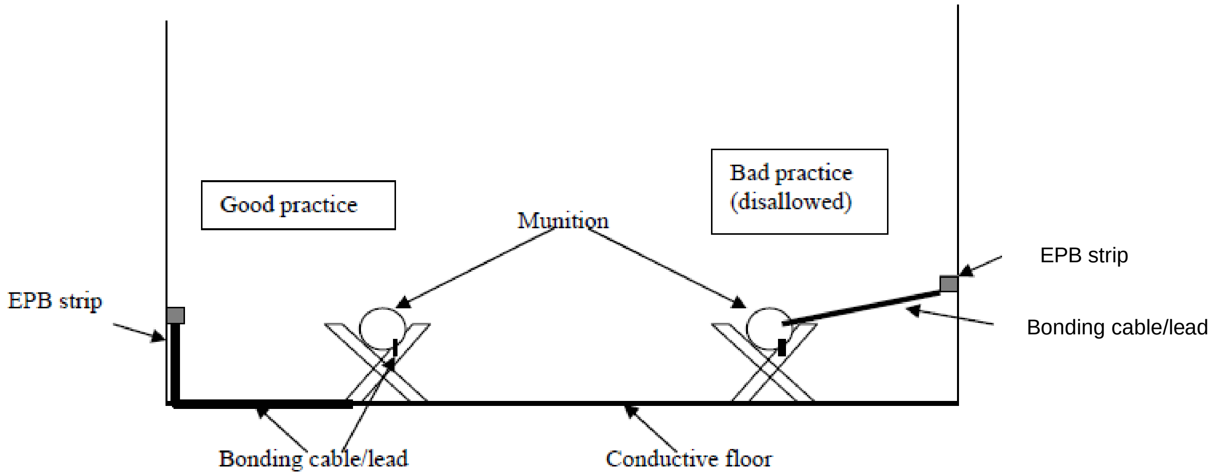


Figure 1: Bonding of ammunition with a connecting lead

All cables used to make bonds to the EPB strip should be run down the wall from the strip and along the floor to the munition stand. They should not be taken directly to the stand suspended or held above floor level.

The minimum stand-off distance of 500mm should continue to be maintained in processing areas and this distance should be increased to 2m if an EPB is not made and the item has a dimension greater than 2m. The stand-off distance is measured from metallic objects connected to the walls such as equipment, vent outlets/inlets and elephant trunk vents which do not have insulating sections.

8.3.2. Ammunition in storage

In storage areas EPB is not required for items that are in their approved containers or packaging.

8.3.3. Connections to anti-static and/or conducting floors

Connections to anti-static and/or conductive floors should continue to be made in the specified manner. Connection to an EPB strip is not necessary for electrostatic control purposes should such floor connections exist. The purpose of the EPB is to provide a low resistance earth bond for lightning protection purposes.

8.3.4. Facilities with no external LPS

Internal lightning protection may be needed even when the external LPS is not required as defined by the exclusions in Clause 8.1.3.

8.4 Lightning hazard to personnel (LEVEL 1)

An LPS cannot prevent a strike on an explosives structure or building and thus cannot ensure that an explosive event will not take place. It is essential to provide for the evacuation of personnel from an explosive site should a thunderstorm be approaching. Explosives sites shall have a clearly defined response to lightning hazards that shall include an evacuation plan that provides for making safe the munitions and securing and electrically isolating the evacuated facilities. The entire procedure shall be exercised at least annually.

8.4.1. Risk assessment

The head of the establishment shall carry out a risk assessment of the likelihood and consequence of thunderstorms affecting explosives areas. If the outcome of the assessment dictates that an effective warning system should be installed, then specialist guidance should be sought. Whichever system is eventually chosen should be capable of providing at least 30 minutes warning of an approaching thunderstorm.

8.4.2. Making safe the explosives facility in the event of a thunderstorm (LEVEL 1)

8.4.2.1. Storage facilities

In the event of a thunderstorm warning or a sudden thunderstorm:

a) stop work immediately;

b) do not deliberately earth explosives assemblies but ensure that they are least 500mm from the walls of the facility;

c) close all windows, doors, and vents;

d) switch off the electricity from outside; and

e) evacuate to a safe location.

8.4.2.2. Open storage facilities

In the event of a thunderstorm warning or a sudden thunderstorm:

a) stop work immediately;

b) cover and repack unpacked explosives should time permit; and

c) evacuate to a safe location.

8.4.2.3. Processing facilities

In the event of a thunderstorm warning or a sudden thunderstorm:

a) stop work immediately;

b) if time permits, disconnect electrical test equipment from explosives assemblies;

c) do not deliberately earth explosives assemblies but ensure that they are at least 500mm from the walls of the facility; and

d) evacuate to a safe location.

8.4.2.4. Stabling and marshalling areas

In the event of a thunderstorm warning or a sudden thunderstorm:

a) stop work immediately;

b) place all road and rail vehicles under cover if time permits; and

c) evacuate to a safe location.

9 Operation of conducting and anti-static regimes (LEVEL 2)

Many explosive substances and articles are sensitive to electrostatic discharge (ESD). If an item of ammunition cannot be hardened or protected against ESD then measures should be taken to prevent ESD endangering the explosives. This may be achieved by ensuring any electric charge is removed at least as fast as it is generated.

A sensitive component is any safety critical component of a weapon system or platform susceptible to the effects of ESD. Whilst initiation is the major hazard, other hazards should also be considered when any safety critical sensitive electronics, fuels, or degradation products such as gaseous hydrogen from aluminised explosives may be present.

9.1 Technical definition of anti-static and conducting regimes and safety

The technical definitions listed below are derived from the ignition energies of the explosives used in the most sensitive exposed components. Therefore, it is essential for safety that an ESD protected area (EPA) shall ensure that any electrostatic energy sources are below the ignition energy of the most sensitive exposed component.

The following definitions are vitally important for all aspects of explosives safety:

a) an anti-static regime is operated when explosive substances, EIDs or EEDs that in their current configuration have ignition energies of above 1MJ and below 156MJ. In the majority of cases the sensitive components of weapon systems are protected from harmful ESD by other components in the weapons system such as, for example, a rocket motor casing. Deliberate measures such as covers, packaging and circuit breaks provided by safety and arming units (SAU) are also provided. It is therefore reasonable to assess the weapon in its present state rather than its most vulnerable configuration; and

b) a conductive regime is required in the presence of explosive substances, EIDs or EEDs that in their current configuration have ignition energies of 1MJ and below. This regime should be enforced when processing any explosive or explosive assembly containing any components whose sensitivity is not known.

The selection of the correct electrostatic regime for explosives substances is based on the tests explained in IATG 01.50 *UN Explosive hazard classification system and codes*.

The above regimes shall be implemented in any situation in which explosives or explosive assemblies could be exposed to an electrostatic hazard. The manager of the building or process should ensure all exposed sensitive components are identified, their sensitivity is quantified and the appropriate regime implemented and maintained.

Training is a vital part of maintaining the above regimes. This training should include knowledge of the ammunition at the ammunition technical level for supervisors and training of all staff in operating in an ESD regime and the use of personal protective equipment such as clothing, footwear, earthing wrist bands, the use of the hazardous area personnel test meter (HAPTM) and hand tools. Whenever possible safe operation shall be achieved by design rather than procedure to ensure that the risk is reduced and/or mitigated to ALARP levels.

9.2 Sources of static electricity and control measures

9.2.1. Personnel (LEVEL 2)

In a properly constructed, maintained, and tested facility following the guidance in this IATG module, the single highest risk of the generation of hazardous levels of electrical charge are the personnel employed in the facility. Their mobility, high capacitance and conductivity mean that they constantly generate, store, and dissipate electrical charge. The charge build-up can be released by a single discharge. Therefore, all those involved in handling sensitive explosives or explosive processing should be effectively and continuously grounded. This can be achieved by providing a discharge path to ground via conductive and/or anti-static shoes and floors. Wrist straps connected to grounded conductors may suffice when dedicated facilities are not available.

9.2.2. Equipment (LEVEL 2)

Plant, conductors and other equipment should be earthed and bonded to ensure they are at a common ground potential. Trolleys, conveyors, and other mobile equipment also have the potential to generate static electricity, store it and subsequently discharge it. Therefore, they should be provided with an effective path to earth. Any tyres fitted to equipment should be of an antistatic or conducting material. Gaseous or fluidic systems such as low and high pressure compressed air systems should be fitted with grounded antistatic or conducting components. Drive or conveyor belts should be of anti-static or conductive material depending upon the regime in force within the room.

If operations performed within a building require the installation of an anti-static or conducting floor, it is preferable to install a conducting grade floor. This allows for future flexibility in the use of the building. However, in some environments this might be outweighed by the increased risk of electrocution in the event of an equipment fault.

9.2.3. Benches (LEVEL 2)

Explosives processing benches should be at least 500mm from any external facility wall and metallic structural members. Should the bench surface or structure be metallic and have a dimension >2m it should be connected to the facility equipotential bonding system at the lowest point. Metallic benches <2m and installations where a conductive mat is used for the work surface on an insulating bench may be connected to the conducting floor instead of the equipotential bonding system.

If it is impossible to achieve 500mm separation from the external walls or metallic structural members a risk assessment shall be undertaken which addresses the hazard from lightning side-flashes. However, should this be the case then:

a) no explosive items should be left on the bench when the room is unoccupied; and

b) an effective lightning warning system is in place that allows items to be safely stowed and an orderly evacuation to be undertaken.

9.2.4. Racks (LEVEL 2)

It may be necessary to provide racking in some PES. If this is the case, then the following restrictions should be in pace to protect the explosives against lightning:

a) the minimum distance between the walls and ceiling of the building and the racking should be 500mm; and

b) conductive explosives storage racking should be connected at its base to the facility earth system unless there is at least 2m separation between it and the building structure. An additional connection to a conductive or anti-static should not be an alternative. The racking should not be connected to earth above its base.

9.2.5. Specialist equipment (LEVEL 2)

Specialist equipment for explosives assemblies should have any special requirements for the dissipation of static charges identified at an early stage, be compliant with national technical authority regulations and the requirements of this IATG. It should have all necessary connections to the ground earthing plane using conductive wheels, tyres, feet etc. as appropriate.

9.2.6. Relative humidity (RH) (LEVEL 1)

It is important to maintain the correct RH within explosives processing rooms and storage facilities. This will ensure static charge will not easily be acquired and that it can be quickly dissipated. The RH limits are described in the specifications for the corresponding electrostatic regime. Some materials require hours of conditioning at the appropriate RH to achieve the desired electrical behaviour. To ensure safe dissipation of charge from the surface of exterior clothing and packaging made from natural fibres such as cotton, it is particularly important that they be conditioned at the appropriate RH.

All explosives process rooms should be fitted with sufficient displays to allow the user to readily confirm the RH meets the requirements of this module. Additional sensors and displays may be required within regions of large and/or segregated electrostatic areas.

9.2.7. Hazardous area personnel test metre (HAPTM) (LEVEL 2)

A HAPTM shall be used by any person as soon as they enter any area where a conductive regime is in force. Anyone who fails the test shall either make modifications to ensure a pass or shall leave the area. The HAPTM confirms the subject's total resistance to earth is below 1MΩ. This is the maximum acceptable resistance for operating in a conductive regime. Personnel wearing conductive footwear on a conducting floor will normally achieve a pass.

The term footwear means shoes or boots but does not include temporary systems of heel grounding or similar additions to ordinary footwear that are commonly issued to temporary visitors to explosives process rooms. Anyone approaching within 1m of any explosive or explosive assembly shall not use such temporary electrostatic dissipative material.

A HAPTM shall be placed at the entrance to the area and the earth electrode shall be connected to the earthed grid of the conducting floor. A metal earth plate should not be used as the foot electrode. Anyone undergoing testing shall stand on the conductive floor. The test shall only be undertaken in dry footwear as it is possible to obtain a pass with wet footwear which, when dry, would insulate the wearer from earth and cause a fail. Visitors equipped with temporary earthing devices such as heel grounders may be permitted into conductive and anti-static areas but shall not be allowed to touch any explosives assembly. HAPTM shall be calibrated as per the manufacturer's instructions.

9.2.8. Earthing

Earthing should be as per the requirements of the national technical authority and international good practice guidelines. Metal sheaths or armouring of all electrical cables, metallic pipes, rails or guides entering a building should be bonded to the nearest part of the LPS above the test links at the points of entry. They should also be earthed at positions 75m and 150m from the building. If the outer sheaths of cables are stripped to facilitate this connection the stripped length should be properly protected against corrosion.

In underground installations, extra earthing should be installed at intervals no greater than 75m along the access roadway or shaft. This measure is intended to protect the integrity of the earthing system by using protected multiple earths (PME) and also to provide a degree of transient suppression.

Metal service pipes should not be used as earth electrodes.

9.3 Anti-static regime and precautions (LEVEL 2)

9.3.1. Flooring

Anti-static flooring should be provided as required by national technical authority regulations and international good practice. This flooring is designed to dissipate a static charge by relatively slowly discharging the floor, and anything electrically connected to it, to earth. International best practice states that anti-static floors should have a resistance from the surface of the floor to earth of between 50kΩ – 100MΩ. However, in explosives processing buildings, especially in rooms with potentially explosive atmospheres, the upper limit should be 2MΩ. Flooring should be tested in accordance with Annex H.

In the absence of a suitable HAPTM for anti-static environments safety should be assured by annual floor and shoe testing. However, if there exists a requirement to upgrade to a conductive regime, then the building must include the addition of a HAPTM.

An RH of ≥40% should be maintained. RH monitoring equipment with an accuracy of at least +/- 5% RH is permitted.

9.3.2. Shoes and clothing

Personnel should wear anti-static footwear that complies with the resistance requirements of the national technical authority and international best practice including the inclusion of safety caps and other features to provide protection from accidental foot injury.

Personnel should wear outer clothing of materials whose outer exterior surfaces have a surface resistivity of $1 \times 10^{12}\Omega$ or less at an RH of 40%. The clothing should be stored in an environment of the same or higher RH than its working environment. The clothing must be of a homogenous textile and not of material that relies upon a conductive grid or coating and also provide protection against fire and flash burns. Clothing should fit properly and be correctly fastened. Gloves should not be worn unless, as a result of a risk assessment, they are identified as personal protective equipment (PPE) to protect operators from an additional hazard. In this situation, it will be necessary to balance the relative risks between the explosives and other identified hazard, although anti-static gloves are available. Personnel shall not don or remove clothing whilst in the presence of explosives substances or articles.

9.3.3. Other materials

Loose resistive, that is, material such as a plastic, rubber, glass etc with a surface resistivity of $10^{11}/m^2$ in the working area, should be restricted to a size <75cm^2. In this context the word “loose” is meant to permit the presence of >75cm^2 of resistive materials which will be safe because they are fixed and remote from the sensitive materials or devices. In many cases loose items may be treated to improve their electrostatic characteristics.

9.3.4. Relative humidity

An RH >40% should be maintained in the area at all times.

9.3.5. Wrist and leg straps

If wrist or leg straps are specified for use in an anti-static regime, then the following standards should be applied:

a) straps should be of the quick release type. End-to-end resistance including the strap, cabling and termination contact shall be ≥750kΩ and ≤35MΩ;

b) a dedicated connection point for straps should be established next to the working area and should be easily accessible. The connection point should be clearly identified; and

c) electrostatic dissipative footwear should be constructed such that the contact made with both feet meets the requirement for an electrical path from the wearer to contact points on each foot of the footwear in both toe and heel region.

9.3.6. Testing of anti-static equipment before use

Checks on wrist straps and ground cords should be made at the start of each working day. Each check shall be made with the wrist strap worn on the wearer's wrist and in contact with the wearer's skin. Checking shall include the measurement of end-to-end resistance.

Leg, toe and heel straps should be checked prior to use or on entry to the static controlled area. The wearer's leg strap shall be in contact with the wearer's skin. Toe and heel straps shall be tested with the appliance worn by the wearer.

Measurement of the above checks should be as per national technical authority requirements.

9.4 Conducting regime and precautions (LEVEL 2)

9.4.1. Flooring

Conducting flooring should be provided in accordance with the requirements of the national technical authority and international good practice. The resistance from the surface of the floor to earth should be less than 50 kΩ. If for some reason conductive floors cannot be used, an alternative system of control of electrostatic charge may be specified but will require the written agreement of the national technical authority. Flooring should be tested in accordance with Annex H.

9.4.2. Shoes and clothing

See Clause 9.3.2.

9.4.3. Other materials

No materials capable of retaining any significant electrostatic charge or of permitting the electrical isolation of significant conductors should be permitted within the working area. Should a high RH be maintained wood and other cellulose materials may be permitted.

9.4.4. Relative humidity

An RH of ≥ 65% should be maintained. RH monitoring equipment with an accuracy of at least +/- 5% RH is permitted. However, in exceptional circumstances approved by the head of the site RH limits may be reduced to an absolute minimum of 40%. However, should the head of the site wish to process at RH of 40 - 65% the following restrictions should apply:

a) there shall be no processing of bare primary explosives;

b) individual personnel shall continue to pass the HAPTM test;

c) all materials whose static dissipative properties are dependent upon a high RH shall be removed; and

d) it shall be demonstrable that no hazardous levels of electrostatic charge can exist at the reduced RH. This parameter will require the use of specialised equipment, testing techniques and personnel.

9.4.5. Equipment restrictions and effective grounding

Conveyor belts should be conducting types complying with tests approved by the national technical authority. The electrodes should be placed on with one electrode on each surface. The maximum acceptable resistance is 100 kΩ.

Bench tops, chairs and containers should be of conducting material and should be effectively bonded to the conductive floor or equipotential bonding system. Seat covering material should be of a static dissipative material.

All conductors are to be effectively grounded. For the purpose of this module, this means <1MΩ maximum resistance to earth.

9.5 Mixed or hybrid conducting areas

It is possible to mix the various conducting regimes i.e. uncontrolled, anti-static and conductive within the same building or room. However, specials precautions should be taken, and it should be noted that the administration and operation of such areas will be complex. This will require careful and deliberate control of personnel moving between the various regime areas. Areas to be considered are flooring, conveyor belts, bench tops, chairs, seat covering, footwear, clothing, PPE, explosives and other containers. This list is not comprehensive, and a careful study and comprehensive risk assessment of the process will be necessary.

9.5.1. Marking and mixing of different electrostatic regimes

The areas should be clearly defined in terms of the different electrostatic regimes in operation on a scaled drawing held by the national technical authority and the areas must be demarcated by permanent or semi-permanent barriers. Any change to the demarcated areas should be accompanied by a risk assessment and justification. This shall be sent to the national technical authority via the head of the establishment.

It is vital that the correct HAPTM should be available at the points of entry and/or exit to the controlled area. Within the controlled areas, the appropriate controls must be followed. If the fabric of a building or room provides a conductive regime but the building is required to process explosives natures that require an anti-static regime or an uncontrolled electrostatic environment, it is not necessary to fully maintain all features of the conductive regime. However, the rules for the testing and maintenance of conductive floors should still apply.

9.5.2. Mixed regimes and portable equipment use

Having mixed electrostatic regimes within the same room or building requires strict control on the use of portable electrical equipment. Any such equipment used within the zoned area should be double insulated to remove any risk to personnel of electrocution resulting from the use of defective equipment within a conductive regime.

9.6 Safety of personnel and safety checks (LEVEL 2)

9.6.1. Residual current devices (RCD)

If anti-static or conductive regimes are in operation, personnel should be protected from lethal electric shock by an RCD to levels as required by the national technical authority. Should it not prove possible to provide such electrical protection by the use of an RCD, the head of the establishment shall provide adequate protection to an operator such that the risk of a lethal electric shock is removed, in so far as is reasonably practicable.

9.6.2. Mains powered electrical equipment

All fixed electrical equipment installed within arm's reach of, or portable equipment used by, a person standing on the conducting floor should be double insulated to comply with national technical authority requirements. Alternatively, the equipment may be fed from a fixed separated extra low voltage (SELV) supply complying with national technical authority standards. This requirement should apply to all users of the facility including but not exclusive to cleaning staff, maintenance staff and process workers.

When conducting or anti-static flooring is installed a notice prohibiting the use of unauthorised electrical equipment should be displayed.

Weekly visual checks of the electrical bonding of benches, floors, chairs, trolleys, mats, workstations, separately grounded equipment or any other equipment that grounds an operator permanently or temporarily should be carried out. Equipment subject to change of configuration should be checked immediately after that change and thereafter at weekly intervals.

9.7 Electrical bonding of anti-static and conductive flooring (LEVEL 2)

9.7.1. Building floor and protective covering interface

The floor underneath the anti-static or conductive should be protected by an effective damp proof membrane. Bonding strips should be laid under each separate piece of floor covering to ensure effective electrical continuity throughout the floor. The bonding strips should be laid on the floor to form a grid of 600mm spacing under the protective floor covering. The spacing of the grid should ensure that the electrical resistance of the floor to building earth is compliant and consistent across the entire floor area.

9.7.2. Earthing and bonding

An absolute minimum of two paths to earth should be provided for each piece of floor covering. The grid should be connected to the electrical earth of the building in positions ideally at diagonally opposite points of the floor. Grids should not cross flexible expansion joints. If necessary, flexible bonding cables may be used to couple adjacent grids.

If the floor covering is made of tiles, then the bonding tape should be laid under each row of tiles and all of the tapes should be connected together by a tape laid at right angles.

9.7.3. Bonding materials and dimensions

Stainless steel bonding tapes should be used but the use of brass and copper is acceptable. However, aluminium shall not be used. The tapes should be at least 50mm wide if using sheet material as this will provide reliable connectivity across sheet joints; the tapes should be not less than 0.2mm thick. For some flooring systems such as those of homogenous polymeric material and with a trowelled finish, the width of the conductive tapes is not important.

However, the tapes should be of sufficient mechanical robustness to last the design life of the floor and provide a low enough resistance to not contribute to the 50kΩ limit for the electrical resistance of the flooring. Electrical continuity of under floor joints should be achieved by riveting, soldering or conducting adhesive and connections to the earthing system of the building should be made with screw clamps.

Any adhesives used should be electrically conducting but if a non-conducting adhesive is used care should be taken to prevent the adhesive affecting the conductivity between the bonding tapes and the under surface of the floor covering. Adhesives shall be chemically compatible with the explosives present in the building.

9.7.4. Protective surface maintenance

Waxes and polishes shall not be used on anti-static and conducting floors. The method and frequency of cleaning should be that recommended by the manufacturer of the flooring material. If any area of the floor exhibits evidence of contamination by dirt, grease etc. that could affect its electrical resistivity, then the area should be cleaned by the recommended method immediately.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.10 *Introduction to risk management principles and processes.* UNODA;

d) IATG 02.20 *Quantity and separation distances*. UNODA;

e) IATG 02.30 *Licensing of explosives facilities*. UNODA;

f) IATG 02.50 *Fire safety*. UNODA;

g) IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*. UNODA;

h) IATG 05.60 *Hazards of electromagnetic radiation*. UNODA; and

i) IATG 06.60 *Works services (construction and repair)*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[15] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[15] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) AASTP-1, Edition B Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html; and

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[16] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[16] Where copyright permits.

Annex C
(informative)
Lightning protection systems (LPS)

Ideally, a LPS should be included as a requirement during the design and construction of explosives facilities. It should be effective, simple, rugged and permanent. It should also be accessible for testing and maintenance, particularly to earth termination networks that are hidden from view.

C.1 Construction and design of an LPS

Modern explosives facilities use metal extensively in their construction and it should be utilised in order to maximise the number of parallel conducting paths if use of a surface mounted air termination system is allowed. Properly bonded reinforcing bars in an RC building may be used as down conductors and steel roof cladding may be used as an air termination network provided a minimum gauge of metal is used.

The following types of construction provide the best options for the provision of inherent lightning protection:

a) a reinforced concrete (RC) construction with cast in-situ walls, roof and floor with all connections fully bonded and earthed; or

b) a steel portal frame with earth bonded profiled sheet cladding.

If the building is not of the above types, then a LPS system should be installed.

C.2 Construction materials

When selecting materials for a LPS system, their compatibility and corrosion characteristics will be critical. Different metals in contact with each other should be close to each other in the electro-chemical series to reduce the risk of electrolytic interaction. If the possibility of significant electrolytic action exists, thermic welded or dry sealed metallic joints should be used to provide adequate protection. Conductors for use as suspended air termination networks should be stranded hard-drawn copper, aluminium, or copper coated steel and be specified by the national technical authority.

C.3 LPS

Buildings may be designed with either an integral or separated LPS. In an integral system the LPS is either attached to the building or utilises parts of the building structure. A separated LPS is physically separated from the building LPS and is not fixed to or is part of the building structure.

C.3.1 The component parts of an LPS are:

a) an air termination network;

b) down conductors;

c) an earth termination network;

d) earth electrodes; and

e) test joints and bonds.

C.4 Air termination network (ATN)

An air termination network intercepts the lightning strike. It is generally fixed either to the roof of a building or utilises the roof structure in the case of an integral LPS or is a pole close to the building and standing taller than the building being protected and is struck in preference to the building.

C.4.1 Types of ATN

There are three types of integral ATN and they are illustrated at Appendix 1 to this Annex. The three types are:

a) surface mounted air termination;

b) an RC structure with fixed air termination (Figure C.1); or

c) a steel frame and roof (Figure C2).

There are two types of separated ATN and they are also illustrated in Appendix 1. The two types are:

a) suspended air termination (Figure C.4); or

b) vertical air termination (Figure C.5).

C.4.1.1 Surface mounted air termination

This design of LPS is by far the most common. The roof conductors should form a mesh of the size as required by the national technical authority but ideally 10m x 5m, or smaller if necessary, and it should be made of bare copper only.

Conductors may be laid directly on the roof as long as roofing materials do not cover them. The edges are the most vulnerable parts of a roof and therefore conductors running along an edge should be placed as close as practicable to the edge; 100mm or closer is the ideal.

If a single facility has roofs at different levels, each level should be protected. The fixed air termination network on a roof at one level may provide protection to a roof at a lower level. In this case a separate network on the whole or part of the lower roof may not be necessary. Specialist advice should be sought.

C.4.1.2 RC structures with fixed air termination

The wall and roof reinforcing bars of RC structures should be brought out in a minimum of two diagonally opposite locations on the structure. They should be bonded to the surface mounted air termination network and the down conductor. If separate down conductors are installed, these should also be bonded to the reinforcing bars at the tops of the walls.

Where a down conductor is attached to a reinforced concrete column or a concrete encased steel column, the steel work should be connected to the down conductor above the test joint. The reinforcement of the wall, floor and the reinforced column or steelwork should be contiguous with the reinforcement of the roof.

Pointed vertical conductors or finials are not normally provided on a surface mounted air termination but are entirely appropriate for RC structures and explosives buildings.

C.4.1.3 Steel Frame and Roof

If the building has a metal roof, then the roof will form the air termination network. It is vital that the metal roof is properly bonded to the LPS down conductors.

If the roof is part of a steel framed structure then the steel frame may be designed to form the down conductors for the LPS. In such cases all metalwork between the steel frame and roof should be electrically bonded and the joints tested to ensure they have a resistance of ideally 0.5Ω or less.

C.4.1.4 Suspended air termination network

A network of this type comprises two or more poles supporting and bonded to an aerial conductor or system of conductors. The support poles should be positioned at least 2m from the facility. When one pole consists of a non-conducting material, a conducting tape running the length of the pole is to be provided to bond the aerial conductor to the earth termination network. All stay wires are also to be bonded to the earth termination network.

In order to prevent flash over, the minimum clearance between the lowest part of an aerial conductor system and the protected facility should not be less than 2m in the maximum sag condition caused by snow and ice. However, should the facility have sharp or pointed metallic earth bonded components protruding from the protected building, such as a ventilation stack, a clearance of >5m should be required from the highest point on the structure.

C.4.1.5 Vertical air termination network

A vertical air termination network comprises a single metallic pole positioned at least 2m from the facility. Stay wires should be bonded at the upper end to the LPS and, at the lower end, should be bonded to the buried ring earth electrode.

C.5 Down conductors

Surface mounted air termination networks should be provided with two or more down conductors around the perimeter of the facility. They should be equally spaced as far as possible and not be more than 15m apart. Down conductor material should be copper, and each down conductor should have an associated earth rod as specified by the national technical authority.

Down conductors should not be taken inside buildings, but metal structural elements used as down conductors may have internally exposed parts. This should be taken into account with respect to the internal layout of the facility.

If the reinforcing bars or steel frames of a facility are being used as the down conductors, then the connection to the earth termination network should be approximately 100mm above ground level. The connection to the reinforcing bars or frame should be such that it can be inspected readily but it should also be protected from the elements.

C.6 Earth termination networks

These should be located as close as possible to the facility being protected but should be not less than 600mm from the wall footings. An earth termination should consist of rod electrodes, tapes or other means of providing a connection to the earth.

C.6.1 Metal rod electrodes

Rod electrodes should be driven to the depth necessary to give the desired earth resistance. The minimum depth should be that at which the rod penetrates into soil of permanent dampness. If more than one rod is necessary to obtain the desired resistance, the spacing between the rods should be at least equal to the driven depth. Rod electrodes have a life of some 30 years. Increasing resistivity is caused by failure of the copper plating and the subsequent rusting of the rod material. Failing rods should be replaced.

All earth electrodes of a system should be interconnected by a ring conductor buried at least 600mm below ground. The earth systems of adjacent structures should be interconnected where reasonably practicable and where the ground conditions make the achievement of the required earth resistance difficult. In difficult ground conditions where rod electrodes prove ineffective specialist civil engineering advice should be sought.

If a facility is sited on bare rock, a satisfactory earth electrode may be obtained by rock drilling and back filling the hole with sifted soil or a mixture of carbon powder and copper dust before driving the earth rods. The diameter of the hole should be 75mm or greater. Coke, breeze or fly ash should not to be used as back fill because they have a corrosive effect on copper. There are commercially available products that may be used to improve the ground conductivity around electrodes. In areas of high soil resistance or restricted space limiting the number of rods that can be driven chemical rods may be used in conjunction with conductive or moisture retaining backfill.

C.6.2 Chemical rod electrodes

Chemical earth rods provide a controlled release of a saline type solution into a backfilled area. They may be used if difficult ground conditions are encountered and may remove the need to drive extra rods if space is limited. These types of earth rod require regular re-filling with an appropriate chemical solution so a maintenance regime should be adopted when using these rod types in order to maintain their effectiveness. Chemical rods offer more consistent performance in desert conditions or climates with distinct wet and dry seasons.

C.6.3 Estate management and testing

Should increasing earth rod resistance necessitate the driving of additional rods, the facility engineering drawings should be amended to reflect the change and the future testing regime should test the rods as one electrode. Water pipes or other services should not be used as part of the earth termination system or as the earth electrode.

In order to allow for the electrical isolation of and access to the electrodes during testing, the upper ends of the electrodes should be terminated in a small covered service pit. Where conditions such as the need to bond to metal parts of the facility require a conductor to be exposed, the conductor should be attached to and encircle the facility at a height of 500mm above ground level. It should be permanently bonded to all down conductors. If the conductor is attached to the facility it is to be visible throughout its whole length. Should door openings, paths and roadways make it necessary for the conductor to go underground it should be drawn into a non-metallic pipe.

C.7 Test joints and bonds

C.7.1 Joints

A multi-way, clamp type test joint should be constructed in each service pit. Only earth termination networks should be permitted below a test joint.

Poles supporting an air termination network should be provided with test joints at 500mm above ground level and connected to the earth termination network and to any stay-wires at points as near as practicable to the pole.

Earth electrodes should be capable of being isolated and a reference earth electrode should be provided for testing purposes, particularly when the surrounding soil is concreted or tarmacked.

If the steel structures of a facility are used as the down conductors, sufficient test points should be provided to enable the low resistance continuity of the steel structure to be checked. This is especially important for those parts of the structure that are not visible or accessible.

C.7.2 Bonds

All major items of metal external to, and forming part of a facility, should be bonded to the LPS. Bonding material for both internal and external bonds for explosives buildings should be annealed copper. Steelwork that is less than 2m long i.e. metal window frames, small ventilators and other small metal fittings, provided they are more than 500mm from any LPS components, need not be bonded.

Resistance testing of bonds should be performed during acceptance of the LPS installation and requires periodic inspection through its life.

The metal sheath or armour of incoming electrical supply cables should be bonded to the LPS and to the enclosure of the main switch at the cable entry point only. The metal sheath or conduit of each circuit leaving the main switch should be bonded to the switch enclosure. All other metal service pipes or conduits should be bonded to the LPS at their point of entry to the facility only. All straight runs of metallic conduit, pipe work or metallic cable sheathing should be bonded to the LPS at each entry and exit point. It should be possible to isolate the LPS connection for test purposes.

All railway and crane rails within a facility should be bonded at each end to the LPS. Any rails extending outside the facility should be bonded to the LPS at their point of entry/exit.

The LPS should be connected to the facility earth bus bar at one point only. The means of connection should be such that it can easily be disconnected to enable tests to be made.

C.8 Underground facilities

As stated previously, normally an underground facility does not require an LPS. However metal and structural parts of the site that have less than 600mm of earth coverage should be protected as for an above ground site.

C.8.1 Exposed headwalls

If an earth covered facility has an exposed headwall then the headwall should have an air termination network connected to the reinforcing bars of the roof concrete and all exposed metalwork should be bonded together and connected to the earthing system at the entrance to the structure.

C.8.2 Less than 600mm of earth cover

Should a facility have less than 600mm of earth cover it should be protected against lightning strikes. The following requirements should be met:

a) roof conductors may be fixed directly to the roof of the facility;

b) the earth termination network conductor should run underground at a distance of approximately 1m from the base of the earth cover. It should be taken across the head wall or other wall not covered with earth at 500mm above ground level;

c) down conductors should pass through the earth cover at a distance of 500mm from the structure. They should also be taken down the head wall or any other wall not covered with earth; and

d) the joints between down conductors and the earth termination network should be readily accessible for inspection. These joints should be within 150mm of the ground surface in a covered inspection pit.

C.9 RC facilities such as igloos and other cast in-situ buildings

C.9.1 RC facilities

If correctly designed and constructed RC facilities will have inherent lightning protection. The structural steel components of the structure create a shield only if the conducting elements are electrically contiguous. For RC structures this can only be assured by ensuring that the wall reinforcing bars are bonded to the reinforcements of the roof and floor during construction.

To provide the inherent protection all metallic penetrations should be bonded to the reinforcing bars where they penetrate the structure. Extensions of the reinforcing bars should be provided to connect strike termination devices to reduce the risk of structural damage from lightning. Steel portal frame with earth bonded profiled sheet cladding will provide a Faraday cage like structure but will afford less shielding effectiveness than reinforced concrete structures. Under-floor reinforcing mesh should also be bonded to the portal frames during construction.

It cannot be assumed that all existing RC and metal clad structures will provide inherent protection. Therefore, a low voltage shielding effectiveness test should be carried out by appropriately qualified personnel. If this is not possible then an approved external LPS should be installed.

The most important lightning protection feature of a RC explosives facility is the reinforcing bar mesh within the concrete shell. This will carry some 90% of the lightning current from a strike. Therefore, it is essential that the reinforcing bars completely encircle the volume of the facility i.e. the roof, walls and floor. The reinforcing bars in the roof, walls and floor should be bonded as follows:

a) reinforcement crossovers should be welded at a maximum of 2.5m centres in both faces; and

b) remaining reinforcement crossovers should be wire-tied at every intersection.

The nature of the metallic connection and the very large number of bars and crossing points of such a construction ensures a substantial sub-division of the total lightning current through a multiplicity of parallel discharge paths. To be fully effective as a shield against fields produced by lightning the RC mesh size should be no larger than 30cm.

No separate down conductors are necessary on a facility of RC construction. However, at roof level a surface mounted ATN should be fitted to reduce the structure's physical elements from damage due to external spalling should the facility receive a lightning strike. The fixed ATN should be directly bonded to the reinforcing bars in the number of positions required for down conductors in at least two diagonally opposite places.

If a pitched metal roof is fitted on a RC facility, then the roof may act as the ATN provided that the minimum material thickness requirements required by the national technical authority are met. If this type of roof is specified it is recommended that at least two finials are fitted, one at each end of the roof ridge.

Other metallic penetrations, such as conduits and pipes, should be bonded to the closest reinforcing bars at the point of entry. All doors and windows should be bonded to their frames and the frames should be bonded to the structure reinforcing bars.

C.9.2 Steel framed buildings

A steel-framed building with metal cladding may be regarded as a Faraday cage if:

a) the components of the facility are bonded together with a resistance of les than 0.5Ω; and

b) the resistance to earth of each vertical stanchion does not exceed 10Ω.

However, these values can only be tested during construction of the building and therefore all bonding and earth termination network resistance testing should be performed during the construction of the facility. Testing of the resistance to earth of each stanchion should be made before any electricity supply cables, rails or other metallic pipes are attached to the structure. Where these earth resistance requirements are not met with, a ring conductor bonded to each stanchion and with earth electrodes at each end of the structure should be provided

The minimum thickness of metal used for the cladding and the roof, which forms part of the air termination network, should be of a thickness as specified by the regulations of the national technical authority or to internationally accepted standards.

The foundations of the facility may have low earth resistance without the need for additional earth electrodes, particularly if the facility foundation includes reinforced piles. Measurement of the earth resistance of the newly completed foundations will identify if they are compliant or if more earth electrodes are needed.

The steel frames should be fitted with connections at the top and bottom as a means of bonding the roof and earth to the frames. If the foundation alone is used, provision should be made to bond each vertical stanchion of the steel structure to the earth matrix and in turn to the foundation concrete reinforcing bars and mesh.

Metallic penetrations, such as conduits and pipes, should be bonded to the facility at their point of entry. Details of bonding connections between the steel frame, cladding, roof, walls etc should be decided at the design stage.

Steel portal framed, metal clad structures may not need periodic testing of the permanently made bonds that make them self-protecting from the effects of lightning, and it should be the aim of the designers of the system to achieve this aim.

C.10 Open storage of explosives

Explosives being stored in the open for long periods require a LPS which provides a 30° cone of protection or suspended air termination. This requirement may be dispensed with if it can be shown after a thorough risk assessment that an explosives event due to a lightning strike is unlikely due to ammunition insensitivity, low strike probability etc.

Short term storage may be provided with LPS cover in the form of a temporary vertical, or suspended, air termination LPS.

C.10.1 ISO containers

ISO containers loaded with ammunition may be open stored with the following restrictions:

a) unpackaged explosives should not be stored in ISO containers. Ammunition packaging should provide a standoff distance from container walls;

b) the container meets the requirements of Clause 8.1.3; and

c) containers storing explosives should not be stacked.

C.11 Testing of LPS

Inspection, testing and recording of the results of LPS tests should follow national technical authority guidelines and meet the requirements of Table 6. When selecting a testing regime, the following requirements should be adhered to:

a) a ‘fall of electrical potential’ test utilising supplementary electrodes is the preferred test method;

b) in commissioning of new or refurbished facilities use of the fall of potential method is mandatory;

c) clamp-on style test equipment may be used for periodic testing of LPS, but every fifth test period should be conducted using the fall of potential method;

d) clamp-on testers cannot test earth electrodes accurately if a ring conductor is still in circuit and if the LPS is still cross bonded to the low voltage incomer sheath. It is mandatory that both should be disconnected for the earth electrode test; and

e) test records shall clearly show which test method has been used.

C.11.1 Testing conformance and parameters

When an LPS is tested it should meet the following parameters:

a) the resistance to earth of an individual earth electrode with all connections removed should not exceed 10Ω multiplied by the number of earth electrodes in the entire earth termination network;

b) a buried ring conductor should be treated as part of the earth termination network. With all earth electrodes connected to the ring conductor and all equipotential bonding conductors to incoming services, crane and railway rails etc removed the total resistance to earth should not exceed 10Ω;

c) with all earth electrodes connected to the system and all equipotential bonding removed the resistance to earth of a system at points approximately equidistant between earth electrodes should not exceed 10Ω; and

d) there should be a maximum resistance of no more than 0.5Ω across equipotential bonds.

Structures with a Faraday cage LPS (Figure C.6) and without an external LPS should be tested if specific control of the requirements was not in place during construction. Adequacy of bonding and electrical continuity of the structural elements in the walls, roof and floor should be validated by measuring the transfer impedance frequency response using appropriate test instruments. These are complex tests and specialist electrical and civil engineering advice should be sought.

C.12 Design parameters

No LPS can guarantee total immunity from damage by lightning discharge. The Faraday cage, together with suspended air termination, is considered to provide maximum protection when all other measures such as surge protection and equipotential bonding have been taken.

The main danger from structural metal or metal cladding not forming part of the LPS is damage from side flashing where its position relative to roof or down conductors may offer an alternative current path to earth. This can be avoided by isolation, by distance or by bonding.

Each earth electrode of the system should be inter-connected by a ring conductor, which should preferably be buried. Because of the need to bond other objects to it, it is permissible to leave it exposed on the walls of the facility. In these cases, the interconnection is no longer part of the earthing system. It should not form part of the testing of the earth terminations and the connections to the down conductors, with which it inter-connects, should be fixed and permanent.

The use of unnecessary clamp connectors, which are liable to be disconnected, should be avoided. Such connectors should only be used where it is necessary to disconnect for test purposes.

External LPS conductors should not be coated in insulating material or painted.

C.12.1 High risk explosives

A 15°/30°zone of protection or the so-called 20m rolling sphere (see below) should be used for facilities of highest risk. Explosive items in this category are those sensitive to electrical induction, thermal shock, mechanical shock, or where the consequences of an explosion may be very serious.

C.12.2 Zones of protection of a separated LPS

International good practice and the results of much experimentation have shown that the zone of protection provided by a vertical air termination is a solid angle of 30° which has its apex at the highest point of the mast. For masts not exceeding 10m in height, the described volume is protected from all but the highest severity direct lightning strike as long as no part of the structure extends outside of the protected zone.

The zone of protection provided by a suspended air termination is described by a triangle with an angle of 30° to the vertical support pylons. As above, for suspended air terminations not exceeding 10m in height, the described volume is protected from all but the highest severity direct lightning strike as long as no part of the structure extends outside of the protected zone.

C.12.3 Rolling sphere protection

High structures that require a separated LPS exceeding 10m in height are special cases because the protected volume cannot be adequately defined by the 30° angle. As the leader approach of the lightning is described by a sphere centred on the leader end, the protected volume can be determined by rolling an imaginary sphere of radius equal to the step length all around the protected building and where it touches the LPS the protected volume is defined. The striking distance is related to the severity of the lightning strokes – the greater the severity of the stroke the greater the striking distance. In general terms, the smaller the sphere, the greater the protection but the LPS installation becomes more costly.

A 20m sphere should be used for buildings containing explosives and will describe protection against all but the lowest 5th percentile severity direct lightning attachments. Figures C.7 and C.8 of Appendix 1 show a 20m rolling sphere as applied to a vertical air termination and suspended air termination respectively where the height is greater than 10m. An approximate angle that would describe the protected volume derived from the rolling sphere method would be 15°. The rolling sphere principle is described at Figure C.9.

Appendix 1 to Annex C
(informative)
LPS designs

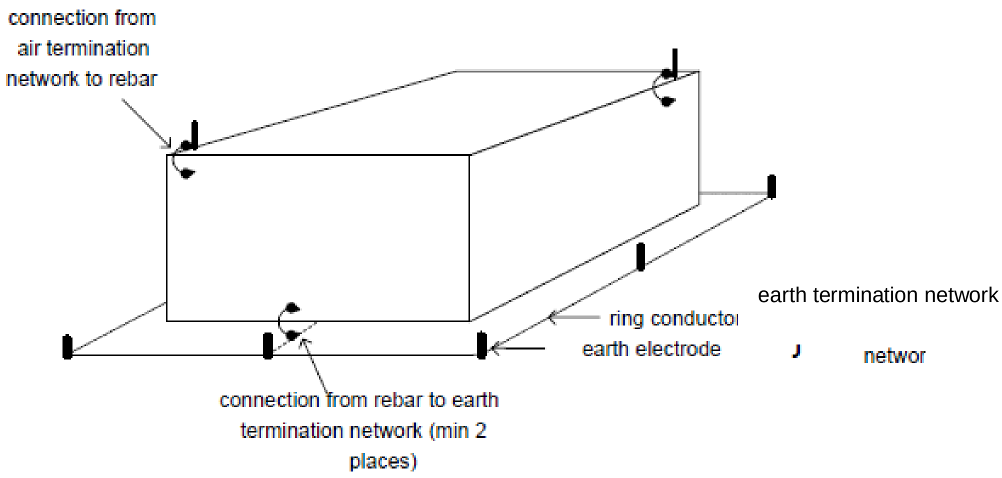


Figure C.1: Air termination network on a RC structure

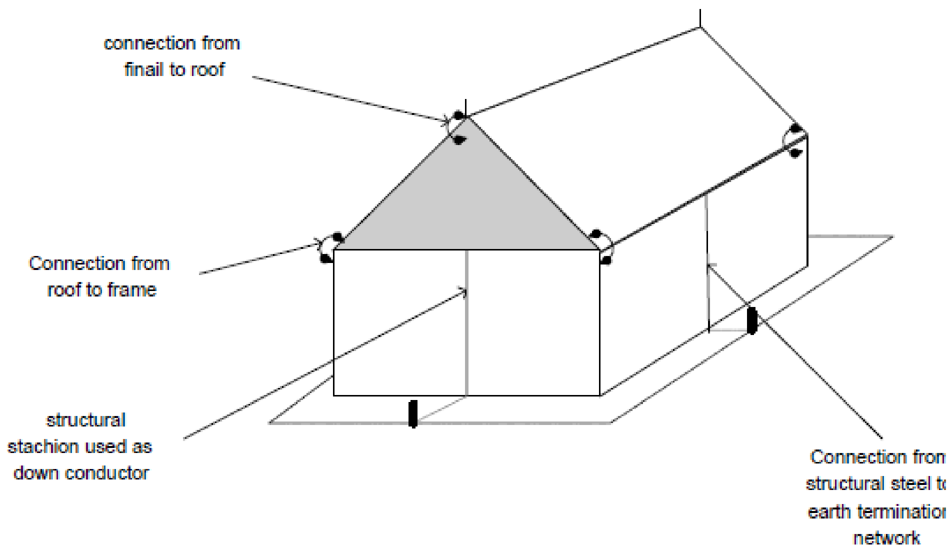


Figure C.2: Steel framed facility with metal cladding

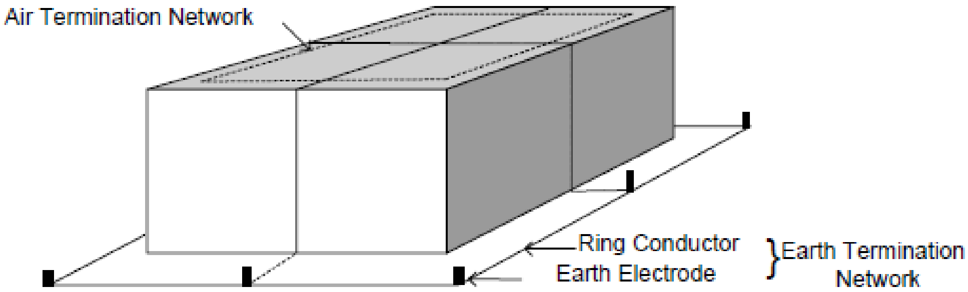


Figure C.3: Other methods of construction

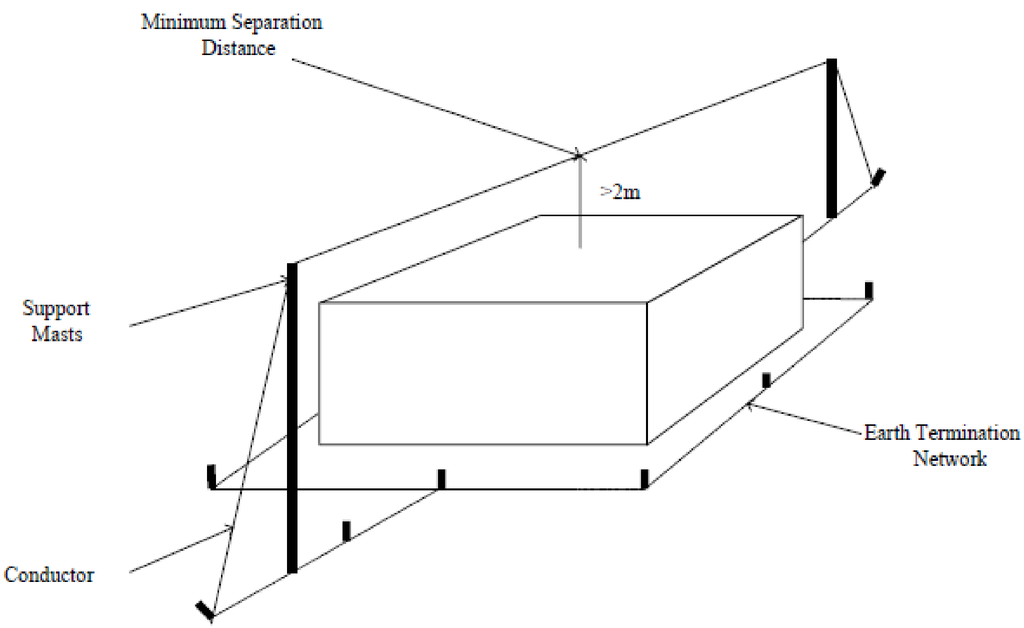


Figure C.4: Suspended air termination network

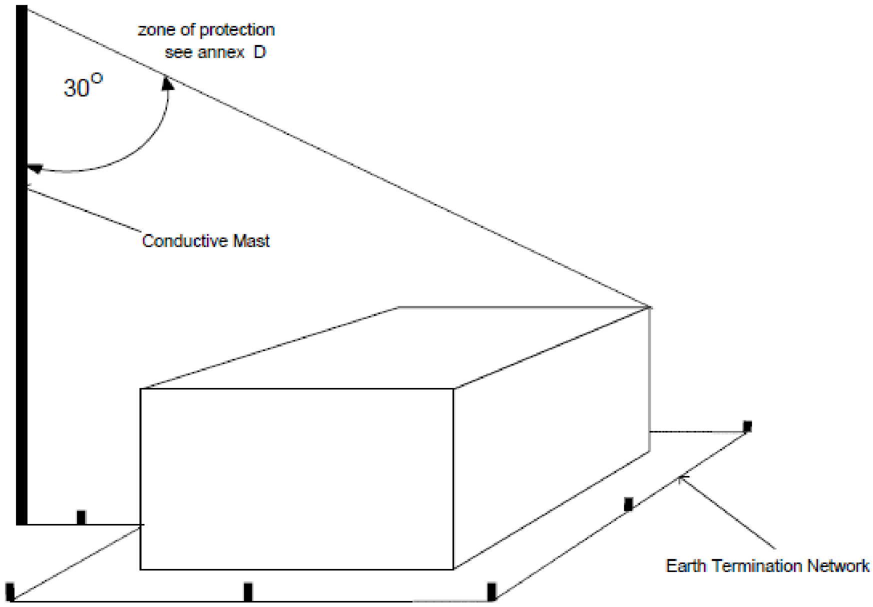


Figure C.5: Vertical termination network

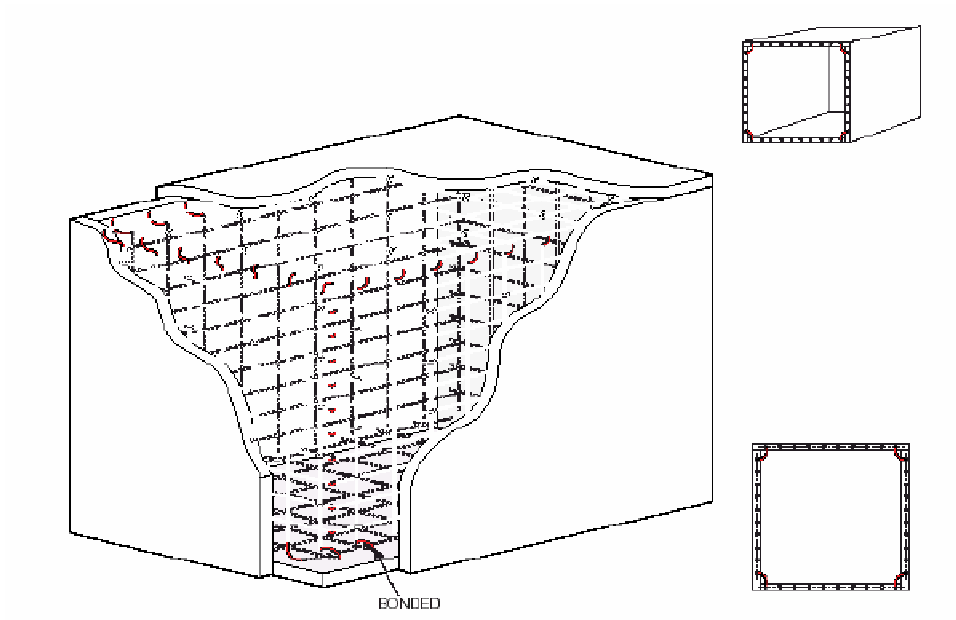


Figure C.6: Faraday cage construction

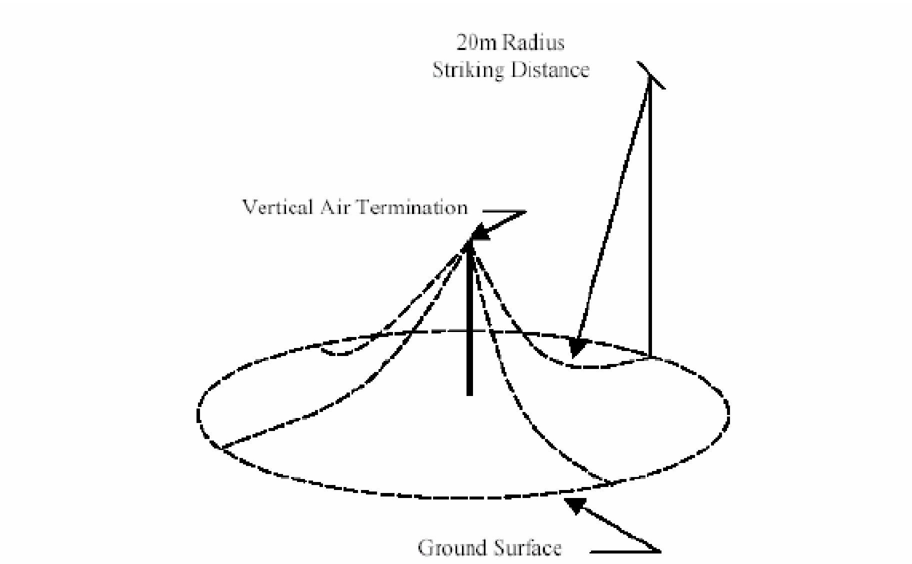


Figure C.7: Vertical air termination – 20m rolling sphere

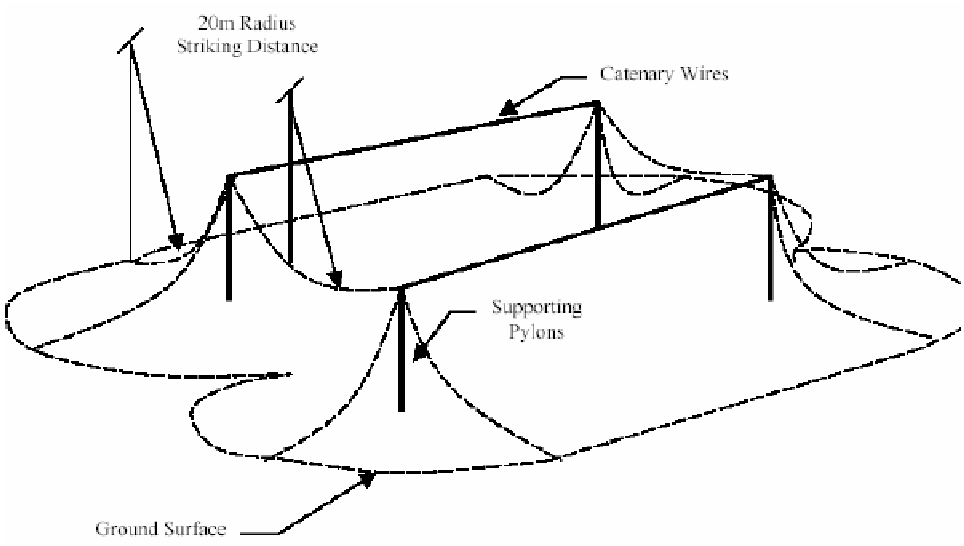


Figure C.8 Suspended air termination – 20m rolling sphere

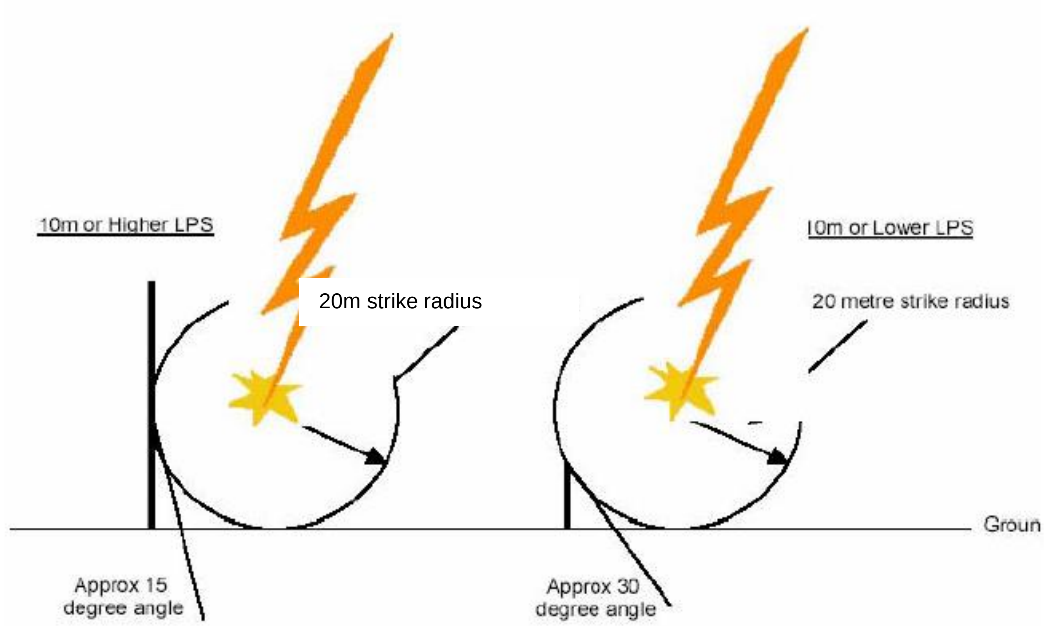


Figure C.9: The principle of the 20m rolling sphere

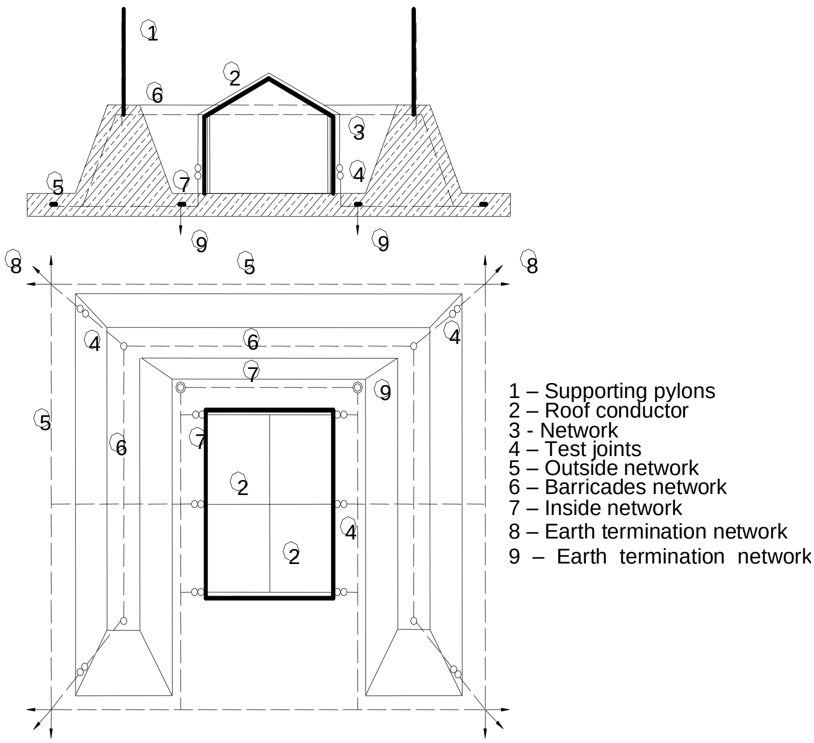


Figure C.10: The two levels of lightning protection systems

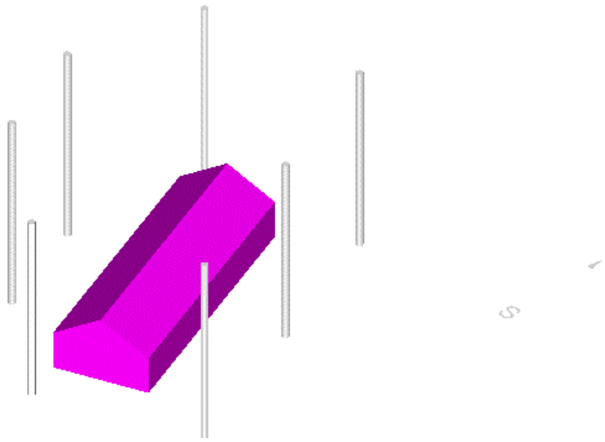
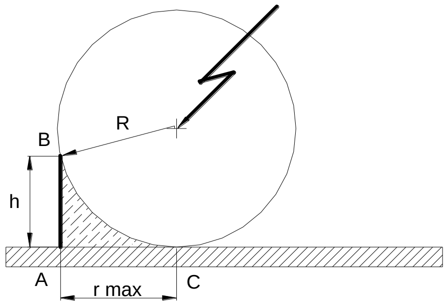
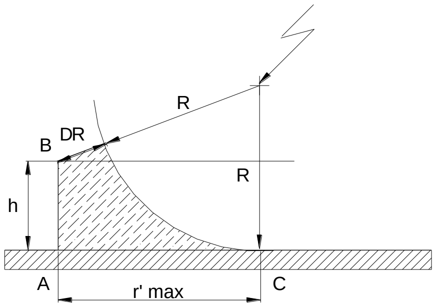


Figure C.11: Supporting pylons protection system around ammunition facility



$$AC = r_{\max} = \sqrt{h(2R - h)}$$

Figure C12: Protection zone of the supporting pylon protection system



$$R' = R + \Delta R \ (m), \quad \Delta R = v \ \Delta t \ (m),$$

$$r'_{max} = AC = \sqrt{h\left[2\left(R + \Delta R\right) - h\right]} \ (m).$$

Figure C13: Protection zone of the supporting pylon with LPS - early streamer emission

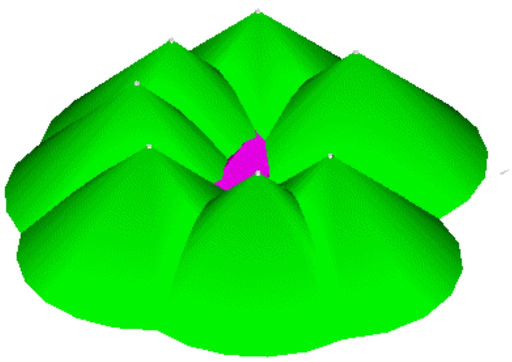


Figure C14: Improper Placement of the supporting pylons around the ammunition facility

Annex D
(informative)
Applicable EU regulations

Table D.1 contains European Union standards that could be used as reference by national technical authorities for electrical installations within explosive facilities.[17]

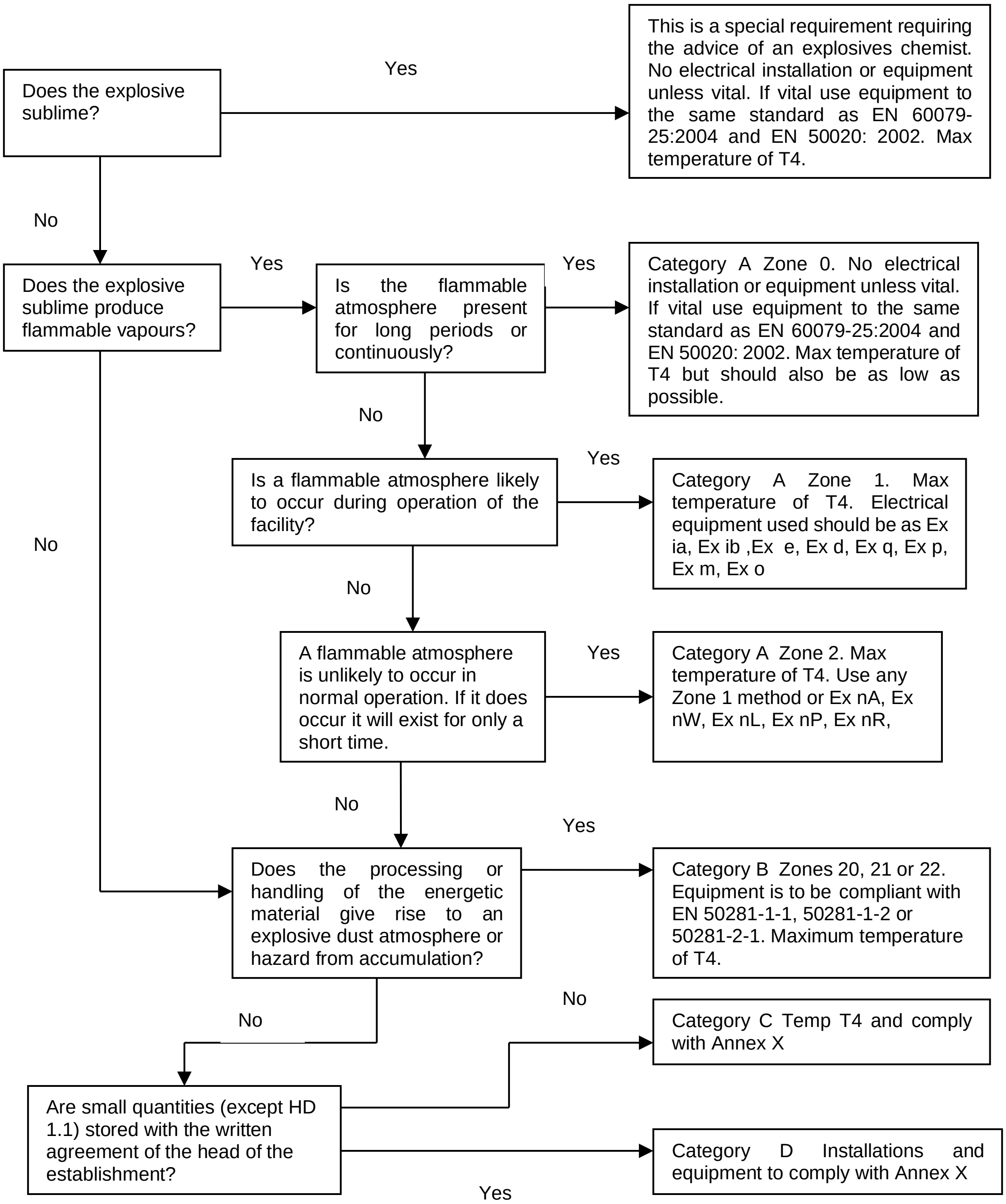
EN Standard #	Title
EN 1127-1:1998	Explosive atmospheres – Explosion prevention and protection – basic concepts and methodology.
EN 1175:1998	Safety of industrial trucks – electrical requirements.
EN 1755:2000	Safety of industrial trucks – operation in potentially explosive atmospheres – use in flammable gas, vapour, mist and dust.
EN 1834-1:2000	Reciprocating internal combustion engines – Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 1: Group II engines for use in flammable gas and vapour atmospheres.
EN 1834-2: 2000	Reciprocating internal combustion engines – Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 2.
EN 10015:1992	Basic specification. Protection of electrostatic sensitive devices. Part 1. General requirements.
EN 20284:1993	Conveyor Belts. Electrical conductivity. Specifications and method for test.
EN 20344:2004	Personal Protective Equipment – Test Methods for Footwear.
EN 20345:2004	Personal Protective Equipment – Specification for Safety Footwear.
EN 50014:1997	Electrical apparatus for potentially explosive atmospheres. Part 1 General Requirements.
EN 50015:2002	Electrical Apparatus for Potentially Explosive Atmospheres: Oil immersion ‘o’.
EN 50016:1998	Electrical Apparatus for Potentially Explosive Atmospheres: Pressurised “p”.
EN 50017:1998	Electrical Apparatus for Potentially Explosive Atmospheres: Powder Filling “q”.
EN 50018:2000	Electrical apparatus for potentially explosive atmospheres. Part 5 Flameproof Enclosures 'd'. Superseded by 60079-1:2003 but remains current.
EN 50019:2000	Electrical apparatus for potentially explosive atmospheres. Part 6 Increased Safety 'e'. Superseded by 60079-7:2003 but remains current.
EN 50020:2002	Electrical Apparatus for Potentially Explosive Atmospheres: Intrinsic Safety “i”.
EN 50021:1999	Electrical Apparatus for Potentially Explosive Atmospheres: Type of Protection “n”. Superseded by 60079-15:2003 but remains current.
EN 50028	Electrical Apparatus for Potentially Explosive Atmospheres: Encapsulation “m”. Superseded by 60079-18:2003 but remains current.
EN 50281:1999 (Parts1 and 2)	Electrical Apparatus for use in the presence of Combustible Dust.
EN 60529:1992	Degrees of protection provided by enclosures (IP code).
EN 60309-2:1992	Plugs, sockets-outlets and couplers for industrial purposes.
EN 60702-1:2002	Mineral insulated cables and their terminations with a rated voltage not exceeding 750V.
EN 60079-0:2004	Electrical apparatus for explosive gas atmospheres. General requirements.
EN 60079-1:2004	Electrical apparatus for explosive gas atmospheres. Flameproof enclosures ‘d’.
EN 60079-7:2003	Electrical apparatus for explosive gas atmospheres. Increased safety ‘e’.
EN 60079-10:2003	Electrical apparatus for explosive gas atmospheres. Classification of hazardous areas.
EN 60079-14:2003	Electrical apparatus for explosive gas atmospheres. Electrical installations in hazardous areas (other than mines).
EN 60079-15:2003	Electrical apparatus for explosive gas atmospheres. Type of protection ‘n’.
EN 60079-17:2003	Electrical apparatus for explosive gas atmospheres. Inspection and maintenance of electrical installations in hazardous areas (other than mines).

[17] These have been deliberately excluded from the biography at Annex C to IATG 01.10 *Guide to the IATG*.

EN Standard #	Title
EN 60079-18:2004	Electrical apparatus for explosive gas atmospheres. Construction, test and marking of type of protection encapsulation ‘m’ electrical apparatus.
EN 60079-25:2004	Electrical apparatus for explosive gas atmospheres. Intrinsically safe systems.
EN 60898:2003	Specification for circuit breakers for over-current protection for household and similar installations.
EN 60947-2:1996	Specification for low voltage switchgear and control gear. Part 2. Circuit breakers.
EN 60947-5-1:2004	Electromechanical control circuit devices.

Table D.1: Technical design, test, and construction standards

Annex E
(informative)
Selection of correct electrical category



Appendix 1 to Annex E

Example of Electrical Category Signage for Explosive Buildings

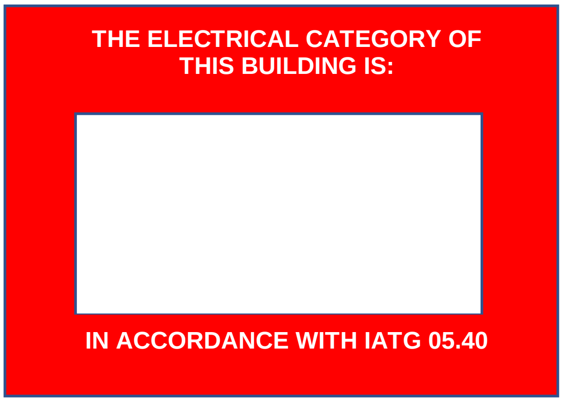


Fig E1 Example of Electronic Category Signage

Note: this signage can also be used for marking where electrical categories change within a building by replacing the word ‘BUILDING’ with room, area etc.

Annex F
(informative)
Requirements of Category C electrical fittings and equipment

F.1 General requirements

The following recommendations may be used as the selection criteria for equipment used in Category C explosives buildings. National technical authority requirements shall take precedence, but these recommendations are considered international good practice.

F1.1 Assumptions and protection levels

The recommendations are based on the assumption that enclosures without ventilation openings are not necessarily airtight, but comply with the construction requirements and type tests in the following paragraphs. The protection against ingress of solids and liquids provided by the enclosures is assumed to comply with IP 44 (See Table 5).

The design surface temperature of enclosures under normal conditions should not exceed T4 levels and water or oil filled radiators should not exceed T6 levels.

Any equipment that is compliant with a more demanding standard is acceptable for Category C environments, provided it meets the surface temperature limits above.

Acceptable standards are:

a) IP 45 – IP 68 (Table 5); and

b) hazardous area equipment for Zones 0, 1, 2, 20, 21 or 22.

F.2 Construction

The following construction parameters should be met:

a) enclosures may be made of metal or plastic;

b) all materials used in the construction including inspection windows and light transmitters should resist the propagation of flame;

c) transparent covers including inspection window and light transmitters may be glass or plastic. They should be positively secured to the main enclosure; and

d) enclosures should be provided with appropriate conduit and/or cable entries.

F.3 Testing

The tests are to be type tests and are to be made on a representative enclosure that is a new condition. It should pass all specified tests and should satisfy those requirements that can be checked only by inspection. The tests are to be carried out at an ambient temperature of 25°C +/- 5 °C.

Manufacturers should have the appropriate ISO 9000 accreditation and shall certify that production equipment complies with the specification against which the type tests were conducted.

F.3.1 Test schedule for electrical installation and equipment

Test number 1 is to measure protection against the ingress of foreign bodies at level IP40. This is a search test made with a steel wire of 1mm diameter. The test should be deemed satisfactory if the wire cannot enter the enclosure.

Test number 2 is test protection against the ingress of liquid at level IP04. The test ensures that the equipment is protected against liquid splashed from any direction.

Impact testing of enclosures, including light transmitting parts, should ensure that they withstand the impact energies listed in Table F.1. Each impact is to be made by a mass of 1kg falling from the appropriate height to provide the required impact. The striker should be a hardened steel sphere of 25mm diameter.

The enclosure is to be tested when it is fully assembled and mounted on a rigid base. When the plane of the impact is to be altered the base should be moved to achieve the desired new position.

Component	Impact Energy (J)	Drop Height (m)	EN50102 Code
Guards, protective covers, fan hoods and cable entries.	3.5	0.35	IK08
Plastic enclosures.	3.5	0.35	IK08
Light metal or cast metal enclosures.	3.5	0.35	IK08
Enclosures of materials other than above with wall thickness of less than 1mm.	3.5	0.35	IK08
Light transmitting parts without guards.	2	0.2	IK07
Light transmitting parts with guards.	1	0.1	IK06

Table F.1: Impact energies for testing

F.4 Drop test for portable equipment

One sample of the portable equipment electrical apparatus is to be dropped. The equipment should be dropped four times from a height of 1m. The attitude of the equipment when dropped should be such to ensure maximum damage would be caused by the drop e.g. on a corner, a glass face etc. The drop is to be on to a concrete surface. The integrity of the apparatus enclosure should be impaired after this test, but the equipment need not necessarily be functional after the test.

Annex G
(informative)
Requirements of Category D electrical fittings and equipment

G.1 General

Category D comprises buildings and rooms where authorised quantities of explosives, except HD 1.1, are stored with the written agreement of the head of the establishment. The explosives shall not be exposed and should not give rise to flammable vapours or explosives dust.

G.1.1 Protection

The protection against the ingress of solids and liquids provided by the enclosures should be IP 44. Enclosures including light transmitters should be capable of withstanding the impact energy as required by EN 50102, IK08.

G.2 Construction

Equipment construction requirements are as follows:

a) all plastics used in the construction including inspection windows and light transmitters should resist the propagation of flame;

b) transparent covers including inspection windows and light transmitters may be glass or plastic, but the plastic material must comply the flame propagation requirements above. They should be positively secured to the main enclosure; and

c) enclosures should be provided with appropriate conduit and/or cable entries.

Annex H
(informative)
Measuring the resistance of conductive and anti-static flooring

H.1 Background

In order to avoid a hazardous accumulation of electrical charge, the dissipation path should permit a current that at least balances the worst case charging current of 10^{-4}A. In several standards 100V is used as the threshold value and these electrostatic control measures are based on the assumption that a person below this potential will not present a credible hazard to explosives.

This limit is reflected in the design of the conductive regime hazardous area personnel test meter (HAPTM) that applies 100V across the test subject-footwear-flooring combination. However, it is important not to test at voltages significantly in excess of 100V because it is probable that some of the elements in the path from the contact surface of the floor to the earth point will not obey Ohm's Law. As a consequence, the effective impedance of any such element is likely to decrease with increased potential. This means that if the test is conducted at a potential **above** 100V it may give a false impression of the effectiveness of the earth system.

H.2 Pre-test cleaning

The head of the establishment should ensure and certify in writing that all explosives have been removed from the facility before anyone with electrical equipment is allowed to enter the building. Floor cleanliness is essential in providing integrity and extending the life of the flooring material. Contaminants such as oils and grease can be removed using proprietary spill absorbent and then cleaned as described below. The floor is to be cleaned prior to testing using materials approved by the manufacturer and the following method should be used:

a) prepare the floor cleaner in accordance with the manufacturer's instructions;

b) clean the floor, either manually or with a floor scrubber that has transverse horizontally mounted brushes only. Machines with contra-rotating brushes should not be used as they concentrate the dirt at the junction of the brushes and may ingrain it into the floor;

c) remove all traces of the cleaning agent by rinsing with clean water; and

d) allow the floor to dry.

H.3 Floor inspection

After cleaning the entire floor area it should be inspected before proceeding with the test. The inspection shall:

a) identify worn areas which should be repaired or replaced as necessary;

b) identify any floor damage which should be repaired or replaced as necessary;

c) identify any areas of contamination not removed by the pre-test clean. These should be re-cleaned; and

d) map on the matrix shown below at Figure H.1 the outline of the facility, the chosen test points, and all areas of wear, damage, and contamination. Include the position of the connections from the facility earth to the floor. The floor is not to be marked. A test should be conducted at least once in each area of flooring measuring 1.5m x 1.5m.

H.4 Conductive floor testing

The floor should be measured using the following testing regime:

a) carry out a visual check to confirm the electrical integrity of the connection of the floor to the facility earth system;

b) confirm that the electrical continuity of the earth electrode connection to the conductive floor connection, at more than one point, is less than 0.5Ω. It may be necessary to remove any outer protective covering from the connections before electrical testing;

c) wet the test point using the wetting agent;

d) connect one end of the test instrument to the floor earth reference point and connect the other to the movable test probe;

e) measure the floor resistance at each test point and record the result on the matrix;

f) any results of greater than 50kΩ mean the floor has failed test. However, re-cleaning and testing may cure marginal test results. If this not successful repair or replacement should be necessary; and

g) insert the completed matrix into the building log book.

H.5 Anti-static floor testing

The floor should be measured using the following testing regime:

a) carry out a visual check to confirm the electrical integrity of the connection of the floor to the facility earth system;

b) confirm that the electrical continuity of the earth electrode connection to the conductive floor connection, at more than one point, is less than 0.5Ω. It may be necessary to remove any outer protective covering from the connections before electrical testing;

c) connect one end of the test instrument to the floor earth reference point and connect the other to the movable test probe;

d) measure the floor resistance (dry) at each test point and record the result on the attached matrix. If any result indicates less than 100kΩ wet the test point using the wetting agent and retest to ensure that no result is less than 50kΩ;

e) if any result indicates more than 2MΩ, wet the test point using the wetting agent and retest to ensure that no result is greater than 2MΩ;

f) all results should be between 50kΩ and 2 MΩ, or the floor will have failed the test. However, re-cleaning and testing may cure marginal test results. If this not successful repair or replacement should be necessary; and

g) insert the completed matrix into the building log book.

H.6 Wetting agent specification

A general purpose wetting agent can be made of four (4) parts by mass of polyethylene glycol and one (1) part by mass of distilled water.

H.7 Test equipment

The test probe should be a clean metal electrode of brass or copper, having a diameter of 25mm ± 1mm and a mass of 225g ± 15g.

H.7.1 Conductive flooring

To measure conductive flooring resistance the measuring instrument should have an open-circuit voltage of approximately 100V direct current (DC) and be capable of measuring resistance between the values of 0 and 100kΩ with a resolution of 1kΩ or better and an accuracy of ±5%. The test should also require low resistance test leads of sufficient length to span the entire facility floor.

H.7.2 Conductive flooring

To measure anti-static floor resistance the measuring instrument should have an open circuit voltage of 100V DC and be capable of measuring resistance between 50kΩ and 100MΩ with a resolution of 5kΩ and an accuracy of ±5%. The test should also require low resistance test leads of sufficient length to span the entire facility floor.

Conductive Floor Test Sheet Results (each square has sides of 1.5m)							
						Test Results	
						Measuring Point	Value (kΩ)
						1	
						2	
						3	
						4	

Figure H.1: Example conductive floor test sheet

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date under the edition number and date of the .

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted onwww.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 05.50

Third edition
March 2021

Vehicles and mechanical handling equipment (MHE) in explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 05.50:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The use of mechanical handling equipment (MHE), cranes and other vehicles in explosives storage areas, facilities or buildings presents an inherent risk of fire or explosion, which should be minimised. This IATG module provides guidance on the risk reduction measures to be taken when using MHE and other mobile equipment within, or close to, explosives facilities. The IATG also includes guidance to regulate their standards of design and manufacture.

Vehicles and MHE in explosives facilities

1 Scope

This IATG module provides guidance on: 1) the risk reduction measures to be taken when using mechanical handling equipment (MHE) and other mobile equipment within or close to explosives facilities; and 2) the design and manufacture of MHE and vehicles to appropriate standards.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition management activities.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Categorisation of vehicles and MHE and permissibility in explosives areas (LEVEL 2)

IATG 05.40 *Safety standards for electrical installations* categorises buildings containing explosives according to the nature of explosives stored, handled or processed in the building. It also categorises electrical installations and equipment to be used in the building. A similar system should also be used to categorise vehicles and MHE permitted inside buildings containing explosives. Ancillary items in use with vehicles and powered mobile MHE shall also comply with the equivalent standards of the main equipment with which they are utilised.

This IATG module covers the following categories of equipment:

a) forklift trucks;

b) mobile cranes;

c) fixed pedestal jetty cranes;

d) travelling portal jetty cranes;

e) ship and barge mounted cranes; and

f) overhead travelling cranes.

This IATG module is not intended to cover the following:

a) lifts;

b) conveyors; or

c) lifting gear used to attach the load to the crane hook.

4.1 Vehicles permitted in categorised areas (LEVEL 2)

Table 1 summarises the types of vehicles that may be used in the various electrical category areas and zones:[3]

Category and Zones	Permitted	Design and Manufacture Specifications
Category A Zone 0	▪ All vehicles and MHE shall be prohibited.	
Category A Zone 1 **Category A Zone 2**	▪ Diesel powered vehicles ▪ Diesel powered MHE ▪ Electrically powered vehicles ▪ Electrically powered MHE	See Annex C
Category B Zone 20 **Category B Zone 21** **Category B Zone 22**	▪ Diesel powered vehicles ▪ Diesel powered MHE ▪ Electrically powered vehicles ▪ Electrically powered MHE	See Annex D
Category C	▪ Diesel powered vehicles ▪ Diesel powered MHE ▪ Electrically powered vehicles ▪ Electrically powered MHE	See Annex E
Category D	▪ All vehicles	

Table 1: Vehicles and MHE permitted in electrical category zones

4.2 Vehicle compatibility and categorised areas (LEVEL 2)

Different categories of military diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE are, in some cases, compatible, although some are not. Table 2 summarises the compatibility of different Category Type vehicles.

Category Area of Vehicle	Compatibility with other Area Categories							
	Cat A Zone 0	Cat A Zone 1	Cat A Zone 2	Cat B Zone 20	Cat B Zone 21	Cat B Zone 22	Cat C	Cat D
Cat A Zone 0	Yes	Yes	Yes	No	No	No	Yes	Yes

[3] See Clause 4 of IATG 05.40 *Safety standards for electrical installations* for definitions of category zones.

Category Area of Vehicle	Compatibility with other Area Categories							
	Cat A Zone 0	Cat A Zone 1	Cat A Zone 2	Cat B Zone 20	Cat B Zone 21	Cat B Zone 22	Cat C	Cat D
Cat A Zone 1	No	Yes	Yes	No	No	No	Yes	Yes
Cat A Zone 2	No	No	Yes	No	No	No	Yes	Yes
Cat B Zone 20	No	No	No	Yes	Yes	Yes	Yes	Yes
Cat B Zone 21	No	No	No	No	Yes	Yes	Yes	Yes
Cat B Zone 22	No	No	No	No	No	Yes	Yes	Yes
Cat C	No	No	No	No	No	No	Yes	Yes
Cat D	No	No	No	No	No	No	Yes	Yes

Table 2: Vehicles and MHE permitted in electrical category zones

4.3 Vehicles authorised to enter a potential explosion site (PES) (LEVEL 1)

Electrically operated vehicles and MHE shall always be preferable, from a safety viewpoint, to those operated by internal combustion engines. Electrically powered vehicles and powered mobile MHE can be permitted in a potential explosion site (PES) under certain specific conditions.

Petrol engines shall not be permitted in a PES. Diesel powered vehicles and diesel powered mobile MHE can be permitted in PES under certain conditions.

Diesel engines that have petrol starting systems, and vehicles powered by liquid petroleum gas (LPG), butane or propane operate under the same combustion/ignition conditions as petrol engines and shall not be permitted in any PES other than Category D.

Vehicles and powered mobile MHE authorised for use within a PES shall conform, as a minimum, to the conditions set out in Annexes C, D and E.

4.3.1. Standard vehicles in a PES (LEVEL 1)

A standard, unprotected vehicle or powered mobile MHE may be brought into a Category C explosives area, holding yard or marshalling yard, but shall be subject to the restrictions detailed below:

a) the area shall be authorised only for the storage and handling of qualified[4] explosives;

b) there shall be no processing permitted;

c) the unprotected vehicle shall be used only for the receipt or despatch of qualified explosives;

d) the vehicle engine shall be stopped before loading or unloading commences and it shall not be restarted until the operation is complete and all explosives are secured;

e) loading and unloading shall be performed by MHE that is of a suitable standard to enter the PES;

f) the unprotected vehicle shall be inspected by a competent person to ensure that it is without defects before the vehicle is allowed to enter the explosives area. In particular, the inspection will cover the fuel, brakes, electrical and exhaust systems, ensuring that no leaks or hazardous condition exists; and

[4] See IATG 01.50 *UN Explosive hazard classification system and codes*.

g) should the vehicle emit sparks, its engine shall be turned off and the explosive packages offloaded prior to its immediate removal from the explosives area.

4.3.2. Standard vehicles in an explosives area but not a PES (LEVEL 1)

Emergency vehicles shall be allowed access to explosives facilities, including during exercises. However, during an emergency, care must be exercised to ensure crews are not placed in jeopardy or are made aware of the hazards associated with the emergency.

Privately owned vehicles may enter an explosives area in order to move staff. They shall be equipped with a fire extinguisher and shall not present an increased fire risk. Authority for such vehicles is subject to the written permission of the head of the establishment. Privately owned vehicles are not allowed in a PES and shall be parked in designated car parks.

Contractors may be permitted to enter explosives facilities with vehicles and powered mobile MHE. Whenever possible, the requirements of this module shall be met. Should this not be possible, then further control measures shall be implemented.[5]

4.3.3. Identification of mechanical handling equipment (LEVEL 1)

All mobile MHE, including cranes, shall be clearly identified by a manufacturer's label, sign writing, plating or other suitable means to define the electrical category areas and zones (see Table 1) in an explosives facility in which it is cleared for use.

4.3.4. MHE engines and fuel standards (LEVEL 2)

Internal combustion engines shall be of the compression ignition (CI) type. Cold starting fluids shall only to be used in a permanently installed system that injects fluid into the inlet air manifold downstream of the inlet flame arrestor. The length and bore dimensions of any cold start fluid injection jet shall be proportioned so that the jet is flameproof. Cold starting fluids shall not be used in conjunction with any electrical starting aids.

Diesel fuel shall have a flash point of not less than 55°C. Other fuels may be used in diesel operated internal combustion engines provided that the fuel has a flash point of not less than 38°C and the ambient temperature of the area in which the vehicle is working shall be at least 5°C below the flash point of the fuel. Allowance shall be made for solar heat gain where vehicles are working in strong sunlight. The auto-ignition temperature of either fuel is to be not less than 250°C. These temperatures shall be derived from internationally accepted test methods used by qualified test organisations. When additives are used in fuels, the flash point and auto-ignition temperature will normally be reduced and therefore allowances should be made for this during the test. Fuel and cold starting aid fluid shall only be carried in a fixed tank. No provision shall be made for the carriage of spare fuel or starting fluid.

4.3.5. Tyres and ancillaries (LEVEL 2)

The tyre of at least one road wheel shall be electrically conducting in accordance with the requirements of the national authority. All wheels on any one axle are to be fitted with tyres of the same type. Ancillary items in use with vehicles and powered mobile MHE are to comply with the equivalent standards as the main equipment with which they are utilised.

[5] See IATG 06.60 *Works services (construction and repair)*.

4.3.6. Electromagnetic compatibility (EMC) (LEVEL 2)

All vehicles and powered mobile MHE shall be compliant with the requirements of IATG 05.60 *Hazards of electromagnetic radiation*. Equipment may be marked with the appropriate standards if the manufacturer states that it meets the requirements of a relevant EMC standard without an EMC test having been conducted. Those purchasing equipment shall therefore obtain test results for the equipment from the supplier/manufacturer to demonstrate compliance.

5 Lifting equipment not in regular use (LEVEL 2)

All mobile cranes, ship or other mounted cranes of all kinds, and all cranes not in regular use, shall be subjected to the following tests before use:

a) all pre-use checks recommended by the manufacturer;

b) testing of every crane motion for several minutes without load, each motion individually at first then by a combination of two or more motions simultaneously as appropriate, and then repeating the test with an inert load on the crane. The load shall be at least equal to the maximum load to be handled. For mobile cranes the strength and stability of the crane at its location is important. The test shall include simulating the maximum reach the crane would be required to move the load;

c) on floating cranes, the test lift and its load shall be repeated after any break of one hour or more, or at any time when required by the ship's captain, the nominated representative, the loading supervisor or master stevedore or the crane operator. The test lift shall be witnessed by a representative of both the loading and receiving parties; and

d) assurance shall also be obtained that cranes not in regular use are adequately maintained and that the probability of failure shall be at least equal to that which the crane would be afforded if it was subject to regular use.

6 Safe working load (SWL) (LEVEL 1)

The SWL shall not be exceeded under any circumstances other than those prescribed in the relevant test procedures. This situation shall only be permitted under the supervision of a competent person.

7 Management and control of MHE in explosives areas (LEVEL 2)

All MHE and other lifting equipment used in explosives areas shall be authorised by the head of the establishment. They shall meet the requirements and restrictions of this IATG.

7.1 Serviceability

No unserviceable vehicle or powered MHE shall be permitted to enter any explosives facility. Particular attention shall be paid to exhaust systems. If a fault is discovered on any vehicle or MHE during use that affects safety, the vehicle or MHE shall be immediately withdrawn from use and removed from the operating area.

7.2 Maintenance and testing

Vehicles and powered MHE shall be maintained and subjected to periodic testing in accordance with the manufacturers' approved schedules and national authority approved regulations. Maintenance, tests and inspection are crucial elements involved in the safe operation of MHE. Adequate maintenance, tests and inspections will improve the overall condition of the MHE and lessen the possibility of accidents. This regime should also apply to any rail vehicles and appliances. The vehicle or MHE manufacturer shall provide maintenance schedules, which include the maximum performance limits and test criteria. These shall ensure the continuing effectiveness of any safety devices or other safety features fitted. These test and maintenance schedules shall be incorporated into the national authority maintenance schedules. Vehicles and MHE for use in above ground and underground explosives facilities shall be properly maintained and periodically tested in accordance with these schedules.

7.2.1. Exhaust system maintenance

Particular care is to be taken when carrying out maintenance of exhaust systems on vehicles and MHE. Following any maintenance to the exhaust system, it should be reassembled with new gaskets and shall be tested for leaks before the equipment is allowed to be used. Exhaust system flame emission tests are not required during routine maintenance.

7.2.2. Exhaust system modifications

A spark arrester is any device which prevents the emission of flammable debris from combustion sources, such as internal combustion engines. Spark arresters play a critical role in the prevention of vegetation fire and the ignition of explosive atmospheres. Vehicles may be fitted with spark arresters as a precaution but fitment of such devices does not change the classification of vehicles permitted in categorised areas as captured in Table 1 above.

7.2.3. Modifications (LEVEL 1)

Modifications to vehicles and MHE shall not be carried out unless specifically authorised by the national technical authority.

7.2.4. Firefighting equipment (LEVEL 1)

Vehicles and powered MHE shall carry sufficient fire extinguishers of a type suitable for the fuel used, and which will also deal with electrical fires. Additional means of firefighting shall be available at garages, refuelling points and battery charging facilities.

7.3 Equipment breakdown

If a breakdown, including failure to start readily, occurs near to a PES, the vehicle or MHE shall be off-loaded of any explosives before any repairs begin. Only minor repairs, sufficient to allow the vehicle or MHE to be moved, shall be permitted. If major repair *in situ* is required, the head of the establishment shall approve this after ensuring all precautions are taken to minimise the risk involved. However, the preferred option should be to have the vehicle or MHE towed or recovered to outside the explosives area.

7.4 Speed limits (LEVEL 1)

The maximum speed limit within an above ground explosives area for each type of vehicle and MHE shall be designated by the head of the establishment, taking heed of the equipment manufacturers' guidelines. As a guideline, it is recommended that the maximum speed limit in an underground storage should be 8 kph and in above ground storage 16 kph. Speed limits should be clearly indicated by signs or notices and highlighted within local orders.

7.5 Loading and unloading operations

During loading and unloading operations, the engines of all load carrying road vehicles shall be switched off unless the engine is required to facilitate the loading or unloading of the vehicle, e.g. a forklift truck, lorry mounted crane etc.

7.6 Parking and garaging

7.6.1. Parked vehicles and parked vehicles loaded with ammunition

Vehicles and powered mobile MHE should not be left unattended in a PES or in an explosives area. Parked vehicles loaded with explosives shall be treated as a PES as required by IATG 02.20 *Quantity and separation distances*.

7.6.2. Garaging

Garaging in an above-ground explosives facility should not be within the inter-magazine distance (IMD) of any PES.

Vehicles and MHE used in underground sites should be garaged at a selected area above ground. Should this not be possible then the head of the establishment should authorise a selected area underground that is sited as far as possible from the explosives.

7.7 Refuelling of vehicles and MHE (LEVEL 1)

Vehicles and MHE shall only be refuelled at authorised above-ground refuelling points and fuel tanks shall not be filled beyond the specified capacity. No spare fuel shall be carried.

Where refuelling points are authorised in underground sites, the fuel shall be taken underground in approved containers in sufficient quantities for one day's work only. The refuelling point should have a floor of concrete which is impervious to fuel and have a suitable method of spillage containment sufficient to ensure that 100% of a spillage can be contained, and that any surge resulting from the sudden release of fuel is also contained. It should also have an adequate ventilation system.

7.8 Ventilation

Should vehicles and MHE be permitted in an explosives building, adequate ventilation shall be provided to ensure 100% removal of exhaust fumes. This is a critical personnel safety issue. See also Clauses 7.7 and 7.9.

7.9 Battery charging and battery maintenance (LEVEL 1)

The batteries of electrically powered vehicles and electrically powered mobile MHE shall be maintained and charged only at authorised locations. The maintenance and charging of some types of batteries can produce hydrogen gas, which is explosive, and therefore the process shall be viewed as dangerous. After battery charging, the MHE should stand for a minimum period of 1 hour before entering an explosives area.

8 MHE operator instructions

Formal instructions should be developed for MHE operators to cover the following:

A) ammunition and explosives shall be handled in a manner so as to prevent shock or friction that may cause a fire, explosion or damage to the material. These materials shall not be thrown, dropped, dragged, or tumbled over floors or over other containers;

B) containers of bulk ammunition and explosives shall be handled carefully to avoid rupture of the containers or the container seams and to prevent undue friction between the containers;

C) MHE shall be kept clean at all times;

D) the load shall be checked before fully lifting the forks or moving the MHE. Only stable or safely arranged and secured loads shall be handled;

E) more than one pallet or container should never be lifted unless it is strapped together as a unit load and is within the rated capacity of the MHE; and

F) it is the responsibility of all personnel operating MHE to be aware of unsafe conditions. All unsafe conditions or materials shall be reported.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.20 *Quantity and separation distances.* UNODA;

d) IATG 05.40 *Safety standards for electrical installations.* UNODA;

e) IATG 05.60 *Hazards of electromagnetic radiation*. UNODA; and

f) IATG 06.60 *Works services (construction and repair)*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[6] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[6] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020; and

c) NFPA 505. *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*. National Fire Protection Association. USA. (Also see Tables C.1 and D.1 for CEN Standards).

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[7] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[7] Where copyright permits.

Annex C
(informative)
Special requirements for Category A area MHE

C.1 Authorised vehicles in a Category A PES

Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE are authorised to enter a Category A Zone 1 PES (for Category 2G vehicles) and Category A Zone 2 PES (for Category 2G and 3G vehicles). However, they shall comply with the minimum applicable national technical authority standards. Recommended European (EN) standards are listed below in Table C.1.

EN Standard #	Title
EN 1127-1:1998	Explosive atmospheres – Explosion prevention and protection – Basic concepts and methodology.
EN 1175: 1998	Safety of industrial trucks – Electrical requirements.
EN 1755: 2000	Safety of industrial trucks – Operation in potentially explosive atmospheres – Use in flammable gas, vapour, mist and dust.
EN 1834-1: 2000	Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 1: Group II engines for use in flammable gas and vapour atmospheres.
EN 1834-2:2000	Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 2.
EN 60079-10:1996	Classification of hazardous areas.
EN 60079-14:1997	Electrical installations in hazardous areas (other than mines).
EN 60079-17:1997	Inspection and maintenance of electrical installations in hazardous areas (other than mines).
EN 12895:2000	EMC.

Table C.1: Technical design and construction standards for Category A vehicles and MHE

C.2 Temperature restrictions

The maximum surface temperature of any part of the vehicle or powered mobile MHE shall be specified for the potentially explosive atmosphere that is anticipated but shall not exceed T4 (135ºC).

Annex D
(informative)
Special requirements for Category B (dust) area MHE

D.1 Authorised vehicles in a Category B PES

Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE are authorised to enter a Category B Zone 11 PES (for Category 2D vehicles) and Category B Zone 22 PES (for Category 2D and 3D vehicles). However, they shall comply with the minimum applicable national technical authority standards. Recommended European (EN) standards are listed below in Table D.1.

EN Standard #	Title
EN 1127-1:1998	Explosive atmospheres – Explosion prevention and protection – Basic concepts and methodology.
EN 1175: 1998	Safety of industrial trucks – Electrical requirements.
EN 1755: 2000	Safety of industrial trucks – Operation in potentially explosive atmospheres – Use in flammable gas, vapour, mist and dust.
BS EN 50281:1999	Electrical apparatus for use in the presence of combustible dust. 1-1 Electrical apparatus protected by enclosures – Construction and testing. 1-2 Electrical apparatus protected by enclosures – Selection, installation and maintenance. 2-1 Test methods for determining minimum ignition temperatures.
EN 12895:2000	EMC.

Table D.1: Technical design and construction standards for Category B vehicles and MHE

D.2 Temperature restrictions

The maximum surface temperature of any part of the vehicle or powered mobile MHE shall be specified for the potentially explosive atmosphere that is anticipated but shall not exceed T4 (135ºC).

Annex E
(informative)
Special requirements for Category C area MHE

E.1 Authorised vehicles in a Category C PES

Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE may be authorised to enter a Category C PES subject to the restrictions detailed within this Annex. They shall also comply with the minimum applicable national technical authority standards. Recommended requirements are:

a) the maximum surface temperature of any part of the vehicle or powered mobile MHE shall not exceed T4 (135ºC). This requirement may be met by shielding which is designed to prevent explosives coming into contact with any surface whose temperature exceeds 135°C;

b) the surface temperatures of components under the covers of the powered mobile MHE in its normal operating condition shall be as low as is reasonably practicable but shall not exceed T3 (200°C);

c) an approved spark arrestor shall be fitted to the exhaust system;

d) the air intake system shall be fitted with a dry air cleaner;

e) a cold starting aid, which ignites fuel in the air intake manifold, if fitted, shall have an approved flame trap between the air cleaner and the cold start device;

f) the engine shall be fitted with oil pressure loss and high coolant temperature warning devices, or an automatic shut down device;

g) the EMC performance shall be to national authority specifications with a recommendation of EN12895:2000; and

h) vehicles shall be clearly marked clearly ‘Category C – All Areas’.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date under the edition number and date of the .

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted onwww.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 05.60

Third edition
March 2021

Hazards of electromagnetic radiation

IATG 05.60:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

There has been a significant global increase in the use of electronic communication and detection devices. Their uses include mobile telephones, wireless communication links to high-powered transmitters for voice communication, electronic data transmission, asset tracking and radar. These items produce and receive radio frequency (RF) fields of varying intensity. This intensity is controlled by their output power and antenna gain. This is potentially hazardous when used in close proximity to explosives that have an installed electrical means of initiation.

The undesired coupling of RF energy can cause inadvertent actuation of electrically initiated devices (EIDs). This hazard can be minimised by intrinsic design characteristics, screening and specialised packaging. However, there are situations when EID are vulnerable to unintended initiation such as during transportation, removal or replacement procedures.

This IATG module identifies the potential dangers and provides advice on the level of national technical authority statutory regulations required as well as the basic precautions that should be taken during storage, movement and processing of ammunition susceptible to RF hazards.

Hazards of electromagnetic radiation

1 Scope

This IATG module introduces potential hazards to ammunition and explosives posed by electromagnetic (sometimes called radio frequency) radiation. It provides guidance on the development of national technical authority statutory regulations for the precautions that should be taken during the storage, handling, processing and movement of ammunition susceptible to RF hazards.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply. In this IATG, the term “ordnance” can be interpreted as “ammunition and explosives”.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition management activities.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background (LEVEL 2)

Many items of ammunition and explosives are, or contain, an electrically initiated device (EID). EIDs are sometimes used instead of percussion or friction initiators and are activated through the application of sufficient electrical energy. Electro-explosive devices (EEDs) are a sub-set of EIDs, but the terms are commonly interchanged. This module uses the more general term EID. In general, EIDs are susceptible to radio frequency (RF) radiation and require specific safety considerations – during classification and throughout their life cycle. In some nations, such considerations are conducted under the term Hazards of Electromagnetic Radiation to Ordnance (HERO).

Ammunition and explosives shall only be stored and logistically transported in the packaging in which they were tested and classified. The testing regime should ensure the ammunition and explosives are not susceptible during storage and transportation in the original packaging and should identify the susceptibility when outside this packaging, whether within the logistics chain (e.g. inspection or maintenance) or after having been issued for use.

RF can cause ammunition accidents, the consequences of which can be catastrophic, resulting in loss of life, major damage to, or destruction of, weapons, and even mission failure. As a result of this susceptibility to RF radiation, this section suggests controls that national authorities should impose throughout the life cycle of the ammunition. It should be noted that the military RF environment is exceptionally challenging.

While this module provides some general guidance to the national authority, it focuses mainly on storage and transportation and not the rest of the ammunition life cycle.

5 Susceptible items (LEVEL 2)

Any length of wire in an RF field will act as an aerial and pick up energy from that field. An electromagnetic (EM) hazard exists if the wire forms part of an EID and the RF level is sufficient to induce a power or current in excess of the no-fire threshold (NFT) power for the device. The NFT power or current is defined as the power required to produce a 0.1% probability of fire at the 95% single-sided lower confidence limit when applied to the EID for a time which is long compared with the thermal time constant (τ) of the device, i.e. $>10\ \tau$.

5.1 EID firing circuits

The amount of power fed to a connected EID will depend on the length and configuration of the wires and on the ratio of the source to load impedance of the firing lines and EID. Unless firing circuits are properly designed, sufficient power to fire most EID can be picked up in substantially lower RF field strengths than those experienced during in-service life. Firing circuits associated with EID, or other electrical conductors such as wires, tools and fingers in contact with the EID or firing circuit, when placed in an RF field, will act as antennae and will pick up some electrical energy from the field.

5.1.1. EID circuits and connectors

The wires of an EID, when they are separated, may form an effective dipole antenna and provide an optimum impedance match to the EID giving maximum transfer of power to the EID from the radiation source. Unless appropriate precautions are taken, the power or energy levels induced into a firing circuit from an RF field may be sufficient to initiate an EID. EID separated from their parent systems or systems opened up for maintenance or test shall be regarded as less safe than when installed into the system as intended by design. Well-designed ammunition will fail safe when the EID has been compromised by RF radiation (e.g. Fuze shutter interrupts explosive chain), but this may still result in critical assets being no more than "hittiles".

5.1.2. Ammunition container assemblies (ACA)

The use of metallic ammunition containers does not automatically provide sufficient attenuation for EID in isolation, or for EID contained in non-metallic systems that are not adequately protected. The attachment of external cables and test sets to systems containing EID will usually increase their susceptibility to EM energy pick-up.

5.2 Testing for susceptibility

All complete explosive systems containing EID should be assessed for their susceptibility to radiation hazards (RADHAZ). This assessment should be based on national technical authority requirements and should be assessed by a practical trial conducted at a trials site. The assessments should cover the susceptibility of EID during preparation, testing, storage, transportation, loading, and when loaded on the launcher or weapons platform. Table 3 lists susceptibility categories and activities associated with them[3].

Category	Activity
1	Assembly and disassembly of weapons or stores and testing of sub-systems by personnel or test equipment generally in storage depots.
2	Testing of all up weapons or stores in test houses or alongside/on board ships.
3	Storage and transportation of weapons/stores in approved packaging.
4	Storage and transportation of weapons or stores not in approved packaging, whilst handling, assembling, loading/unloading to platform e.g. vehicle, gun, aircraft or launch platform.
5	Weapon or stores loaded to their intended use platform e.g. to an aircraft or in its launcher.

Table 1: Susceptibility categories and associated activities

6 Safety and separation distances (LEVEL 2)

A wide range of communication equipment emitting RF fields may be found near ammunition containing EIDs, including data loggers, mobile phones, pagers, radios etc. This means safe distance restrictions shall be required. EIDs and/or weapons being handled and weapons under preparation, test or maintenance are susceptible to much lower levels of RF and controls shall be required to ensure they remain safe.

The magnitude of an RF field decreases with increasing distance from the source. The hazard area for transmitters using omni-directional or rotating antennas is often defined as a right-cylindrical volume of air space centred on the transmitter. For single and multi transmitter sites that have fixed directional beams radiating predominately in the same direction such as satellite tracking sites, the hazard area is mainly in the direction of the beam.

Where no safety data exists for a particular piece of transmitting equipment, the safe distance should be determined using the simplified method outlined in Annex C. The formulae and graphical methods have been developed to facilitate the determination of safe distances when the output characteristics of transmitters and susceptibility characteristics of EID are known.

7 Storage, processing and transport (LEVEL 2)

EID are encountered in a variety of configurations between their manufacturing stage and their ultimate use or disposal. These configurations range from trade packaging in bulk, in-service packaging and sub-packages, installation in munitions and various stages of separate and exposed states that occur in processing and training.

[3] Within HERO programs, items are classified as HERO Safe, HERO Susceptible or HERO Unsafe.

It is important to understand how these configurations can influence the basic precautions to be adopted in storage and transport. Transportation precautions should also include measures to be taken in emergencies, from straight forward vehicle breakdowns to accidents involving fire and/or casualty evacuation.

Building materials are generally ineffective in providing EM protection for EID. Structures normally provide no protection at all in transmission loss from frequencies below 1MHz but many provide some protection in the form of reflection loss if the polarisation and angle of incidence of the EM energy happens to be favourable, (although this is rare and should not be assumed). Therefore, it should be assumed that the field strength that exists inside a building or vehicle is the same as that of any external field. However, if the attenuation of EM radiation which is provided by a specific building has been determined from, for example, a screened room, then this may be used to determine safe distances from sources of EM radiation. It should be noted that open doors or windows affect the screening integrity.

EID and systems containing EID should only be stored or processed in authorised depot and unit storage and process areas. These areas should be selected on the basis of:

a) the susceptibility of the EID or munitions containing EID during storage or processing as appropriate; and

b) the radiated power of transmitters in the area related to the susceptibility of the most sensitive EID present.

7.1 Storage

In depots where weapon processing is being undertaken, susceptibility levels may be much lower than is normal and it is necessary to fully understand the RF environment in which work is being carried out and the interaction with the ammunition and weapon system firing circuits. The environment will depend on local transmitters both on-site and in the local area.

Historically there has been a total ban on the use of transmitters within an ammunition storage area (ASA) unless approved by the national technical authority. This is now being reconsidered in light of the spread of the usage of these systems into every aspect of the management system. Therefore, the head of the establishment shall assess the use of all radios, including mobile phones, to be used in the vicinity of an EID, or stores containing an EID, for their potential HERO risk. The sub-paragraphs below set out suggested revised rules:

A) no deliberate RF transmitters shall be allowed inside an explosives building unless agreed after specialist ammunition technical advice is provided;

B) no deliberate RF transmitters of any power shall be allowed inside an ASA unless they are essential for an activity – in which case it will be specifically designed to be safely used;

C) risk assessments shall include safe distance calculations for the radios, portable or fixed;

D) portable radios, personnel communication equipment, mobile phones or personal electronic devices (PED) shall not to be used in areas adjacent to an ASA or magazines or close to exposed ordnance or ordnance under preparation unless they meet the general requirements in Clause 7.1.1.;

E) the minimum safe distance for the use of any management radio[4] or other transmitter in the vicinity of an EID, no matter the susceptibility of the explosive nature, when obtained by calculation shall be 3m;

[4] Including RFID and other low power Automatic Identification Technology (AIT) devices

F) the safe distance shall apply equally to the use of radios in vehicles transporting EID unless specific agreement is obtained from the national technical authority; and

G) only certified radios classified safe to the relevant standard may be used in areas where an explosive atmosphere may exist.[5]

7.1.1. Transmitter requirements

Only essential transmitters should be installed within an ASA. They should meet the requirements of this paragraph. Exceptions should be provided by the national technical authority in accordance with the following guidelines:

A) transmitters with a power output of ≤1W and with an aerial gain of ≤6dB across the frequency spectrum are acceptably safe at a distance of ≥10m from the exterior of the buildings; and

B) transmitters with a power output of ≤10W, with an aerial gain of ≤ 6dB and with a frequency of >300MHz are acceptably safe at a distance of ≥5m from the exterior of the buildings. These distances shall also be maintained between the transmitter and ESA transit routes.

7.1.2. Within an ASA

Within an ASA and also external to buildings where EID initiated items are only stored in their approved containers (and not being unpacked, handled or being worked), transmitters with a power output of ≤25W and with an aerial gain of ≤6dB across the frequency spectrum are safe at a distance of 3m from the exterior of the buildings. This rule shall only be permitted where essential and where strong controls are in place and can be assured to be in place for the lifetime of the transmitter.

7.1.3. In a process building

In general, the use of transmitters within buildings of an ASA shall be prohibited. However, this is an area where much research is being conducted and specialist national technical authority advice should be sought on this subject.

7.1.4. External to the perimeter

Outside the ASA and at least 100m from a processing building, radios with a power output of ≤50W or with no significant antenna gain may be safely used. For higher power radios or radars, an assessment should be made to determine the possible field strength in processing areas. For some very high-power broadcast transmitters, air traffic control radars or military radars this may require knowledge of their location out to distances of 3km. In cases such as this, specialist assistance should be sought.

7.1.5. Mobile phones and pagers

The use of mobile phones and pagers shall be controlled in the vicinity of munitions. Mobile phones and pagers shall not be used:

A) in the presence of hazardous vapours;

B) in explosive storehouses (ESH), potential explosion sites (PES), magazines and weapon stowage areas or ammunition process buildings; or

C) close to ammunition and explosives under preparation.

[5] See IATG 05.40 *Safety standards for electrical installations*.

Mobile phones and pagers may be used in other areas provided that only standard handheld phones or pagers are used, and that the minimum separation distances are calculated in accordance with Annex C or are a minimum of 4m, whichever is the larger.

Although most radio pagers are passive devices with respect to electromagnetic power output, they may still contain components capable of causing a spark and are therefore a hazard in an area where there are exposed explosives or flammable vapours. A class of pagers exists, referred to as Talkback pagers, that may transmit messages in addition to receiving them. Typically, the transmission frequency range is 146 to 174MHz and the maximum effective radiated power (ERP) is 50mW.

7.1.6. Asset Tracking

Where it is appropriate to attach an RF asset tracking system to a weapon or approved container, or close to it, the safe distance is dependent on the transmit power and frequency. Due to the near field effects, this distance does not allow the use of simplified formulas such as those at Annex C.

There are generally three types of RF asset tracking/radio-frequency identification (RFID) tags in use: active RFID tags, which contain a battery and can transmit signals autonomously; passive RFID tags, which have no battery and require an external source to provoke signal transmission; and battery assisted passive (BAP) RFID tags, which require an external source to wake up but have significant higher forward link capability providing greater range.

Active and battery assisted RFID shall not be taken into an explosives area unless specifically approved by the head of establishment who should seek specialist ammunition technical advice. In the case of the passive tags, the equipment used to read the tags shall not be taken into an explosives area unless specifically approved by the head of establishment who should seek specialist ammunition technical advice.

7.1.7. Data Loggers

In order to provide environmental data, approved data loggers may be attached to a number of munitions or their containers. Many of these devices are passive until interrogated and thus should be removed for interrogation. Removal of these data loggers should be in an approved process facility and the readers approved for use in that area or the logger removed to be read.

7.2 Transportation (LEVEL 2)

7.2.1. Road transportation

It is not practicable to obtain a safe EID environment during transportation through the use of calculated safe distances. For this reason, all EID and systems containing EID and being transported should be safe in a field strength of at least 200V/m (100Wm^{-2}) at all frequencies for road transportation.

7.2.2. Other modes of transport and items not cleared for transportation

EID and systems containing EID which have not been cleared to an EM environment of 100Wm^{-2}, and those requiring protection in a more severe RF environment such as by ship or aircraft movement, shall be protected during transit by enclosure in a metal box or by approved materials providing sufficient screening. Specific instructions on munitions incorporating EID, which are either cleared or not cleared for transportation depending on RF protection, should be obtained from the national technical authority.

Where the items need to be closer than the minimum 3m to vehicle fixed transmitters or antenna, specialist advice shall be sought from the national technical authority. Dependent on the power output, frequency and cable routing, this may in some cases be reduced to 0.5m if the system is packed in approved containers and has been assessed as safe as a result of specialist testing. When it is considered necessary to transport systems containing EID of unknown susceptibility, advice should be obtained from the national technical authority. Personnel engaged in such activities shall be made aware of EM hazards and observe consignor's instructions fully. Note should be made of any special instructions covering loading, unloading and handling when EID are most vulnerable to EM radiation.

7.2.3. Anti-theft tracking devices

Many vehicles are now fitted with anti-theft tracking devices or stolen vehicle recovery systems. The driver may not be aware of this; as such it should be assumed that all vehicles entering an ASA have them fitted. It has been assessed that the probability of accidental initiation of EID is negated by maintaining a distance of 5m between the vehicle and the exterior walls of any building containing explosives.

7.2.4. Emergency situations

In the event of an incident or accident[6] during the movement of ammunition, items that do not normally present a high RADHAZ risk may become vulnerable if there is damage to their inherent protection, be it structural or packaging. In such a situation, controls on the use of RF transmissions in the immediate vicinity should be imposed immediately:

A) no RF transmission shall be allowed within a radius of 10m from the EID;

B) any emergency services using vehicle borne sets with ERP greater than 5W should not transmit within 50m of the damaged equipment; and

C) drivers and/or escorts in vehicles transporting EID should be issued with emergency instructions as approved by the national technical authority.

When an accident occurs in which it is suspected that RADHAZ may be a cause, it is important that the details of nearby transmitters (e.g. which ones were active, on which frequencies, power levels, etc) and the configuration of any ammunition and explosives involved (e.g. proximity to transmitters, whether disassembly, handling, or loading was being performed, etc). . Annex D provides further information on the information to be collected. Specialist technical assistance should be sought to aid in assessing the accident and the information collected.

8 Safety Statement.

No RF emitters, even of very low power, shall be allowed to touch ammunition and explosives. Special consideration may need to be paid to personnel with medical implants and medical body worn devices, particularly those using Wi-Fi® or Bluetooth® technologies.

[6] Ammunition accidents and incidents should be investigated in accordance with IATG 11.10 *Ammunition accidents and incidents*

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 02.10 *Introduction to risk management principles and processes*. UNODA; and

c) IATG 05.40 *Safety standards for electrical installations*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[7] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[7] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this module:

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

b) AECTP-500, Edition E, Version. 1. *Electromagnetic Environmental Effects Tests and Verification, Category 508, Ordnance Test and Verification Procedures*. NATO Standardization Organization (NSO). December 2016. http://nso.nato.int/nso/nsdd/listpromulg.html; and

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[8] used in this module and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/convarms/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

[8] Where copyright permits.

Annex C
(informative)
EID and firing circuit sensitivity (LEVEL 2)

C.1 Definition

An EID is a one-shot explosive or pyrotechnic device used as the initiating element in an explosive or mechanical train and that is activated by the application of electrical energy. They are designed to produce a specific output such as detonation, flame or gas in order to perform a particular task. An explosive reaction process occurs in an EID when either:

A) the temperature of a small amount of primary explosive is raised above its ignition temperature, by the heat generated following an input of electrical energy; or

B) a secondary explosive is detonated by the mechanical shock created when a high voltage is discharged into a low resistance bridge such as an exploding bridge wire (EBW) or exploding foil initiator (EFI).

C.2 Types of EID

EID can be divided into 2 groups— low voltage and high voltage. They can be further categorised into 3 types:

A) low voltage (LV) devices with long thermal time constants, typically 10ms - 50ms, such as EBW. These are often called power sensitive EID;

B) LV devices with short thermal time constants (typically 1µs - 100µs) such as film bridge (FB) and conducting composition (CC), often known as energy sensitive; and

C) high voltage (HV) devices with a secondary explosive such as EBW and EFI, which require a fast, high voltage discharge pulse to initiate them. These are known as HV energy sensitive.

C.3 Firing thresholds

Power sensitive devices tend to integrate transient energy and, in the case of repetitively pulsed radars, they will respond to mean or average power levels. LV energy sensitive devices tend to respond to the peak power level of an electrical transient or pulse and pulse stream such as pulsed radar and this should be taken into account when determining their susceptibility.

HV energy sensitive devices are considered to require such a specialised, fast rising pulse that accidental initiation from a radio or radar field is not credible and risk assessments indicate a very low probability of accidental initiation. Whilst this describes the characteristics of each type of EID it does not mean that they react only to power or energy impulses. In determining No Fire Thresholds (NFT) both types of reactions should be considered in relation to statistical sampling based on 0.1% probability of firing at a single-sided lower 95% confidence level. To illustrate the results of such sampling on a typical EBW EID (Igniter Type F53) and a typical CC device (Type M52) NFT figures are shown below.

EID	Resistance Range (Ω)	NFT Power (mW)	NFT Energy (mJ)	Time Constant (ms)
Igniter Type F53	0.9 -1.6	130	2.3000	18.000
M52 CC Igniter	1k – 1.2M	14	0.0022	0.157

Table C.1: Example no-fire thresholds for EID

C.4 Transmitters and field strength calculation

Any radios being used should be of known field strength as supplied by the manufacturer or the national technical authority. A graph of field against distance is the preferred data format. Radios being used by establishment personnel or contractors should ideally not be used in areas where ammunition is being handled or in the vicinity of routes when ammunition is being handled, during loading or unloading operations or close to ammunition being loaded onto a firing platform or launcher. Where this cannot be avoided a safe distance shall be calculated and applied.

The following information is the minimum required to calculate transmitter field strength:

A) type of aerial, directional or omni-directional;

B) the mean power being supplied to the transmitter antenna in Watts;

C) the frequency or frequency band of the transmitter; and

D) the antenna gain.

If the transmitter has a pulse waveform and the EID is one whose thermal time constant is small (i.e. energy sensitive) the following is also required:

A) the pulse repetition frequency (PRF) in pulses per second; and

B) the pulse width (PW) in seconds.

This information is normally found in the equipment handbooks, from equipment manufacturers or from the national technical authority. Calculation of field strength should only be undertaken by qualified personnel and the national technical authority should be consulted.

When susceptibility levels have been calculated, this information should be used to determine minimum separation distances, i.e. the hazard area, for explosive stores from radio and radar transmitters. There will generally be several minimum distances, which will take into account the specific activity being undertaken.

Where the transmitter information and the susceptibility of the EID are known, the transmitter power density hazard graph (see Figure C.1 below) can be used to determine the safe distance for the operation of radios or other equipment emitting RF radiation. The susceptibility data normally provided applies to a continuous wave (CW) environment. In this environment, all EID are susceptible to induced power (i.e. average power over a period > τ). However, conducting composition (CC) and thin film EID are pulse sensitive such that in a pulsed RF environment they are also susceptible to energy induced from a single pulse or a pulsed stream.

Where the transmitter information is known, but the susceptibility of the EID or explosive store is unknown, then reference should be made to Table C.2. The table is an example only and assumes the 0.003W/m^2 susceptibility figure for an F53 EBW with a 2m length of firing lead to calculate the minimum safe distance. These distances may then be used for frequencies up to 1GHz. This table should be used against data from a specific EID and is provided as an example only.

The safe distances determined under this module are subject to any over-riding limitation laid down elsewhere for the protection of personnel against biological effects of RF radiation.

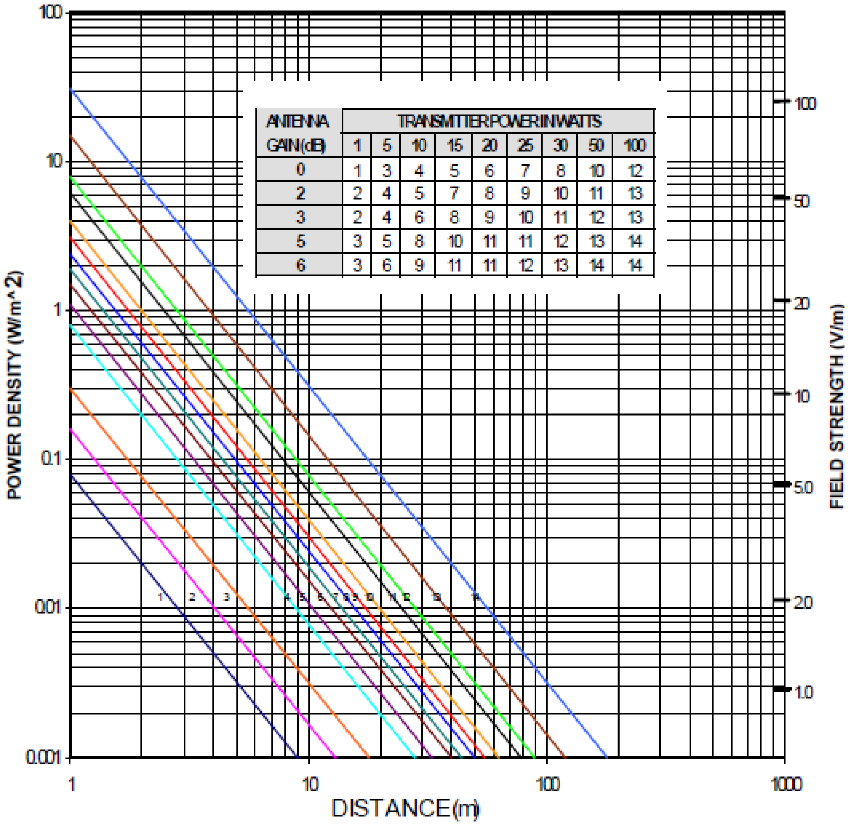

Figure C.2: RF power density hazard graph for frequencies from 60 to 500MHz

Antenna Gain Ratio (dBi)	Transmitter Power (W)							
	1W	4W	6W	10W	15W	25W	30W	50W
Unity	5.0m	10.0m	13m	17.5m	20.0m	26.0m	28.0m	36.5m
Special	6.5m	13.0m	16m	20.5m	25.0m	32.5m	35.5m	46.0m
Standard	7.5m	15.5m	18m	23.0m	28.0m	36.5m	40.0m	51.5m
High Gain	10.0m	18.5m	22m	29.0m	35.5m	46.0m	50.0m	65.0m

Table C.3: Worst case separation distance

Annex D
(informative)
RF Report

1. For all emitters that could potentially pose an RF hazard, record the following emitter specifications. You are encouraged to interpret "potentially" in a broad manner.

A) RF emitter

B) transmit antenna

C) RF emitter operating mode

D) transmit frequency;

E) power output, both peak and average if known;

F) modulation;

G) antenna rotation rate or settings;

H) bore sight or aspect angle of radiating antenna to the A&E location;

I) approximate distance between the transmitter antenna and A&E; and

J) for radars and satellite communication transmitting systems:

   i. pulse width;
   ii. duty cycle; and
   iii. pulse repetition frequency.

2. For handheld transmitters, smart phones, cell phones, tablets, computers and computer accessories record the:

A) manufacturer;
B) model;
C) location;
D) mode/setting (AM/FM, wi-fi, Bluetooth, cellular, airplane mode)

3. Describe any discrepancy between the standard operating procedures and the actual operating procedures that were followed.

4. If applicable, record the exact location of where personnel physically touched an A&E item, and under what conditions.

5. As appropriate, and to aid in the detailed technical investigation, record contact details for:

A) unit RF safety officer or general safety officer;
B) unit explosives safety officer;
C) officer of the day;
D) weapons officer; and
E) fire department.

6. Ensure the details of all A&E items involved are recorded.

7. Attach this report to the accident case file.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.10

Third edition
March 2021

Control of explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 06.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for ‘through-life management’ approach to ammunition management. The IATG can be applied at the guidelines’ **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Explosives facilities, by their very nature, present special hazards and these hazards must be uppermost in the minds of those responsible for their administration and of those who work in them. This IATG module outlines the control regime that should be implemented in explosives facilities. It is strongly recommended that the information contained in this IATG module should be the minimum standard of national technical authority regulations.

Control of explosive facilities

1 Scope

This IATG module introduces the principles and requirements for the routine control of activities within ammunition and explosive areas and facilities during the storage, handling, processing and internal transportation of ammunition and explosives.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition stockpile management activities.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

'shall' indicates a requirement: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

'should' indicates a recommendation: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

'may' indicates permission: It is used to indicate a course of action permissible within the limits of the document.

'can' indicates possibility and capability: It is used for statements of possibility and capability, whether material, physical or casual.

4 Personnel employed in explosives facilities (LEVEL 2)

4.1 Training and supervision

Before being employed in an explosives facility all personnel shall receive training, on a national technical authority approved syllabus, on explosives safety, fire prevention, firefighting and security. This training shall be repeated at regular intervals, as laid down by the national technical authority, for all staff members regardless of rank or position and shall be recorded.

In addition to the above, task-specific training shall be provided to personnel who operate specialized equipment (cranes, forklifts, truck drivers, etc.).

Personnel employed in an explosives facility shall work under strict supervision until they have acquired a working knowledge of all safety requirements. This applies to anyone training to be an explosives worker or an explosives area support worker.[3] Any training within an explosives area shall take place only when it cannot reasonably take place elsewhere. This training shall be the subject of a risk assessment. Such training may include, but not be limited to, training in the storage, handling, processing and inspection of explosives and explosives facilities.

Before entering an explosives area, a trainee shall receive appropriate instruction on explosives and explosives area safety. The number of trainees and other workers in the explosives area and their distribution shall be controlled to take account of individual and societal risks.

Supervisors shall not oversee any task involving the handling, processing, or storage of explosives until such time as they are considered by the head of the establishment to be thoroughly familiar with all the relevant regulations relating to the task.

4.2 Special conditions of employment (LEVEL 2)

4.2.1. Disabled personnel

Disabled personnel may be employed within an explosives facility and each case shall be considered on its merits. The head of the establishment shall be satisfied that the nature of the disability does not present an unacceptable risk. However, within these parameters, and where circumstances permit, disabled personnel may be employed.

A major consideration regarding the hiring of a disabled person to work in an explosives operation is their ability to evacuate, or to be evacuated, safely in the event of an explosive event or other serious situation, without putting others at risk.

4.2.2. Young people

Good practice and experience has shown that persons under the age of 18 years, or persons over 18 years when there is reason to suspect that they are immature or irresponsible, should not be employed in, or permitted access to, any facility where explosives are stored or handled, except under appropriate supervision. A person under the age of 16 years should not be employed in any such facility.[4]

There may also be national legislation that applies to the hiring of persons under 18 years of age to perform hazardous operations.

4.2.3. Women

Hiring managers and heads of establishment shall ensure that the selection or appointment of qualified women is not affected by conscious or unconscious gender biases.

4.3 Specific employment conditions (LEVEL 2)

Individuals employed to work in an explosives area shall be responsible and of sound mind. The following shall not be employed to work in explosives areas:

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[3] See IATG 06.60 *Works services (construction and repair)*.

[4] In line with the principles contained within United Nations General Assembly Resolution *263* Session 54, *Optional Protocols to the Convention on the Rights of the Child on the involvement of children in armed conflict and on the sale of children, child prostitution and child pornography*. 25 May 2000.

- persons addicted to excessive consumption of alcoholic liquors or to controlled substances; and
- users of illegal substances.

5 Security[5]

5.1 Patrolling and guarding (LEVEL 1)

Explosives facilities should be patrolled in accordance with national technical authority regulations and the requirements of IATG 09.10 *Security principles and systems*. Each entrance to an explosives area, except when closed and secured, shall be guarded by sentries who shall:

- prohibit entry by unauthorised personnel and personnel disqualified by this module;
- scrutinise or, if suspicious, search all personnel and personal vehicles before admitting them;
- challenge personnel as to whether they possess controlled articles or contraband as defined below; and
- operate the control of entry system as described below.

5.2 Control of entry (LEVEL 1)

No one shall be permitted to enter an explosives facility during normal working hours unless he or she produces a current official pass applicable to the area in question authorised by, or on behalf of, the head of the establishment, or has been specifically authorised to do so by the head of the establishment in person. During non-working hours, no one shall be permitted to enter an explosives facility unless he or she is specifically authorised to do so by, or on behalf of, the head of the establishment. Such entry into explosives facilities shall be via recognised entrances only. No person who shows signs of intoxication or drug abuse is to be allowed to enter an explosives facility.

The head of the establishment shall ensure there is in place a system for the mustering of all staff in the event of an incident in the explosive area. This system may take the form of a swipe card, numbered disc, etc. The custody, issue and return of discs or the control of swipe cards shall be strictly controlled and the building in which this function is carried out should be one that is unlikely to be destroyed or seriously damaged in the event of a fire or explosion. The use of barricades for protection should be considered. For small explosives facilities, for example a single potential explosion site (PES) or small group of PES, consideration should be given to the adoption of this or a suitable similar system such as a log book.

5.3 Contraband (LEVEL 1)

The entry of certain items into explosives facilities is strictly controlled. These are known as controlled articles or contraband and are described below. Cases of doubt regarding the status of a particular item shall be referred to the head of the establishment and, if necessary, the national technical authority. Until the item is thus approved it should be considered as contraband.

5.3.1. Example of a contraband notice

An example of such a notice is at Annex C. It shall be prominently displayed at all of the entrances to all explosives facilities. This notice is to be produced locally to the required size as designated by the head of the establishment or national technical authority.

[5] Also see IATG 09.10 *Security principles and systems*.

5.3.2. Smoking materials and designated smoking areas (LEVEL 1)

Smoking shall be strictly prohibited in an explosives area or PES except in places designated as smoking areas. These areas are known as designated smoking areas (DSA) and shall operate as required by the head of the establishment. All smoking and smoking related materials shall be declared at the control building. Means of ignition, including the removable portions of car lighters, shall be handed in. The owner may then take cigarettes or tobacco direct to the DSA. In order to avoid taking means of ignition into the area, a non-removable electric cigarette lighter may be fixed to the wall in the DSA.

Where such lighters are not provided, then the means of ignition shall be taken to and from the DSA in a locked red box observing the appropriate requirements detailed below. A separate red box shall be used to transport the smoking materials. The 'Red Box' containing smoking materials should always be locked and the key shall be in the physical possession of a designated person.

5.3.3. Firearms (LEVEL 1)

Firearms are prohibited within an explosives area or facility with the following exceptions:

A) controlled weapons required in proof, test or trials facilities;

B) firearms carried by authorised personnel on guard, defence and operational duties, or for authorised tactical exercises. Although these persons should normally patrol within a fenced boundary area;

C) firearms held in authorised locations for rapid deployment of defence force personnel. The keys for these weapons shall be held under secure arrangements, separate from the explosives area keys; and

D) firearms used for sports shooting or vermin control, in organised events that have been subjected to a formal risk assessment and which have been authorised by the head of the establishment.

5.3.4. Food and drink (LEVEL 1)

No alcoholic drinks shall be taken into an explosives area. Food and non-alcoholic drinks may be admitted subject to the prior approval of the head of the establishment. For reasons of hygiene and health, the consumption of food or drink is not permitted inside an ASA, and such items shall only be consumed in designated locations.

5.3.5. Battery powered devices (LEVEL 1)

Battery powered devices of any description, including mobile telephones and MP3 players, shall not be taken into an explosives facility unless specific authority has been obtained from the head of the establishment and the requirements of IATG 05.40 *Safety standards for electrical installations* have been met.

5.4 Searching of personnel (LEVEL 1)

Before entering an explosives facility all personnel shall search their pockets and bags and deposit outside the entrance any controlled articles that they have with them. A suitable, secure personal container should be provided for the reception of such articles. All persons employed in or visiting an explosives facility may, if they consent, be subjected to a thorough search at the entrance before entering and when leaving, or at any time whilst they are in the explosives area. The search is to be made in accordance with national technical authority regulations. Should they not consent then they should be prevented from entering or leaving until the head of establishment makes a decision on the appropriate next steps.

Personnel shall only be searched by personnel of the same gender and only in the presence of personnel of the same gender. Any body-search policy should be determined by the national technical authority. Searches shall be carried out at random intervals and a record maintained. Personnel unwilling to consent to search shall not be admitted to an explosives facility.

Visitors are also liable to be searched if this is considered desirable by access control personnel. Visitors shall only be searched by personnel of the same gender and only in the presence of personnel of the same gender. Visitors who do not submit to this liability are to be refused admittance. Before any visitor is searched, reference is to be made to the head of the establishment.

5.4.1. Footwear

Metal shod footwear is prohibited in a PES.

5.5 Magnetic therapy products (LEVEL 1)

The wearing or carrying of magnetic therapy products such as bracelets, 'spot' magnets and joint bandages are expressly forbidden within an explosives area.

5.6 Spark, flame, or heat producing items (LEVEL 1)

Spark, flame, or other heat producing items shall not be permitted inside an explosives facility unless required for a specific reason, such as a works service. Any item required shall be authorised using the permit to work system.[6]

5.7 Lighting of fires (LEVEL 1)

The unauthorised lighting of fires in explosives facilities is strictly prohibited. Authority for the lighting of fires shall be given by the head of the establishment in special circumstances only. Such authority shall be subject to a formal risk assessment. When authority has been given for a fire to be lit only a means of ignition approved by the head of the establishment shall be used. The means of ignition are to be taken into the facility in a lockable red box by the person authorised to use them. The user is to keep the key to the box in his or her possession and is to allow no other person to have access to the means of ignition, and is to use them only for the purpose for which they have been authorised. Means of ignition are not to be left in the facility when unoccupied but are to be brought out by the authorised person.

Authorisation is to be given in writing by the head of the establishment and shall state the purpose for which the means of ignition are required.

The appropriate numbers/types of fire extinguishers shall be readily available and present.

The fire department should be present during the fire.

A safety monitor appointed by the head of establishment shall verify that the fire has been completely extinguished after its use. The safety monitor should normally be a member of the fire department.

[6] See IATG 06.60 *Works services (construction and repair)*.

5.8 Vehicle tracker devices[7] (LEVEL 2)

Many vehicles are now fitted with anti-theft tracking devices or stolen vehicle recovery systems. The driver may not be aware of this; as such it must be assumed that all vehicles entering an ammunition storage area (ASA) have them fitted. It has been assessed that the probability of accidental initiation of electro-explosive devices (EED) is negated by maintaining a minimum distance of 5m between the vehicle and the exterior walls of any building containing explosives.

To ensure that the risk of the presence of tracker devices to unscreened or unshielded EEDs or guided weapons is as low as is reasonably practicable (ALARP) heads of establishment shall establish a control mechanism that routes any vehicle fitted with a tracker device in such a manner that it will not approach, or pass, within 25m of an ammunition process building (APB), explosive storehouse (ESH), building or area where affected EEDs or guided weapons are or may be present.

5.9 Other controlled items (LEVEL 1)

In normal circumstances, many other items are not permitted to enter explosives facilities. However, there are occasions when the following normally prohibited items may be authorised for entry into a facility by the head of the establishment. For example:

- cameras which are compliant with IATG 05.40 *Safety standards for electrical installations*;
- fuels, oils and lubricants not in sealed approved containers;
- lanterns, oil lamps and stoves; and
- unauthorised tools.

5.9.1. Vehicle radio key fobs (LEVEL 2)

These are battery powered devices to lock and unlock vehicles and should not be permitted inside PES. If the head of the establishment authorises their access, they may be permitted inside explosives areas where protected EIDs are present. Where exposed EIDs are present they shall not be permitted.

6 Estate management

Good estate management is important in promoting the maintenance, safety and serviceability of PES and their contents. In order to promote this, heads of establishment shall liaise with the responsible authorities to ensure all appropriate measures are put in place. Areas of responsibility are to be clearly defined.

6.1 Site plans (LEVEL 1)

The head of the establishment shall ensure that accurate, scaled site plans are drawn up. These plans shall be held at the facility control office and by the fire focal point. Each PES shall be uniquely numbered to ease identification.

6.2 Works services (LEVEL 2)

Works services in, on or in the vicinity of, a PES shall be carried out in accordance with IATG 06.60 *Works services (construction and repair)*.

[7] See IATG 05.60 *Hazards of electromagnetic radiation*.

6.3 Release of surplus facilities for non-explosive use (LEVEL 2)

The national regulations pertaining to explosives clearance and certification of surplus explosives facilities shall be followed. The regulations should ensure that all buildings and land are cleared and land released by national authorities in line and Certified as Free from Explosives (CFFE).[8]

6.4 Roads and drainage (LEVEL 2)

Roads in and leading to explosive facilities should be maintained in a good state of repair. This will lessen the risk of accidents. Drain covers in road surfaces should be serviceable and correctly fitted. Traffic flow systems should be clearly marked. Good drainage of the land in explosives facilities is essential to the proper maintenance of roads, railways and buildings. All streams, ditches and culverts should be kept clear and free of obstruction.

6.5 Railway lines (LEVEL 2)

The head of the establishment should ensure that there is no obstruction to the view of road users or locomotive drivers at junctions of roads and railway lines. Warning notices should be prominently displayed at the approaches to all such junctions and the normal road traffic rules should be observed. If rail lines run between a PES and its associated traverse their use should be confined to traffic serving that building.

6.6 Vermin control (LEVEL 1)

Vermin are a source of damage to buildings and services. Rabbits and other burrowing animals such as termites can cause severe damage to barricades, undermine buildings and roads or damage ammunition and its associated packaging. Control measures should be taken to eliminate vermin and burrowing animals from explosives facilities. However national legislation may protect some of these creatures as they may be 'endangered or protected species' and the head of the establishment should take note of any such legislation when considering solutions.

Regular or periodical inspection should be carried out to ascertain any signs of attack or damage. The soil conditions at the facility will have an impact on the damage that vermin or pests can cause. Pesticides can be permanently imbedded before the construction of buildings or they can be temporarily deployed inside buildings to prevent damage to the buildings and their contents.

6.7 Vegetation and crops (LEVEL 1)

This section describes the minimum recommended standards that should be implemented for the control of grass, trees and vegetation in and around explosives facilities. Grass, trees and vegetation shall be subject to control to ensure that they do not present a hazard to explosives in storage. Uncontrolled growth presents a major fire risk, particularly during dry weather conditions. Close liaison should be maintained between the facility and local firefighting services.

Other hazards will be dependent upon the topography and seasonal changes but include the undermining of foundations, the blockage of underground services by tree and shrub roots, blocking of drains by leaves and grass, and damage to buildings and facilities that could occur if trees fall on them. Trees and vegetation can also provide cover for intruders, particularly around perimeter fences.

Cut vegetation should be removed from the explosive facility on the day that it is cut, and cutting activities should be limited to ensure that the resulting waste vegetation may be removed from the explosive facility on the same day.

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[8] See IATG 06.50 *Special safety precautions (storage and operations)*, para 7.2.

6.7.1. Control measures and a three-area plan (LEVEL 1)

Vegetation, undergrowth, dead leaves, and other growth creates a serious fire risk particularly during extended periods of dry weather. To reduce the risk of fire, a three-area plan should be implemented.

6.7.1.1. Area 1

In this area, no vegetation shall be permitted within 1m of a PES unless it is grass on earth covered buildings.

6.7.1.2. Area 2

Whenever possible, no vegetation over 50mm in height shall be allowed within a further 5m of a PES i.e. within 6m. No vegetation longer than 50mm on, or within 5m of, earth-covered buildings, or on barricades within 5m of a PES shall be allowed. This requirement allows emergency personnel to identify ejected unexploded articles in the event of an explosion. It also permits staff to easily identify damage to barricades caused by burrowing animals.

6.7.1.3. Area 3

Beyond the 6m boundary line the length of vegetation shall be in accordance with the site locally assessed risk (see below).

6.7.2. Site risk assessment (LEVEL 1)

Local assessment of the risks facing the facility is the responsibility of the head of the establishment. A risk assessment team should be formed, and its membership should consist of specialists such as:

A) the explosives safety representative;

B) the fire focal point;[9]

C) the security officer;

D) estate management staff; and

E) any other personnel considered necessary by the head of the establishment.

6.8 Control of trees and shrubs (LEVEL 1)

Trees and shrubs may be permitted within explosives facilities provided that they do not provide a means by which a fire can bridge a firebreak as per the three-area plan. Conifers and spruce trees should not be closer than 30m to explosives facilities. Other types of trees should not be allowed closer than 15m. Trees should be regularly maintained by a competent person to ensure that they remain healthy. The proximity of trees to a PES should be controlled so that in the event of them being blown over they will not hazard the PES or its contents.

[9] See IATG 02.50 *Fire safety*.

6.9 Cut vegetation (LEVEL 1)

Cut vegetation such as grass, branches and hay should be removed from the short grass areas around PES defined by the three-area plan immediately after cutting. If the cuttings are removed to a distance of not less than 50m from a PES, for example stacks of hay and cereal crops, they may be temporarily stacked to await their removal. Such removal should be completed within three days from the date of cutting. The head of the establishment is responsible for ensuring that any grass cutting or vegetation control contract tendered includes the requirement to remove all cuttings in accordance with this paragraph. Burning of cut vegetation shall not be permitted within an ammunition area, without the specific approval of the head of establishment.

6.10 Agriculture and agricultural chemicals (LEVEL 1)

Agricultural operations, excluding the grazing of livestock, may be permitted in explosives facilities subject to the following conditions. These conditions shall be formalised in a written contract between the head of the establishment and the operator carrying out the agricultural operations:

The number of exposed personnel shall be kept to the minimum required.

People and vehicles entering may be subject to search as previously described.

A) agricultural personnel involved in the agricultural operation shall be given the same protection as if they were contractors;[10]

B) any agricultural operation which is within the area encompassed by the inhabited building distance (IBD) shall not involve more days than would normally be required to maintain the area, e.g. grass cutting;

C) the crops grown shall not create a significant fire risk. The unit fire focal point shall advise if increased fire precautions are required, particularly increased fire breaks. These recommendations shall be implemented before agricultural operations commence; and

D) the contract with the operator shall include the stipulation that when agricultural operations cease, the ground is returned to short grass.

Only chemicals and fertilisers whose residue does not produce or cause a significant fire risk shall be used to control vegetation in explosives facilities. Any chemicals used shall be chlorate free.

6.11 Livestock (LEVEL 1)

The grazing of livestock within explosives facilities should not normally be permitted because of the amount of access time to the area normally required by the farmer or his or her employees and its consequential effect on the overall limits and exposure time in the facility. However, should the head of the establishment consider such grazing feasible, a risk assessment should be carried out and the results submitted to the national technical authority for consideration. This shall be done before any contractual obligation is undertaken. Even if the livestock is the property of the facility the same procedure shall be followed.

[10] See IATG 06.60 *Works services (construction and repair)*.

7 Fire and first aid

7.1 Fire (LEVEL 1)

All personnel shall have a responsibility to do all in their power to prevent fires, report any occurrence of fire, to take immediate and appropriate firefighting measures to stop/control a fire before it impacts a PES and to co-operate in any larger firefighting effort. The head of the establishment shall be responsible for the production of fire orders, the establishment of fire prevention measures and a pre-fire plan. Detailed instructions for fire pre-planning and firefighting are given in IATG 02.50 *Fire safety.*

7.2 First aid equipment (LEVEL 1)

First Aid equipment to a national technical authority approved scale shall be available at an accessible point in or at the entrance to all PES and in each process building. Details of first aid treatment for white phosphorous (WP) and other hazardous substances and the precautions to be taken when handling these substances are in IATG 06.50 *Special safety precautions (storage and operations)*.

8 Aircraft overflight (LEVEL 2)

Major explosives areas shall be protected from the potential hazards of aircraft crashes by national technical authority measures, which shall designate these areas as avoidance zones. These zones should preclude aircraft from over-flying such sites at heights of less than 1000m above ground level. Persistent incursions of these avoidance zones should be reported to the national technical authority. Local military air traffic at military airfields with explosives facilities is not generally restricted by such avoidance zones. In this case, the facility explosives safety representative should contact the senior air traffic control officer to request a suitable entry in the aircraft unit standing orders, which highlights the danger of potential disaster at large co-located explosives storage sites. In this way, aircrew can avoid such explosives facilities.

Conversely, explosives areas and facilities shall not be intentionally constructed in locations that would be over flown by existing or planned flight paths.

8.1 Helicopters (LEVEL 2)

Military helicopter operations that over-fly explosives facilities may be permitted for training and exercise purposes provided that:

A) a risk assessment has been conducted by the unit explosives safety representative that demonstrate that the risks are tolerable and ALARP;

B) they are authorised beforehand by the head of the establishment;

C) only passenger or non-explosive transfers are involved;

D) no over-flight of PES is permitted;

E) use is made of the safest ingress and egress routes, which shall be included in local flying and establishment orders; and

F) no movement of explosives is undertaken during the over-flight.

9 Potential explosion sites (PES)

9.1 Cleanliness (LEVEL 1)

PES shall be kept thoroughly clean at all times. Non-static producing doormats may be provided at the entrance to the PES. The floor, workbenches and all platforms and fittings shall be kept free from dust and grit.

Oily rags, waste and other articles liable to spontaneous combustion shall be placed, immediately after use, together with any other refuse, into metal bins provided with lids situated outside the building. These bins shall be emptied at regular intervals and on no account are they to remain filled overnight. Any waste material which is, or is suspected of being, contaminated with explosives substances is to be treated as explosive and stored and disposed of accordingly.

9.2 Action on vacating a PES (LEVEL 1)

9.2.1. Normal vacation

When vacating a PES, all packages shall be closed and sealed if appropriate. All doors, windows and shutters shall be kept closed and secured except when they are open for work or ventilation. When the doors are open, a responsible person shall be left in charge of the building.

When a PES is vacated, the electrical supply shall be switched off at the building master switch. However, in buildings where a constant temperature or humidity is required, the power may be left on provided that the electrical equipment is thermostatically controlled.[11] Other than those provided for security features, all other power supplies are to be switched off.

9.2.2. Temporary breaks

For temporary breaks during the working day, the following actions shall be carried out before leaving the PES:

A) all entrances shall be cleared of any obstruction; and

B) items on gravity rollers shall be secured against accidental movement.

Explosives may be left in process buildings and proof/test facilities if:

C) they are safely secured or stowed away; and

unless specifically stipulated as permissible on the explosives licence, no explosive filling is exposed.

9.3 Emergency evacuation

All personnel employed in explosives facilities shall be made aware of the location of both the normal and emergency exits of the PES in which they work. Whenever a fire-fighting practice takes place, evacuation drills should also to be carried out. In this case, the emergency exits as well as the normal exits shall be used. Emergency doors shall be clearly marked as such, both internally and externally.

The person in charge of the building shall record in the PES log book[12] the date of the practice and the time taken to clear the building. Comment should also be made on the adequacy, the number of exits and the use made of them. Recommendations for additional means of exit shall be made if they are considered necessary.

During these drills workers in process facilities should be encouraged to make use of all available exits and to ignore the normal rules for entering and leaving such buildings. However, care shall be taken that protective clothing and shoes are free from extraneous matter before personnel are permitted to re-enter the facility.

Ammunition packaging, mechanical handling equipment (MHE), gravity rollers and other equipment shall not be allowed to block fire lanes or flow lines, or impede emergency egress from the PES.

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[11] See IATG 05.40 *Safety standards for electrical installations*.

[12] See IATG 06.70 *Inspection of explosives facilities*.

9.4 Lightning (LEVEL 2)

Explosives sites shall have a clearly defined response to lightning hazards. All PES shall be vacated and secured during thunderstorms[13].

Thunderstorms potentially contain a massive build-up of static electricity within the atmosphere and thus present a serious hazard to ammunition and explosive processing. In ammunition process buildings (APBs) work on EIDs and primary explosive is to cease immediately when there is a thunderstorm in the vicinity.[14] . Where it is safe to do so, ammunition and explosives being worked on are to be made safe and all ammunition and explosives are to be repackaged. The APB should then be evacuated and made secure until the thunderstorm has passed by.

A thunderstorm may be considered in the 'near vicinity' when the time between the lightning flash and the thunder report is approximately 25 seconds or less. The 25-second count will place the flash approximately 8 km from the observer.

9.5 Tools, materials, and equipment permitted in a PES (LEVEL 2)

No stores should be allowed in an explosives facility other than the explosives or non-explosives authorised for storage and any tools, equipment or other materials authorised from time to time in accordance with the relevant IATG. Explosives other than those authorised on the explosives licence shall not to be taken into a PES.

9.5.1. Articles in use list (AIU)

An AIU list of tools authorised for use by the authorised processing documentation shall be available in the process room or PES for each approved task. This list shall include brushes, dustpans and dusters etc for the cleaning of the PES.

9.5.2. Tools and equipment

Tools and other equipment of local manufacture should not be permitted unless their use is called for in an approved work instruction and their design is authorised. In cases where it is necessary to test a locally manufactured tool or other piece of equipment in an explosives facility, prior authority should be obtained from the national technical authority. Tools and equipment required for works services and repairs to PES shall be authorised for use as per IATG 06.60 *Works services (construction and repair)*, prior to their use in any PES.

10 Operations in PES

Some operations carried out in a PES are of negligible hazard and may be permitted in explosives storehouses. Operations involving direct work on explosive articles and any exposure of explosives substances shall be strictly prohibited in explosives storehouses. Apart from cleaning operations such as sweeping or dusting, the operations that may be permitted in explosives storehouses are as described in this section.

Other operations may be permitted where movement of the store to a process area creates a greater risk. In such instances the head of the establishment may authorise such work. Each case shall be the subject of a full risk assessment. All other exceptions shall be referred to the national technical authority. However, in general all other operations shall be carried out in Ammunition Process Buildings (APBs).

[13] See IATG 05.40 *Safety standards for electrical installations, Section 8*

[14] It may be possible to get prior warning from the national meteorological office.

10.1 Explosive storehouses (ESH) and open bay storage (LEVEL 2)

The following operations may be permitted within an ESH or open storage bay:

A) re-stencilling and re-labelling of packages and unboxed stores;

B) the build-up and break down of weapon over-packs, ammunition containers and pallet configurations where the packages within are sealed or are unboxed stores;

C) opening unit load containers to check humidity indicators;

D) the maintenance and inspection of aircraft high explosive (HE) bombs as long as the operations are carried out in accordance with instructions issued by the national technical authority;

E) the visual inspection of prepared for use aircraft weapons; and

F) the checking of temperature and humidity indicators and approved data loggers as long as the check does not involve breaching containers or packages.

Low risk, short duration, tasks such as the repacking or visual inspection of a small quantity of ammunition may be permitted in the immediate vicinity of the parent licensed storage building at the discretion of the head of the establishment. In this case only one package (or two packages if fractioning ammunition for issue or storage) may be open at any one time. The doors to the parent building shall be closed.

10.2 Ready use ammunition (LEVEL 2)

In addition to the above activities, if the use of a process building is not reasonably practical, issues, receipts and visual inspection of ammunition may be conducted in a suitable area set aside for the purpose. This task shall be subject to a written risk assessment having been carried out by the facility explosives safety representative and should be authorised by the national technical authority. This activity shall be limited to stores of Hazard Division (HD) 1.3 and 1.4 only.

10.3 Captured enemy ammunition and foreign explosives (LEVEL 3)

Captured enemy and foreign explosives are subject to special regulations, as are improvised explosives recovered as part of Counter-Improvised Explosive Device (C-IED) operations. There may be little available technical information about the explosives and ordnance. It is therefore necessary to define procedures to be adopted to ensure explosives safety is not compromised. The procedures should be as follows:

A) the head of the establishment shall request a copy of the explosive classification certificate from the national technical authority (if available) for the foreign explosive ordnance authorised for storage;

B) written confirmation should be sought stating that the foreign explosive ordnance has been physically checked by a technical specialist acceptable to the national technical authority. This shall confirm that there are no other hazards from the ordnance other than the normal hazards associated with conventional explosives substances (e.g. the ammunition or explosive does not contain radioactive sources or chemical agents);

C) a technical specialist acceptable to the national technical authority should certify that the foreign explosive ordnance or the improvised explosives are safe for storage. This certification should be repeated periodically at intervals as required by the national technical authority;

D) the explosives facilities shall be inspected in accordance with the requirements of IATG 06.70 *Inspection of explosives facilities*;

E) fire assets shall be manned and sited at a minimum of IBD from the PES whenever foreign explosive ordnance is being handled or processed;

F) foreign explosive ordnance or improvised explosives shall not be stored or processed in any PES that contains national explosive assets;

G) during handling and processing of foreign explosive ordnance or improvised explosives, all non-essential personnel shall be located outside the IBD from the PES; and

H) during handling and processing of foreign explosive ordnance or improvised explosives, all activity shall be monitored by a competent person nominated by the unit explosives safety representative. This monitor retains the right to halt all activity if not absolutely convinced about safety. Prior to any handling or processing, the monitor shall be fully briefed on the activities that will take place.

I) Ammunition purchased from a foreign country, which has been qualified by the mandatory tests and has been allocated a UN serial number and compatibility grouping after testing as per the UN regulations, shall be exempt from the above restrictions.[15]

10.4 Ammunition Process buildings (APBs) (LEVEL 3)

This section specifies the guidelines that should be applied to the running of ammunition process buildings (APB). These guidelines shall be applied in addition to those above.

10.4.1. Receipt and issue (R&I) bays

R&I bays are compartmented buildings where one or more compartments are authorised for receipts, issuing and fractioning of packages, and visual inspection of stocks. Only the compartments authorised on the explosives licence shall be used for these activities. R&I bays may also be located in storage areas.

10.4.2. Handling or testing of EID

If EIDs or stores containing EIDs are handled, maintained, assembled, tested or prepared for use, RADHAZ Category 1 safe distances shall be applied.[16] The earthing, conductive and anti-static and processing requirements given in IATG 05.40 *Safety standards in electrical installations* shall also be implemented.

11 Storage

11.1 Covered storage (LEVEL 2)

All explosives and associated non-explosives stores and dangerous goods should normally be stored under cover. Aircraft HE bombs and similar stores such as heavy artillery breech loading (BL) natures may be open stored in temperate climates. Aircraft HE bombs and other permitted items open-stored held in sub-tropical and tropical climates should be protected from the sun by a building or structure fitted with approved air conditioning.

NOTE 1 Open storage provides the least protection from subsequent propagation in the event of an accident or incident. Earth-covered magazines provide the highest level of protection from subsequent propagations.

Some explosive stores are more vulnerable to the elements and if covered storage is limited, the following provisions should be applied, and the following points considered when allocating covered storage:

A) the prior authority of the national technical authority shall be obtained;

B) the inherent liability of particular kinds of an explosive store to damage from exposure;

C) the design of the ammunition packages to resist exposure and their condition;

D) the type of storage required by regulation, i.e. magazine or ESH;

[15] See IATG 01.50 *UN explosive hazard classification system and codes*.

[16] See IATG 05.60 *Hazards of electromagnetic radiation*.

E) the prevailing climate;

F) the need for the security of particular items, for example those items attractive to criminal and terrorist organisations (ACTO); and

G) any special risks from exposure if the condition of the explosives is doubtful.

11.2 Open storage (LEVEL 2)

Where it is necessary to store explosives in the open, the stacks should be covered over with waterproof sheets, which are preferably fire resistant, or other suitable material. Care should be taken to use non-static producing covers, as significant static can be generated during the removal/movement of plastics-based covers.

The sheets should be supported in such a way as to allow a current of air to circulate over and around the stacks. When supports are not available, and the sheets are laid directly on the stacks, every opportunity shall be taken to air the stores by uncovering them periodically in good weather. As a minimum, the stores should be aired at least monthly and more frequently if the prevailing climatic conditions in theatre warrant it. Aircraft HE bombs and similar stores such as heavy artillery breech loading (BL) natures should also be subjected to this regime if possible.

11.3 Explosive items

Explosives shall be stored safely and securely in the special licensed facilities provided.[17] Where explosives storage facilities are not adequate or immediately available, the head of the establishment shall make temporary arrangements to minimise the risk to life and property in the event of an explosion or fire and to prevent deterioration of the explosive stores. Under normal circumstances, explosives storage facilities should not be used for the storage of other equipment, materiel or dangerous goods.

11.4 Non-explosive items

Drill and instructional stores or weapons may be empty or inert filled with a high explosive substitute (HES). These items shall not be stored with live stores to avoid inadvertent mixing in use. All drill, instructional and inert filled stores that have been converted from filled stores shall be subject to technical inspection before they are taken into use. Such stores shall conform to an approved design and prior authority for their conversion is to be obtained from the national technical authority. Drill and instructional stores or weapons should be clearly marked in a manner so as to preclude confusion with live stores.

Non-explosive components, which are related by function to explosives, such as fuze shear wires, may be stored in the same storehouse as their parent stores. The packages shall be sealed and identified and shall be stacked separately from the filled stores.

[17] See IATG 05.20 *Types of buildings for explosives facilities*.

11.5 Dangerous goods and explosive stores filled with dangerous goods (LEVEL 3)

Non-explosive dangerous goods should not be stored in a PES or explosives area because of the additional hazards introduced by their presence. However certain explosive natures or their components contain dangerous goods that are required to be stored because they are related by function to the explosives. Examples of these stores are aircraft flares and missile fuels. In such cases, it may be permitted to store these explosives related dangerous goods in a PES or explosives area so long as they comply with compatibility groups and mixing rules. Otherwise they shall be treated as HD 1.3 for quantity distance (QD) purposes. However, the items and their outer packages shall not be marked with HD 1.3 labels. Such storage should be specifically authorised by the national technical authority.

11.5.1. Items excluded from UN Class 1

An item containing explosives may be considered by the national technical authority as presenting no significant hazard from explosion and may be excluded from UN Class 1 (for example some small pyrotechnics). In this situation, these items may be stored with the explosives items that they are related to but should be treated as HD 1.4S for storage purposes. However, the items and their packages shall not be marked with HD 1.4S labels.

11.6 Ammunition and ammunition packaging (LEVEL 2)

11.6.1. Examination of stocks before entry into a PES

Before being allowed into a PES all pallets, packages and unboxed munitions shall be examined for damage, signs of tampering with seals and so forth. Should such damage or signs of tampering be detected then the pallet, package or munition shall be segregated for detailed examination.

11.6.2. Serviceability of ammunition and its packaging

All stocks of explosives and weapons should be maintained in a serviceable condition and markings on packages and unboxed stores should be legible. Unserviceable or suspect stocks shall be segregated. Defective packages should be repaired or replaced before storage is permitted. This work should be undertaken in an APB. Exceptionally, defective, or damaged packages may, after inspection by a competent person, be kept segregated until repaired.

If the seal of a package is broken or missing and the package concerned is not for immediate use, the inner packaging and contents should be examined by a competent person. If the examination is satisfactory the package should be correctly sealed before storage is permitted. This work should be carried out in an APB. The ammunition account should also be reconciled to ensure its accuracy and a local investigation should take place if any discrepancies arise.

11.7 Commercial explosives and fireworks (LEVEL 2)

11.7.1. Commercial explosives

Commercial explosives should be classified by the national technical authority in accordance with the UN 'Orange Book''[18] requirements prior to storage and are to be kept segregated. All commercial explosives usually have a much more limited safe storage life than military explosives. Storage records should indicate the shelf life of the item. On receipt the explosives should be inspected by a competent person. Explosives that are in poor condition or have been subject to local modification shall not be accepted for storage. This receipt inspection is to include checking for compliance with all national regulatory requirements and the packaging shall be in accordance with the UN Orange Book requirements.

11.7.2. Civilian fireworks

The following guidelines cover the storage of fireworks and apply in all situations where fireworks of UN Class 1 are stored. The maximum time they may be stored in a PES containing ammunition or explosives should be 24 hours. Particular care shall be taken when handling fireworks due to the inherent weakness of the paper or cardboard cases and the high probability of spillage of the filling. Firework fillings are very sensitive to impact, friction, heat or sparks. Therefore, PES shall be carefully cleaned after fireworks have been stored there and before any other explosive is stored. This procedure should be the subject of a risk assessment. Storage in excess of 24 hours shall be approved by the national technical authority but is generally not recommended.

On their receipt and prior to their storage in a PES, the fireworks should be suitably over-packed to prevent the leakage of black powder or pyrotechnic composition.

11.8 Experimental explosives (LEVEL 3)

If they have been classified and qualified by the national technical authority experimental explosives may be treated as normal explosives. However, they should be segregated from other natures within the storage facility.

If not classified or if their safety tests have not been accomplished, such materials shall be completely isolated from all explosives (see Clause 11.10 below). If it is determined that the material is unsafe or unstable, it shall be disposed of immediately using special procedures approved by the head of the establishment.

The owner or sponsor of the explosives shall provide disposal instructions before acceptance into storage. Contact shall be made with the owner or sponsor of the explosives at least every six months. To ensure they retain their identity at all times, the packages and contents should be marked with an identification symbol as required by the national technical authority. This symbology should ensure each item, if unused, is returned to its correct package. Additionally, the packages or stacks should be clearly marked with the sponsor details and any other information deemed necessary, e.g. points of contact.

[18] See IATG 01.50 *UN explosive hazard classification system and codes*.

11.9 Special stores (LEVEL 3)

11.9.1. Gaseous tritium light source (GTLS)

Some weapon systems incorporate a GTLS within the integral sight. This presents a slight radiation hazard if broken in a confined space. These weapons should, as a minimum, be stored in buildings with ventilation openings. The building should also display the trefoil symbol in addition to the fire symbol and any supplementary symbol required by national technical authority regulations. The national technical authority regulations may also specify the maximum storage density in any single building. Finally, the PES should contain national technical authority approved instructions on the actions to be taken in the event of a breakage causing a tritium leak.

11.9.2. Depleted uranium (DU)

DU is mildly radioactive at a level that is low enough to permit handling and transportation with simple precautionary measures. DU has a chemical toxicity at the same level as other heavy metals such as lead, thus allowing handling and transportation in authorised packaging without abnormal risk. The mechanisms whereby radioactivity and toxicity might lead to harmful effects are:

- personnel being in close contact with DU over extended periods; and
- if DU is involved in a fire or explosion in which uranium oxides from the ammunition are dispersed and inhaled by personnel sited downwind from the event.

Advice on the storage of ammunition containing DU should be provided by the national technical authority. Handling and transportation of DU ammunition should be reduced to a minimum and no work or movement is to be carried out without prior reference to a national radiological protection supervisor. General regulations for the transportation of DU ammunition should be provided by the national technical authority and contingency planning for accidents and incidents should also be provided by the national technical authority.[19]

11.10 Isolation and segregation of stocks (LEVEL 3)

11.10.1. Fault and defect reporting

Explosives that are known or suspected of being inefficient, unsafe, whose condition is uncertain, or which cannot be conditioned by the facility's ammunition technical staff should be the subject of action in accordance with the instructions in IATG 01.70 *Bans and constraints*. Serious fault reporting action shall be carried out immediately.

11.10.2. Isolated storage

Isolated storage is the storage of explosives which are in an unsafe or possibly unsafe condition, in separate licensed accommodation away from all other explosives. The following explosives should always be isolated:

A) repairable or unserviceable explosives that are, or are suspected of being, unsafe for use;

B) salvaged stores recovered after an accident, explosion, fire or a trial;

C) explosive items which have failed to function and are unsafe for use, but not unsafe for storage;

D) explosives recovered during explosive ordnance disposal (EOD) operations, (including foreign ammunition or improvised explosives);

[19] Useful technical information on DU may be found in Technical Note for Mine Action (TNMA) 09.30/02 Version 3. 1 February 2015.

E) experimental explosives that may be unsafe or unstable; and

F) any ammunition or explosives on the instruction of the national technical authority or an ammunition technical officer (ATO) or other certified competent person.

11.10.3. Segregated storage

Segregated storage is the storage of explosives whose compatibility groups, whilst not requiring separate storage, do not permit mixed storage. The requirement for segregated storage may be met by any means which is effective in the prevention of propagation between the different groups, for example by a separate compartment, an internal traverse or barrier or by physical distance. The normal mixing of compatibility groups is permitted for explosives requiring segregated storage. The following stores should always be segregated:

A) stores known to be, or suspected of being, faulty but which are not unsafe;

B) experimental explosives;

C) commercial explosives;

D) shelf life expired ammunition;

E) banned ammunition which is safe to store; and

F) enemy explosives.

11.10.4. Isolated storage requirements – QD and CG

A PES that is to be used for the storage of explosives requiring isolated storage should be sited in such a location so as to afford all exposed sites (ES) the QD protection given by the tables in IATG 02.20 *Quantity and separation distances*. The use of reduced QDs shall not be permitted. Explosives requiring isolated storage should not normally be mixed by compatibility group. However, small quantities of less than 10 kg net explosive quantity (NEQ) of any compatibility group requiring isolated storage may be stored in the same PES under the following conditions:

A) explosives of each compatibility group shall be effectively segregated from explosives of any other compatibility group by walls of autoclaved aerated concrete blocks;

B) no explosives of HD 1.1 shall be stored; and

C) the stores are not EOD recoveries. The actions required for the storage of EOD recoveries are at Annex D.

11.10.5. Disposal of isolated explosives

Explosives that require isolated storage should be addressed or disposed of as soon as practicable. Heads of establishment should ensure that items are stored in isolation for only the minimum practicable time and long-term isolated storage of explosives shall require justification. Failure to provide adequate justification may be viewed as a serious safety breach. In the event that disposal is not the corrective means to be used, a constraint shall not be removed from suspect stores until clearance for storage or issue is authorised by the national technical authority after repair or modification.

11.11 Rail and vehicle transit and staging facilities (LEVEL 2)

11.11.1. Rail yards

Platforms of a suitable height should be provided in transit facilities so that handling and load transfer between vehicles can be conducted in a safe and efficient manner. Heavy stores should be handled by means of mechanical handling and this shall be compatible with the building and vehicles used.[20]

The explosives license limits for a transit facility should be clearly displayed and complied with. If necessary, a train should be divided into suitable units at a marshalling yard where the required QDs and protection are available before moving into the transit facility. A transit shed should be emptied of explosives daily.

Dangerous goods, other than those related by function to the explosives present, shall not be handled at a transit shed if explosives are also being handled.

11.11.2. Vehicles

Platforms of a suitable height should be provided in transit facilities so that handling and load transfer between vehicles can be conducted in a safe and efficient manner. Heavy stores should be handled by means of mechanical handling equipment and this should be compatible with the building and vehicles used.[21] If necessary, a vehicle convoy should be divided into suitable units at a marshalling yard where the required QDs and protection are available.

Any area authorised as a staging facility, irrespective of its location, should be clearly marked on the ground. The area should be large enough to accommodate the anticipated traffic flow and number of vehicles expected. There should be a gap of at least 6m around each vehicle to provide fire-fighting access.

Written or electronic records of the usage of a staging facility sited externally to the main explosives facility should be kept in a locally produced log. The record should detail the number and types of vehicles, the HD and NEQ carried and the dates and duration that the facility is occupied. The facility explosives safety representative should review this log at monthly intervals to ensure that the usage of the staging facility does not exceed the explosives licence criteria. If the usage has breached the criteria, advice shall be sought from the national technical authority.

11.11.3. Security

The principles of Clause 5 of this IATG module equally apply to these facilities and shall be applied to the same level.

11.12 Storage conditions (LEVEL 3)

11.12.1. Chemical stability

In general, explosives become less sensitive as the temperature drops. However, very low temperatures may have an adverse effect upon their safety or function when they are subsequently used. Cracking and fragmentation of the explosives can occur which can affect their operation. In propellants, cracking can lead to increased burning rates and, in the extreme, detonation.

[20] See IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*.

[21] Ibid.

Nitro-glycerine freezes below 13°C and may crystallize out. Should this happen, an increase in temperature may cause the leaching of nitro-glycerine. High temperatures may cause exudation, expansion, or increased decomposition rates. Above 32°C decomposition increases rapidly and prolonged exposure to temperatures above 15°C will affect the storage life of nitrate ester-based propellants.

To prevent these effects temperature limitations should be applied to the storage and transportation of certain types of explosives substances and articles and these should be promulgated by policy documents issued by the national technical authority. The purpose of this Clause is not to substitute these policy documents but to amplify the general guidance on temperature limitations for explosives and the mechanisms for measuring and controlling storage temperature. Thus, the most suitable storage accommodation available should be used in order that temperature susceptible explosives are maintained in a serviceable condition for the longest possible period.

Isolated periods of exposure to extremes of temperature may not cause any immediate deterioration but the effects are cumulative. Therefore, the extent of such periods of exposure should be recorded and notified to the national technical authority.

11.12.2. Temperature restrictions

The following restrictions should be considered when making major alterations to existing storehouses and when constructing new storehouses. They should be viewed as the ideal and a benchmark against which current capabilities are measured:

- Temperature limits. When an ammunition or explosive item has more than one class of temperature restriction it shall be viewed as being in the class with the maximum restriction;
- Minimum temperature. To prevent exudation of nitro-glycerine, nitrate ester-based propellants and articles containing such propellants should not be kept in storehouses for a continuous period of more than one month if the temperature in any part of the building is liable to remain below 5°C. If the stipulated minimum temperature conditions cannot be sustained, artificial heating to an approved standard should be installed; and
- Maximum temperature. The efficiency, storage life and safety of some explosives, particularly propellants, are adversely affected by storage at abnormally high temperatures. They are not to be kept in storehouses where the temperature can be expected to rise above the limits shown in the national technical authority policy documents. The use of adequate ventilation, approved air conditioning, or insulation should be considered in order to keep temperatures in storehouses within approved limits. The ammunition and explosives listed below are to be stored in the coolest accommodation possible:
  - ammunition containing amatol or TNT;
  - incendiary ammunition;
  - propelling charges or ammunition containing propellants; and
  - ammunition containing WP or lachrymatory (tear producing) compositions.

11.12.3. Movement

Temperature limitations are equally important during transportation, especially where explosives are to be moved by sea. The accompanying documentation should be annotated with any temperature limitations for the ammunition being moved.

11.12.4. Temperature recording

Where stipulated in the technical publication for the ammunition, explosive or weapon maximum and minimum temperature thermometers or approved temperature data loggers should be installed in the buildings where temperature susceptible explosives and articles are stored, handled or processed and the readings recorded. Approved temperature data loggers may also be placed inside individual explosives packages.[22]

11.13 Ventilation and relative humidity (RH)

Although proper ventilation is vital in a PES, indiscriminate admission of air into the PES may do more harm than good. Proper sealing and protective coating of the ammunition and explosives and their associated packaging will offset some of the effects of moisture-laden air. The higher the temperature of the air, the more moisture it requires to become saturated. On a warm day, the air is drier and better for ventilation than on a cold day. The reverse is also true. Therefore, when the RH is high PES should not be opened for ventilation without first ascertaining that the conditions are suitable.

The ventilation of a closed PES in which the internal temperature is lower than that of the incoming air may result in condensation forming on the internal walls and the explosives and associated packages. With a free flow of air, this condensation normally evaporates during the period of ventilation but when the airflow is restricted, as may occur where the PES is surrounded by barricades or situated in a deep hollow, the rate of evaporation may be slow. Several ventilation periods may be necessary before the condensation finally disappears.

In humid conditions, normal ventilation may not be sufficient to keep condensation at an acceptable level and air-drying or air conditioning apparatus to an approved standard may need to be installed. In temperate climates PES ventilators should normally remain open and only be temporarily closed as an immediate precaution against the entry of rain or fog. Ventilation by opening the doors and windows is not to be carried out unless condensation or excessive heat causes a problem.

Annex E provides further details on ventilation equipment and procedures.

12 Issuing of ammunition

12.1 Stock turnover (LEVEL 2)

As discussed in the previous section, explosives deteriorate with age, lose their effectiveness and reliability and, in extreme cases, become more dangerous to handle and store. Poor storage conditions and temperature extremes speed this process up. Ammunition is an extremely expensive asset and, therefore, to prevent unnecessary wastage from the causes stated above, regular turnover of stocks is essential. As a general principle, the oldest stock should be issued first. However, if units are serving overseas, to avoid the necessity of replacing at short intervals stocks that have become unserviceable through deterioration by age, issues to overseas units may be made from the newest stock.

When new stock arrives for storage it may be necessary to make physical changes to the ammunition stacks by ensuring that the oldest ammunition is the most accessible, as it will usually be issued first. This may mean moving the older ammunition to the top of the stacks, with newer ammunition below. This also has the advantage of avoiding excessive pressure or loading on the lower boxes during prolonged storage.

[22] See IATG 05.40 *Safety standards for electrical installations*.

12.2 Prevention of deterioration of explosives (LEVEL 2)

The operational life of many explosives commences when the packaging is first opened. The safe life of explosives commences on the day of manufacture of the explosives fill. The national technical authority or the manufacturer of the store shall be responsible for promulgating safety and operational life information in the technical publications. Effective systems shall be in place to ensure that explosives are managed and inspected in accordance with the technical publication relevant to the item concerned.

13 Underground storage (LEVEL 2)

13.1 General

The guidelines contained in these paragraphs refer to the administration and operation of underground storage areas and are designed to be supplemental to other storage guidelines in this IATG module. These guidelines should also be observed where applicable.

13.2 Stacking

Stacking in underground storage should follow above-ground rules. Stacks should be kept clear of access routes. Stacks should be regularly monitored for signs of deterioration. Deterioration in the bottom tiers may lead to the collapse of a stack with consequent damage to the contents or may cause a fire or other event. Stack heights should be such to preclude such an event. Stacking heights and methods should be in accordance with approved procedures and to heights authorised by the national technical authority following stacking trials.

13.3 Repair and maintenance

Repair and maintenance of underground facilities shall be in accordance with the general instructions in IATG 06.60 *Works services (construction and repair)*.

13.4 Records

All records of stocks held in an underground storage area and their location, with records of the temperature and humidity readings, roof or wall defects, examinations made, maintenance work done and so forth should be kept outside the underground site in a place not likely to be involved or destroyed in a major fire or explosion.

13.5 Prohibited storage

The following explosives should not be stored in underground sites:

A) captured enemy stocks;

B) items returned by units that are awaiting inspection;

C) items in, or suspected to be in, doubtful or unsafe condition; and

D) items not classified by the national technical authority or not of an approved pattern.

13.6 Limitations in storage

The following explosives natures should only be permitted in single chamber storage sites with complete segregation by nature:

A) those with incendiary or smoke effects belonging to compatibility group H and some of compatibility group G, due to the loss of visibility when smoke is trapped underground;

B) those in compatibility group J due to the risk of an explosive atmosphere posed by any leak;

C) those in compatibility group K due to the difficulty in decontamination; and

D) materials in compatibility group L shall be isolated by specific type.

13.7 Mechanical handling equipment (MHE)

Specific guidelines for MHE use in underground storage sites are provided by IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*. It should be noted that there may be an increased hazard in an underground site caused by the accumulation of exhaust fumes.

13.8 Humidity

High humidity is often found in underground sites and it has an adverse effect on many materials. Humidity shall be controlled by ventilation or approved air conditioning. Where temperature control is not a prime consideration, an approved de-humidifying system may be used which limits RH to 75%.

13.9 Non-Explosive Dangerous Goods

Non-explosive dangerous goods shall not be stored in underground explosives facilities.

Annex A
(normative)
References

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

- IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;
- IATG 01.50 *UN explosive hazard classification system and codes*. UNODA;
- IATG 01.70 *Bans and constraints*. UNODA.;
- IATG 02.20 *Quantity and separation distances*. UNODA;
- IATG 02.50 *Fire safety*. UNODA;
- IATG 05.20 *Types of buildings for explosives facilities*. UNODA;
- IATG 05.40 *Safety standards for electrical installations*. UNODA;
- IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*. UNODA;
- IATG 05.60 *Hazards of electromagnetic radiation*. UNODA;
- IATG 06.50 *Special safety precautions (storage and operations)*. UNODA;
- IATG 06.60 *Works services (construction and repair)*. UNODA;
- IATG 06.70 *Inspection of explosives facilities*. UNODA; and
- IATG 09.10 *Security principles and systems*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[23] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[23] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

- *Handbook of Best Practices on Conventional Ammunition*, Chapter 5. Decision 6/08. OSCE. 2008. www.osce.org/fsc/33371.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[24] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[24] Where copyright permits.

Annex C
(informative)
Suggested contraband notice (LEVEL 1)

This is an [***insert appropriate type (e.g. ammunition storage)***] establishment where military explosives are stored and processed. Stringent regulations for safety are necessary and staff and visitors shall be fully conversant with them. These rules are framed for the protection of the establishment and of all personnel on site and shall be observed at all times.

Unless formally authorised in advance, the following items shall not be taken into an explosives area:

a. Matches or any other means of producing flame or high temperatures.

b. Tobacco in any form, including snuff.

c. Any articles used in connection with smoking.

d. Radio transmitters or receivers, including mobile phones and car key fobs.

e. Tools and other equipment.

f. Any battery or mains operated item.

g. Unauthorised explosives.

h. Dangerous or flammable substances.

i. Cameras.

j. Firearms.

k. Drugs and Medicines.

l. Metal shod footwear.

m. Magnetic Therapy Products.

n. Commercial vehicles unless specifically authorised.

p. Nothing should be carried by the individuals inside explosives facility except a handkerchief and writing materials. All personal belongings should be left at the gate, secured in the locker provided.

Food and Drink. Food and drink shall be declared on entry and shall only be consumed at authorised locations. Food and drink shall not be consumed inside any explosives building.

Liability to Search. Persons are admitted into an explosives area only on the understanding that they and their vehicle are liable to search, by a person so authorised, at any time. Refusal to submit to search will preclude entry to the explosives area.

Additional Measures. Additional stringent control measures may be put in operation at any time.

Annex D
(informative)
EOD recoveries – storage and transport (LEVEL 3)

D.1 Introduction

This annex details the suggested guidelines for the storage and transport of explosive ordnance disposal (EOD) arisings. Included in these guidelines are collections from civilian agencies, individuals and amnesties and all planned area explosive ordnance clearances (EOC). EOD arisings from criminal and terrorist activities are included but are subject to separate current legal forensic procedures.

D.2 Exclusions

The following arisings are excluded:

- life expired or surplus items, in their authorised packaging, which are subject to formal demilitarisation and disposal; and
- disposals of logistic stock holdings that become unserviceable and in their authorised packaging, except where subject to EOD action.

Any EOD action carried out prior to a move of explosive ordnance (EO) to short term licensed storage is also excluded.

D.3 Legal Position

International legislation covering the classification, labelling, packaging, storage and transport of explosives is drawn up to cover new or serviceable explosives in their authorised packaging. It was never designed to cover EOD operations or EOD arisings. National technical authorities should consider exempting EOD operations in its national regulatory framework for ammunition and explosive storage and transport as each EOD incident is different. However, the national technical authority shall then ensure that its EOD organisations have systems in place, which are equally as good.

D.3.1 Competent person

Certain procedures require the approval of a competent person. In respect of EOD arisings, a competent person shall be nominated by the holding or consigning organisation. It would be logical that the holder of this post would be competent by virtue of the successful completion of accredited EOD courses or the award of a trade qualification.

D.4 Terminology

The operational phase of any EOD operation commences at the point to which EOD resources deploy. In simplistic terms, the operator will destroy in-situ or move for disposal any EO found. The operator applies his or her specialist technical knowledge to carry out an assessment to determine whether the item is safe to move. The completion of the risk assessment for transportation and possible concentration centrally of EOD arisings for later disposal lies with the operator at the time of the EOD operation. The operator may move the EO to:

- a more appropriate location for immediate disposal; or
- when the volume or location of EOD arisings prevents immediate disposal, and the operator considers the item safe to transport, a segregated licensed storage location for later disposal.

D.5 EOD operator action

The recovery phase of any EOD operation entails the move of EOD arisings from the discovered location to a segregated licensed store. A safety assessment covering the possible movement of hazardous substances may require completion. All EOD arisings to be moved shall be segregated, packed and marked as the operator deems appropriate for this operational move. The items should be packed in packaging appropriate to the EO nature and which affords sufficient environmental and physical protection.

The planning phase of planned EOD operations such as area clearances should include the procedures for the disposal of items found. Where EO is not destroyed in-situ during that working week the EO shall be moved to short term licensed storage.

D.6 EOD storage

Recovered EOD arisings held in segregated licensed storage locations shall not be regarded as being in an operational situation. The storage and transportation of these holdings from this point should comply with the IATG guidelines in order to control these operations with regard to the safety of life and property.

D.7 Classification of EOD arisings for storage and transport

All EOD arisings should be identified and classified items for storage and the final move from storage to disposal. Problems areas that will be encountered are:

- the validity of classification tests originally carried out on the store/package when pristine may not reflect the current status;
- where packaging exists, unserviceable items may have deteriorated or be damaged and cannot be properly classified;
- some items may be identifiable only by generic type, purpose, estimated net explosive quantity (NEQ), fuzing and other hazards; and
- other items may not be identifiable other than possibly being EO.

D.7.1 Disposal classifications

The following system is regarded as best practice but its use should require approval by the national technical authority. Where the EOD operator or EOD Unit can positively identify the EOD arisings, a disposal classification (DC) from the list at Appendix 1 may be awarded. If generic identification is not possible, the item shall be grouped as DC of 1.1F.

D.7.2 Specific situations

There may be specific situations, such as large scale EOC or large finds, which cannot be dealt with by DC procedures. On these occasions, the operationally responsible unit is to contact the national technical authority for instruction. The national technical authority may grant a temporary classification.[25] Before classification is awarded the national technical authority may wish to examine in detail the planning procedure from reconnaissance and identification through scale of disposal to final disposal arrangements.

D.8 EOD arisings – documentation and records

EOD arisings shall be accounted for and registers of holdings kept. This is an auditable document and should show the item history from recovery to disposal. Accounting management is to be in

[25] See IATG 01.50 *UN explosive hazard classification system and codes*.

accordance with written approved procedures. Once packed, the package should be marked with a unique identifier relating to the contents registered in the accounting system. System records should be kept as a register to record every item identified, transported, stored and disposed of. For recording purposes, closed records should be maintained for a minimum of five years.

D.9 Packaging

The competent person should be responsible for ensuring that only appropriate containers and restraints are used for storage. If available, the correct ammunition container assembly (ACA) and inner packaging fitments should be utilised. If not available, then only suitable, serviceable ammunition containers should be used. When the correct or original packaging is not available, the container contents should be secured against movement by use of expanded foam or other inert packing medium. The package net mass limit for contents, specified in the UN package certification mark for the outer container used shall not be exceeded and each package should be sealed with ammunition seals. Internal separation of stores will be the norm, for which material may be procured locally. To assist with the monitoring of NEQs against explosive limits, recovered items should be segregated and grouped into correctly marked containers if possible.

D.9.1 Package markings for EOD arisings

No UN package certification mark should be applied to the outer container. However, all containers should have the following basic markings applied both in storage and for the subsequent movement to the point of disposal:

- a generic description, or the letters FFE[26] if inert;
- the correct hazard classification code (HCC) and subsidiary risk labels are to be affixed;
- the UN serial number;
- the package all up weight (AUW) in kg;
- the EOD organisation accounting reference of the item or items contained within; and
- the estimated NEQ in kg.

Markings should be clear and legible and marked onto the container directly or by secure printed adhesive label.

D.10 Ammunition natures recovered

D.10.1 HE

Any high explosive items should be further divided into Hazard Divisions (HD) 1.1, 1.2, fuzed and unfuzed EO and stored in accordance with the explosives license.

D.10.2 Small arms ammunition (SAA)

All SAA should be held segregated by weight and packaged by type dependent upon lead content. Pin-fire ammunition and SAA of 0.50 in calibre and above shall be stored separately. SAA is to be sorted as follows:

- SAA with lead content;
- SAA without lead content including powder cartridges; or
- shot gun (all shot types).

[26] Free From Explosive.

D.10.3 Pyrotechnics

Recovered pyrotechnics should be packaged generically by type. Any safety mechanism such as lanyards or pins are to be correctly fitted and, if necessary, secured by the application of suitable adhesive tape. Fireworks shall be packed in such a way as to preclude the escape of loose powder or filling from the container. Pyrotechnics should be grouped for storage and subsequent disposal as follows:

- 1.2G: rockets, rockets hand fired and line throwing apparatus;
- 1.3G: distress flares and hand flares;
- 1.4G: distress flares and hand flares; and
- 1.4G: smoke natures.

D.10.4 Anti-riot and chemical training items

Only lachrymatory and anti-riot (AR) control agents may be held and these are to be identified as those with or without explosive components. Where possible, CS[27] natures should be packed or retained in their designed packaging. Non-explosive natures should be packed separately and marked accordingly. All natures must be packed in grey ammunition containers complete with subsidiary risk labels. Any munitions containing chemical agents (Compatibility Group (CG) 'K') should be dealt with as described below.

D.10.5 White phosphorus (WP)

If WP munitions have to be recovered, the guidelines in IATG 08.10 *Transport of ammunition* shall be applied.

D.10.6 Inert items

Non-explosive and inert items should be boxed and certified free from explosives (CFFE). Where a box is utilised for packing for final disposal, the accounting reference of the items contained should be shown on the exterior. Items too large to be boxed should be packed separately in cage or post pallets and an FFE certificate attached to each item or to the caged pallet in a prominent position. If any doubt exists that an item of EO is FFE, it must be treated as an explosive article and stored accordingly.

D.10.7 Licensing

The location, quantity and method of storing EOD arisings shall be formally endorsed by the national technical authority and specified on the explosives licences for the PES.

D.10.8 Standards of storage

EOD arisings should be stored by disposal classification in dedicated segregated licensed storage not holding other explosives or non-explosive stores. Isolated storage should be used if available. While storage outside is not recommended, the relevant open stack site guidelines should apply.

D.10.9 Safety certificates

[27] 2-chlorobenzalmalononitrile (also called o-Chlorobenzylidene Malononitrile) (chemical formula: $C_{10}H_5ClN_2$)

EOD units without their own licensed storage should arrange for storage with another facility. The EOD operator shall certify that the items are safe for segregated or isolated storage as appropriate. A copy of this certificate shall be placed on the item or stack.

D.10.10 Time constraints

EOD arisings, except forensic evidence holdings, should be stored for no longer than 60 days before being consigned and moved for final disposal. At the final disposal site, to allow flexibility in large-scale disposal programmes, the EOD arisings may be stored for a further 60 days from the date of delivery before being destroyed.

D.10.11 Transportation of EOD arisings

Transportation of EOD arisings shall be as per IATG 08.10 *Transport of ammunition*.

D.10.12 EOD chemical ammunition arisings

Chemical EOD arisings of compatibility group K shall be treated separately. Instructions for anti-riot natures and chemical training items are not subject to this instruction. Chemical EOD arisings shall be stored in segregated storage. Packaging of recovered chemical munitions is the responsibility of the recovering unit in accordance with their national procedures. Marking of packages should be as per this IATG. The munitions shall be moved to the national disposal facility as per national instructions.

Appendix 1 to Annex D
(informative)
UXO recoveries – classification list (LEVEL 3)

Explosive Substance or Ammunition Type	Hazard Classification Code	UN Serial Number
Ammunition, Smoke, White Phosphorus *(water activated contrivances, with burster, expelling charge or propelling charge)*	1.2L	0248
Ammunition, Smoke, White Phosphorus *(with burster, expelling charge or propelling charge)*	1.2H 1.3H	0245 0246
Ammunition, Toxic *(with burster, expelling charge or propelling charge)*	1.2K 1.3K	0020 0021
Ammunition, Toxic *(water activated contrivances, with burster, expelling charge or propelling charge)*	1.2L 1.3L	0248 0249
Articles, Explosive, NOS	1.1C 1.1D 1.1E 1.1F 1.1L 1.2C 1.2D 1.2E 1.2F 1.2L 1.3C 1.3L 1.4B 1.4C 1.4D 1.4E 1.4F 1.4G 1.4S	0462 0463 0464 0465 0354 0466 0467 0468 0469 0355 0470 0356 0350 0351 0352 0471 0472 0353 0349
Components, Explosive Train, NOS	1.1B 1.2B 1.3B 1.DS	0461 0382 0383 0384

Table D.1: List of Hazard Classification Codes for UXO recoveries

NOTE 2 Although the compatibility group is irrelevant as the HD is the most important characteristic the combination of HD and CG is essential because a complete classification and UN serial number can be allocated.

NOTE 3 NOS = not otherwise specified. This allows the allocation of a UN number to unknown articles but that are in the expert judgement of the EOD operator most closely linked to the particular disposal classification selected.

Annex E
(informative)
Ventilation – equipment and procedures (LEVEL 3)

E.1 Common thermometers

One common thermometer (normal wet bulb thermometer) should be provided for each explosive storehouse (ESH) or group of ESH qualifying for ventilation. ESH similar in type and construction may be grouped for this purpose on the advice of the head of the establishment. Common thermometers should be installed in positions as follows where they are unaffected by draughts and can be read without being handled. The following criteria should apply:

- in a non-heated Class A ESH the thermometer may be placed on any inside wall;
- in a non-heated Class B ESH the thermometer should be placed on an inside wall, the exterior of which is in contact with the earth traverse or native rock or soil; and
- in a heated ESH, the thermometer should be installed remote from main heating sources and not more than one metre above floor level.

E.2 Wet and dry bulb thermometers

E.2.1 Location and set up

Every ammunition storage facility should be provided with at least one wet and dry bulb thermometer, the use of which is to be controlled by the head of the establishment. Atmospheric conditions, especially in relation to the amount of water vapour in the atmosphere, can vary between locations in close proximity, especially where there are steep hills. This effect may be intensified when prevailing winds blow off the sea or across desert country.

In areas where it is considered possible that topographical and climatic factors may give rise to such local variations, additional wet and dry bulb thermometers should be installed at suitable points to establish if this is the case. Should the variations warrant the additional use of wet and dry bulb thermometers they are to be installed permanently.

Each wet and dry bulb thermometer should be installed out of doors in a permanent correctly designed screen. The screen should provide protection from direct or reflected sunlight, rain, draughts and wind. The position of the thermometer should be such that it can be read without being handled.

The wet bulb should be well supplied with water and the muslin covering and strand of wick kept clean, thoroughly wet and in good condition at all times. The muslin should cover the bulb completely and no reading is to be taken without ensuring that it is thoroughly wet. Distilled water should be used whenever possible. Should this be impracticable then rainwater, filtered if necessary, may be used instead. Tap water or sea water shall not be used. Only the supplied water container should be used, and containers are to be emptied and rinsed out, with distilled or rainwater, at least once a month to prevent the accumulation of impurities. The muslin or wick should be replaced every fortnight or as soon as it shows any sign of becoming dirty or unserviceable.

E.2.2 Accuracy

All approved thermometers should be manufactured to agreed international best practice specifications, which call for a high degree of accuracy. It is important that all thermometers in use remain accurate. Wet and dry bulb thermometers should give identical readings when both bulbs are dry. Common thermometers should be compared with a wet and dry bulb thermometer. Where appreciable variations are noted, arrangements should be made with local meteorological authorities for the thermometers to be tested and a correction factor then applied. When this is impracticable the thermometer should be replaced. Spare receptacles containing water shall not be stored in the screen with the thermometer because this may increase the humidity of the surrounding air and lead to incorrect results.

E.3 Reading of thermometers

No reading should be taken for at least an hour after cleaning or adjusting a thermometer. Observers should read thermometers so that their line of sight is at right angles to the scale.

In order to avoid heating effects from the warmth of their breath or bodies or from torches they should not approach the thermometer too closely. They should avoid breathing on the wet bulb because this may cause a slight variation in local humidity in addition to the possible heating error. Readings shall not be taken when the water of the wet and dry thermometer is frozen.

E.4 Care of thermometers

After installation, thermometers should only be handled when it is necessary to clean the scale, rewet the muslin on the wet bulb, or to clean or refit the water container of the wet and dry bulb thermometer. These operations should be performed with the least possible disturbance of the instrument.

E.5 Ventilation of ESH

When ventilation procedures are applicable to particular ESH or ammunition stocks, the ESH should be opened for ventilation purposes when directed by the head of the establishment or an authorised representative. The actual times at which the thermometers should be read and ESH opened will depend on local conditions and the head of the establishment should issue orders to suit local circumstances.

Local instructions should be issued as to the use of this equipment because so many types are available on the market that it is impossible to provide guidelines on all types available.

ESH should be closed as soon as favourable conditions cease to apply unless this is impracticable due to work continuing. Ventilation shafts and all other openings should be closed as well as doors and windows.

Amendment record

Management of IATG amendments

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INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.20

Third edition
March 2021

Storage space requirements

UN SaferGuard
Securing ammunition, protecting lives

IATG 06.20:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The safe and effective storage of ammunition and explosives is expensive in terms of storage infrastructure and stock maintenance requirements. Efficient storage, thus ensuring maximum cost efficiency, requires effective storage planning. This IATG module provides guidance on the general practical considerations for storage space planning, whilst other IATG modules provide more specific safety advice for storage, handling, processing, special safety precautions and equipment requirements.

Storage space requirements

1 Scope

This IATG module introduces and explains the general requirements for the estimation of storage space requirements.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'explosive storehouse' (ESH) refers to *any building or structure approved for the storage of explosive materials. (c.f. magazine)*.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'unit of space' (UOS) refers to, *for planning purposes, storage space for palletised stores.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Unit of space (UOS) (LEVEL 2)

As ammunition packaging varies in terms of volume it may be palletised so as to occupy a standard 'unit of space'. This UOS can then be compared against the available storage volume within an explosive storehouse (ESH) to determine the volumetric storage capacity of that ESH.

In NATO, each UOS equates to a standard unit load of a maximum size of 1080mm x 1300mm x 1372mm (i.e. 1.93m^3), subject to a maximum floor loading of 7257kg for a single stack pallet base area. This allows for pallets to be stacked either 3 or 4 high, dependent on the individual pallet weights.

For non-NATO countries, it is recommended that a UOS should equate to $1m^3$, with an All Up Weight (AUW) of 1 tonne, because this significantly simplifies storage planning. Alternatively, the UOS may equate to a cube based on the maximum liner dimension of the type of pallet base in use.

Care should be taken to ensure that the stacking limitations imposed by Clause 5 of IATG 06.30 *Storage and handling* are not exceeded.

5 UOS estimation factors (LEVEL 2)

To safeguard against flashover from a lightning strike on an ESH, all ammunition and explosives, except for correctly packaged small arms ammunition (SAA)[3] in Hazard Division (HD) 1.4, are to be spaced from the ESH structure as follows:

A) the default separation between the outer face of any explosive package including those stored on racks or trolleys and the inner face of any adjacent structural wall or from metallic fittings such as heaters and luminaries should normally be at least 500 mm. As well as providing protection against flashover, this distance allows good natural airflow around stacks and good access for visual inspection, etc;

B) when explosives are packaged in containers larger than the standard NATO pallet and it is impractical to observe the standard 500mm separation distance, then a lesser separation may be used after consultation with the national technical authority; and

C) under no circumstances must the separation distance be less than 150 mm. Where the separation is less than 500mm, the storage arrangements should be periodically reviewed with the aim of re–establishing the standard 500mm separation distance.

Additional spacing requirements are that:

D) all ammunition should be raised 100mm off the floor by the use of pallet bases or wooden dunnage;

E) aisles should be wide enough to permit the operation of mechanical handling equipment (MHE) (usually 2.0m) or for hand pallet transporters (usually 1.2m); and

F) a 20mm air gap should surround each pallet.

The volumetric requirements of the above limitations should be considered when estimating theoretical storage space.

6 Explosive limits

The explosive limits of the ESH should be determined as recommended in IATG 02.30 *Licensing of explosive facilities* and these limits shall not be exceeded.

This may mean that the amount of ammunition that may be stored in that particular ESH occupies a volume of less than the theoretical maximum UOS available. This situation is known as 'NEQ[4] Out'.

Conversely, in some cases for low NEQ ammunition, all of the UOS will be occupied without reaching the licensed explosive limit. This situation is known as 'Bulk Out'.

[3] Defined as less than 20mm calibre.

[4] Net explosive quantity.

7 Example estimation of UOS capability

Table 1 summarises the methodology to estimate theoretical maximum UOS (of one cubic metre) for an ESH.

Dimension	#	Remarks
ESH Width	6m	▪
ESH Length	8m	▪
ESH Height	3.7m	▪
ESH Volume	177.6m^3	▪
MHE Gangway	2m	▪ This reduces the available width.
Available ESH Width	3m	▪ ESH Width minus MHE Gangway and 2 x 0.5m air space at ends of ESH.
Available ESH Length	7m	▪ ESH Length minus 2 x 0.5m air space at ends of ESH.
Available ESH Height	3m	▪ ESH Height minus 100mm air space to floor and 500mm air space to roof. Rounded down to nearest metre for palletisation reasons. Block loose stack height would be 3.1m.
Maximum Theoretical UOS	**63**	▪ One row of 7UOS, three high, = 21 UOS. ▪ MHE Gangway of 2m. ▪ Two rows of 7 UOS, three high = 42 UOS.

Table 1: Example methodology for theoretical UOS maximum

If the ESH has an explosives licence for the storage of 50,000kg of HD 1.1 ammunition, then the effective number of UOS for the storage of HD 1.1 would be 50 UOS. A situation of ‘NEQ Out’ is in place. Conversely, should HD 1.4 be stored in this ESH then a situation of ‘Bulk Out’ would occur.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 03.10 *Inventory management*. UNODA; and

c) IATG 06.30 *Storage and handling*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[5] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[5] Where copyright permits.

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INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.30

Third edition
March 2021

Storage and handling

IATG 06.30:2021[E]

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United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The safe handling of ammunition and explosives (during storage, internal stock relocation, inter-facility movement, lifting and stacking) serves to reduce the risk of accidental damage to the ammunition. It is a major component of overall explosive safety as any damage to ammunition and explosives may result in accidental initiation, resulting in deflagration or detonation of the ammunition, and hence casualties. There may also be a significant financial cost as damaged ammunition would have to be repaired or destroyed and then replaced.

This IATG module provides guidance on the general practical considerations for the storage and handling of ammunition and explosives. Other IATG modules provide more specific safety advice for ammunition processing, special safety precautions and equipment requirements.

Storage and handling

1 Scope

This IATG module introduces and explains the general requirements for the safe storage and handling of ammunition and explosives within explosive facilities and for inter-facility transportation. It complements IATG 06.10 *Control of explosives facilities,* IATG 06.50 *Special safety precautions (storage and operations)* and IATG 07.30 *Ammunition processing operations – Safety and risk reduction* which all provide further detailed safety advice for the storage or processing of ammunition and explosives and the overall safety control of an explosives facility. The requirements of these IATG modules shall also be applied, where appropriate, to the storage and handling of ammunition and explosives.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'storage and handling' refers to those *procedures and activities regarding safe storage and handling of ammunition and explosives*.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

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4 Handling of ammunition

4.1 Safety (LEVEL 1)

All ammunition should be handled with proper care. Under no circumstances shall ammunition safety be compromised in the interests of cost, speed or expediency. Rough handling should be avoided at all times as this is liable to cause a fire or explosion, make items unsafe for continued storage or handling, or cause a failure in operation. If items cannot be lowered to a hard surface without unacceptable impact, suitable padding material should be employed to lessen the impact.

Handling of ammunition should normally be conducted during daylight hours. Where this is impractical, adequate appropriate lighting should be provided to ensure that ammunition can be handled in the safest manner.[3] Adequate lighting also helps to ensure ammunition is correctly identified.

4.2 Classification of ammunition (LEVEL 1)

Any explosive item, before being stored or handled,[4] should be classified for storage and transportation by the national technical authority under the procedures detailed in IATG 01.50 *UN Explosive hazard classification and codes* or the relevant equivalent national legislation. This classification shall only be valid for ammunition in its approved package or, if normally an unpackaged item, when fitted with its approved transit devices (e.g. wooden frame for aircraft bombs). Ammunition should not be over-packed unless the packaging forms part of the original packing specification or is required for other reasons such as movement by air.

4.3 Approval to store (LEVEL 2)

Ammunition and explosives should be subject to prior approval for storage and handling by the national technical authority. The acceptance of ammunition into storage should be conditional on this approval being in place prior to receipt. This process provides the national technical authority with an assurance that the following criteria have been met:

A) the items have the appropriate explosive safety clearances;[5]

B) all storage and handling constraints and any in-storage maintenance requirements are clearly defined, are achievable and are documented;

C) the packaging and any subsequent palletisation configuration of the items ensures safe storage, handling and transportation;[6] and

D) properly documented safe systems of work covering the storage, handling and movement of the items are in place.[7]

[3] Further details on the use of approved electrical equipment are at IATG 05.40 *Safety standards for electrical installations.*

[4] Unless under development when special procedures which fall outside the remit of IATG should be used.

[5] See IATG 01.50 *UN Explosive hazard classification system and codes* and the associated safety tests required for approval.

[6] See IATG 06.40 *Ammunition packaging and marking*.

[7] See IATG 06.50 *Special safety precautions (storage and operations).*

4.4. Physical handling of ammunition (LEVEL 1)

All personnel involved in the physical handling of ammunition shall exercise the greatest possible care at all times. This applies not only to storage facilities but also to ammunition being transported within the explosives facility. Ammunition should not be slid, rolled, dropped or exposed to possible misuse. Packages being moved using conveyor systems should not be allowed to collide with each other. All movement of packaging on conveyor systems shall be deliberate and methodical, and packages shall not be propelled carelessly or violently.

4.5 Damaged packaging (LEVEL 1)

Ammunition and any associated packaging that is damaged is to be separated from other ammunition and inspected by a competent person. In cases where damage is the result of an accident or incident, the actions to be taken should be as per IATG 11.10 *Ammunition accidents and incidents*.

Where damage is caused by dropping, and results in the explosive being exposed or any leakage of liquid, then the item/package is not to be touched, the area is to be vacated and the incident reported immediately in order that specialist technical advice can be obtained.

5 Stacking of ammunition

5.1 Introduction

Ammunition packaging and that of any associated components is a key component to ensuring the safety, serviceability and reliability of the items. In many cases, the improved design of packages and the use of explosive mitigation in packages has resulted in high cost packaging, particularly that of Guided Weapons. This means that it is essential that packaging should be preserved because of the nature of the contents and to ensure a long economical in–service life. Wherever possible, packaging and any associated ancillaries should be retained for reuse.

5.2 General criteria (LEVEL 2)

These criteria are important because they detail the principles of stacking that should be followed to ensure safety and the serviceability of packages and their contents and to achieve efficiency in storage, accounting and handling. They also apply to palletised packages. The national technical authority shall be responsible for detailing specific stacking heights or restrictions and these should be stated in the safe system of work as required by Clause 4.3d:

a) storage surfaces should be firm and level;

1) all packages and unpackaged items should be dry, clean and serviceable before being placed in storage;

2) lot or batch numbers should be stacked by mark or model number, filler / manufacturer, date and lot or batch/Batch Key Identification (BKI) number;

3) pallets and loose packages should be stacked so that identification markings can be easily seen and identified without moving the ammunition packaging;

4) ammunition subject to constraints should be suitably marked or labelled and segregated from other stock;

5) spaces between ammunition stacks should be wide enough to permit easy extraction of single packages or pallets, using mechanical handling equipment (MHE) if necessary, and to permit the checking of package markings. There should be sufficient space to allow for rapid evacuation of personnel in the event of an emergency;

6) wooden battens may be used between tiers of packaged and unpackaged stores to ensure stability;

7) stacks should be square or pyramidal in shape;

8) the top of stacks should be easily reached by MHE with the minimum of stock movement. Dismantling of a stack in order to reach certain lot or batch numbers should be achievable with the minimum of logistic effort;

9) the height of a stack should not prevent the free air circulation from another stack; and

10) stacking requirements and heights may vary to suit individual ammunition nature requirements, restrictions and local conditions.

5.3 Loose packaged ammunition (LEVEL 2)

Wherever possible, packages containing explosives should be palletised for ease of handling and transportation. However, in the event that this is not possible then the following restrictions should be applied, depending upon local conditions:

a) a maximum stacking height of 3.7m for packaged explosives, with the exception of packages containing detonators of Compatibility Group (CG) 'B' which should be stored to a maximum height of 1.5m and those items detailed in IATG 06.50 *Special safety precautions (storage and operations)*;

b) cylinders under 27kg should be stored to a maximum height of 7 tiers;[8]

c) cylinders between 27kg to 45kg should be stored to a maximum height of 5 tiers; and

d) cylinders over 45kg should be stored as a single layer stack.

Packages should be stacked to their lowest profile (i.e. the widest/greatest dimension should be at the bottom) and placed flat on the stack. Stacks of loose packages should also be kept at the lowest profile possible depending upon available space (e.g. two low layers as opposed to one tall stack).

Loose packages should, as far as possible, be stacked in such a manner as to permit free circulation of air around each package.

Loose packages shall be placed on battens so that the stack/package is raised from the floor by a minimum of 100mm. Battens or forklift tine slots forming an integral part of the package may be considered as battening provided they allow the free circulation of air.

All stacks are to be stable, with particular attention being paid to corners.

An unobstructed gangway should be left between stacks.

Loose packages may be stowed on pallets unbanded while at ground level. However, they should be banded for movement or storing above ground level.

5.4 Unpackaged ammunition (LEVEL 2)

Unpackaged explosives may be stacked to a maximum height of 3 m (except where specifically detailed in para 5.5 below) but note should be taken as to the nature and condition of the floor or the ground and the stability of the stacks. Stack stability will vary between ammunition natures and the height specified by the safe system of work or munition restriction.[9] The following restrictions are recommended:

[8] A tier is a single layer on one level.

[9] See IATG 06.50 *Special safety precautions (storage and operations).*

a) the stacking height of aircraft high explosive (HE) bombs and aircraft rockets should not normally exceed 1.5 m;

1) unpackaged aircraft cluster bombs should not to be stacked more than one tier high;

2) if the store is adequately stable it may be stored vertically;

3) if the store is not adequately stable it shall be stored horizontally, cradle stacked in tiers, with the bottom tier secured with wooden wedges and be raised off the floor on battens. Tiers of loose and unboxed shells shall be arranged head to base to prevent damage to driving bands. Battens may be interspersed between tiers if this will aid stability; and

4) stacks are to be constructed to ensure that no weight falls on the suspension lugs or other protruding portions of ammunition being stored in the same stack.

5.5 Specific stacking and handling requirements (LEVEL 1)

Some ammunition natures may require special stacking and handling requirements. The following restrictions are recommended:

5.5.1 Unboxed shells

The grommets should not be displaced and driving bands, or ballistic caps, should not be damaged. Also, the stack construction should ensure that the front end of one shell must not touch or strike the base of another.

Unboxed shells should be stacked in accordance with these height limitations:

A) calibre 140mm and below should be stored to a maximum height of 15 tiers;

B) calibre 140mm and above should be stored to a maximum height of 11 tiers; and

C) loose shell above 203mm calibre may warrant further height restrictions.

5.5.2 Aircraft bombs

Care should be taken to ensure that tails, vanes, identification plates, suspension, and/or lifting lugs are not damaged or distorted. Where possible aircraft bombs should not to be stored, moved or handled with the nose of one bomb pointing towards the base of the other. Aircraft bombs shall be stored unfuzed wherever possible.

5.5.3 White phosphorus ammunition[10] [11]

Packages containing white phosphorous ammunition items may be loose stacked but it is recommended that the following limitations are applied:

A) loose packages may be stacked up to 1.5m in height;

B) packages should be placed on pallets so that there is immediate MHE access to each package or pallet to allow prompt removal of any leaking package. The maximum number of pallets to be moved to afford access to a leaking package should not exceed eight;

C) metal tape cutters should be available to cut metal tape banding;

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[10] Ibid.

[11] See also IATG 06.40 *Ammunition packaging and marking.*

D) containers of water shall be provided, accessible from any point in the potential explosion site (PES) and sufficient in number and dimensions to immerse any size of leaking package/item contained within the PES;

E) a supply of clean water shall be provided for First Aid treatment. Additionally, a supply of Copper Sulphate Solution ($CuSO_4$) should be kept in the immediate vicinity of the storage facility for instant treatment of the Phosphorous burn;

F) personal protective equipment in the form of goggles or eye-shields, a protective apron, elbow length fire retardant gauntlets and fire-retardant head protective wear shall be available.

White phosphorus ammunition should be stored under the coolest conditions available and should not be exposed to direct or indirect sunlight. See Clause 4.1.1 of IATG 06.50 *Special safety precautions.*

5.5.4 Inert items

There may be no height restriction for stacking non–explosive items but consideration should be given to the stability of the stack and also the designed stacking height of specialist containers. The number of tiers to a stack should be reduced if there are any signs of damage to containers in the lower tiers.

Aircraft bomb tail unit containers should normally be stacked on their bases. However, if it is not possible to achieve stability in stacks by vertical storage, containers may be stacked horizontally. In these instances, consideration must be given to the security of the tail unit within the container and the protection provided. Consideration should also be given for horizontal stacking as a means to reduce water retention on containers.

5.5.5 Missile systems

Missile systems require extra care for storage as per manufacture guidance or as documented in technical manuals:

A) missiles often are limited in low and high temperatures;

B) missile racks or packages may be stacked up to 3 items high where space allows;

C) packages should be placed on pallets so that there is immediate MHE access to each package or pallet to allow prompt removal of any damaged package;

D) all missiles (packages) should be pointed in only one direction and may not point toward the front door of a PES.

6 Use of racking (LEVEL 2)

6.1 General

Stacking heights may be increased by the use of racking. Racking of sufficient load bearing capacity should be employed. Once again, however, the strength of the floor may be a limiting factor.

Racking shall be stable and shall not present a tip hazard when fully loaded. Loading should be from the bottom up to preclude a high centre of gravity.

Consideration should be given to overreach in stacking and the additional risk involved should a package be dropped from height. Racking should be of a non-flammable or fire-retardant material whenever possible.

6.1.2 White phosphorus ammunition

Loose packages containing CG 'H' ammunition may be stored on racking, but it is suggested that they are not more than 1.5 m from the floor. They shall be easily accessible to allow prompt removal in the event of leakage.

7 Stack Tally Cards and Pallet Contents Sheets (LEVEL 1)

The use of Stack Tally Cards and Pallet Contents Sheets[12] (see Clause 14.5, IATG 03.10 *Inventory management*) are vital control measures in the accounting and control of ammunition in storage, even if an advanced electronic ammunition control system is in use. In the absence of an electronic system their use is essential.

Stack Tally Cards shall be placed on, or otherwise attached to, each stack of explosives. Each stack tally card format shall show clearly the contents of the stack. Small stocks of differing ammunition natures with different lot/batch numbers may be stacked together providing each lot/batch has its own stack tally card, is easily identifiable and CG mixing rules are applied. When explosives are stored in the open, these stack tally cards may be held in the Ammunition Control Office (or equivalent) and should be filed in stack number order.

Pallet Contents Sheets may be employed, where appropriate, for the purposes of ease of location and positive identification of an item's lot/batch in bulk stacks. These sheets should be the governing document for constraints, stock checking and other accounting functions and must be accurate and legible.

8 Use of lifting equipment and slings (LEVEL 1)

Explosives should only be lifted or slung in their approved containers using approved lifting/slinging methods and equipment as detailed in their safe system of work. The lifting equipment should be subjected to a physical inspection before use as well as periodic inspections according to manufacturers' guidelines and should be fully serviceable and within the test parameters.[13]

Pallets fitted with designed and recognised lifting points may be lifted with the approved slinging gear without using anti–spilling devices such as nets or trays.[14] Such lifts should refer to the slinging method detailed in the safe system of work.[15] Slinging of loads in pallets is to be by threading the slings through the blocks on the pallet base - slinging by using the pallet wings is not permitted.

Only slings which are clearly marked with the working load limit (WLL) and are within test dates are to be used. More information is contained within the Safe System of Work part of IATG 06.50 *Special safety precautions (storage and operations).*

8.1 Ferrous slings

The use of ferrous slings poses a danger from sparks. Ferrous lifting chains, wire rope slings, strops or any rope slings fitted with ferrous hooks shall only to be used for handling items in Electrical Category C or D PES.[16]

[12] The format of a Pallet Contents Sheet should be the same as per a Stack Tally Card.

[13] See IATG 06.50 *Special safety precautions (storage and operations).*

[14] See IATG 06.40 *Ammunition packaging and marking.*

[15] See IATG 06.50 *Special safety precautions (storage and operations).*

[16] See IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities.*

If, exceptionally, ferrous slings are specified for use in PES of other electrical categories, such slings shall only be used to handle the items to and from the working positions. They shall be removed from the room before any explosives are exposed.

8.2 Multi-legged slings

Multi–legged sling assemblies should normally only to be used with all legs attached. Where it is essential to use the single leg of a multi–legged sling to lift a load, the load lifted should not exceed the 0 – 45^o (0 – 90^o included angle between opposite legs of a 4-leg sling) WLL identified on the sling divided by 2.1.

8.3 Slinging of loads

Loads should only be lifted the minimum height necessary to clear obstructions and for the minimum duration. A clear working space shall be cleared around the lifting/lowering point.

Loads should not be slung over other explosives. Spigot-like projections/protrusions such as stanchions should be removed from under the path of the explosives being slung. If this is not possible then suitable mats or padding shall be placed over all projections/protrusions.

When hoisting slings/strops clear from a load, it is essential that all slings/strops, once released, are held clear of the container or load until hoisted to avoid the possibility of the slings/strops snagging on that load.

9 Storage temperature (LEVEL 2)

Many ammunition items are subject to operational and storage limitations. Explosives storehouses should be so designed and equipped that the inside temperature rarely falls below 5°C and rarely rises above 25°C. Additionally, daily temperature variations should not differ by more than 5^{0}C and the relative humidity (RH) should be no greater than 75%.

There are many explosives that can safely be kept in storehouses with no space heating, insulation or air conditioning installed. However, an adequate and serviceable means of ventilation in storehouses will prevent deterioration of the building structure, increase the service life of the ammunition, and enhance ammunition safety.

9.1 Temperature restrictions

When considering the storage of ammunition, the following should be taken into account:

A) any explosive having more than one class of temperature restriction shall be regarded as being in the class with the maximum restriction;

B) to prevent the exudation of nitro-glycerine, nitrate ester based propellants (or articles containing such propellants) should not be kept in explosive storehouses for a continuous period of more than one month if the temperature in any part of the building is liable to remain below 5°C. If the stipulated minimum temperature conditions cannot be met consideration should be given to fitting artificial heating to an approved standard;[17]

[17] See IATG 05.40 *Safety standards for electrical installations.*

C) the efficiency, storage life and safety of some explosives, particularly propellants, are also adversely affected by storage at high temperatures. The use of adequate ventilation, approved air conditioning, or insulation should be considered in order to keep temperatures in storehouses to a minimum. The ammunition natures listed below should be stored in the coolest accommodation possible:

(1) ammunition containing Ammonium Nitrate/TNT (Amatol) or TNT;

(2) incendiary ammunition;

(3) propelling charges or ammunition containing propellant; and

(4) ammunition containing white phosphorus (WP) or tear-producing compositions.

Temperature limitations are equally important during transportation, especially where explosives are to be moved by sea. Any accompanying documentation should therefore be annotated with any temperature limitations for the store being moved.

9.2 Temperature recording (LEVEL 1)

Maximum/minimum thermometers or approved temperature data loggers should be installed in storehouses where temperature susceptible explosives and articles are stored, handled or processed and the readings recorded. Humidity and other environmental considerations are covered in IATG 06.50 *Special safety precautions (storage and operations)*.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA*;*

c) IATG 03.10 *Inventory management*. UNODA*;*

d) IATG 05.40 *Safety standards for electrical installations.* UNODA; and

e) IATG 06.40 *Ammunition packaging and marking*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[18] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[18] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions which should also be consulted to provide further background information to the contents of this guideline:[19]

a) AASTP-1, Edition B, Version 1. NATO Guidelines for the Storage of Military Ammunition and Explosives. NATO Standardization Organization (NSO). December 2016. http://nso.nato.int/nso/nsdd/listpromulg.html;

a) *Handbook of Best Practices on Conventional Ammunition*, Chapter 2. Decision 6/08. OSCE. 2008. www.osce.org/fsc/33371;

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[20] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[19] Data from many of these publications has been used to develop this IATG.

[20] Where copyright permits.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.40

Third edition
March 2021

Ammunition packaging and marking

IATG 06.40:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Ammunition and explosives should normally be packaged and stored in packaging that is designed to protect the contents from all foreseeable hazards of physical damage and environmental deterioration, throughout the envisaged life of the item, up to and including final disposal of the item. The packaging should also be appropriately marked to provide information to enable the explosives to be stored, handled and transported correctly; packaging is a key safety measure.

Insufficient resources means that it is not always possible to establish a unique set of criteria that dictate conventional ammunition packaging and marking standards. Instead, it is necessary to identify a framework of guidelines, which provide the options for a graduated improvement in safety in packaging, and marking of ammunition and explosives within an integrated risk management process. Such guidelines should be based on internationally accepted good practise and legislation, in this case the *UN Recommendations on the Transport of Dangerous Goods*, also known as the 'Orange Book'.[3] Therefore, this IATG module contains general practical information on the requirements for ammunition packaging and marking although the national authority should determine its own system of ammunition packaging and marking most suited for its own national defence, security and industrial purposes.

[3] See IATG 08.10 *Transport of ammunition*.

Ammunition packaging and marking

1 Scope

This IATG module contains general information on the requirements for ammunition packaging and marking.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'packaging and marking' refers to *those procedures and activities regarding the safe and secure packaging of ammunition and the associated markings on the packaging to ensure the correct information is available in line with international agreements*.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Ammunition packaging

4.1 Packaging requirements (LEVEL 1)

All military explosives should be packaged and stored in packaging that is designed to protect the contents from foreseeable hazards of physical damage and environmental deterioration throughout the envisaged life of the item, (up to and including the final disposal of the item).

The packaging should have undergone the tests prescribed in the UN Orange Book[4] and any other national legislative requirements. It should only be approved for use after scrutiny of environmental and handling requirements and consideration of compatibility of packaging materials with the base explosives. As a result of these tests, the ammunition and its associated packaging should be awarded a Hazard Classification Code and accompanying UN number for the filled package. The package should then be appropriately marked and have the correct dangerous goods labels attached.

4.2 Design and safety of explosive packaging (LEVEL 1)

Any materials used in the packaging of explosives shall be chemically compatible with any explosives with which they may come into contact, either physically or via vapour from the packaging. Therefore, any repackaging task should use the original packaging material. Substitution of non-approved material could lead to an explosive incident and should be prohibited.

Failure to keep ammunition in approved packaging may present a risk in terms of either damage and/or deterioration of the explosives. Both of these may have repercussions on the service life, and functioning of the explosives, or safety of the storage facility. Additionally, the UN number may become invalid for transportation outside a State's borders.

Any explosive item, before being stored or handled, should be classified by the national technical authority for storage and transportation as per the procedures detailed in IATG 01.50 *UN Explosive hazard classification and codes* or equivalent national legislation. This classification should only be valid for ammunition in their approved packages or, if normally an unpackaged item, when fitted with their approved transit devices e.g. aircraft bombs.

4.3 Change of hazard classification code (LEVEL 2)

It should be understood that items not contained in the correct packaging may undergo a change of Hazard classification code and therefore may affect the calculations carried out under IATG 2.20 *Quantity and separation distances* and how the ammunition may be mixed during storage and transportation. These changes can be significant as they may affect the storage plan, the aggregation rules and change the explosive limit considerably.

4.4 Physical handling of ammunition packages (LEVEL 1)

All personnel involved in the physical handling of ammunition shall exercise the greatest possible care at all times.[5]

4.5 Temporary packaging (LEVEL 1)

Ammunition should be packed in its approved packaging. However, small quantities of explosive stores or items may be transported, for issues in and around a unit, in temporary packaging provided that the items are prevented from moving around inside the packaging by using suitable packing material. The exterior of the package is to be marked with the actual contents and the relevant Hazard Classification Code (HCC) label. As soon as the explosive item has been removed from the package, the information on the package is to be removed. Explosives received other than from normal sources of supply, e.g. as a result of explosive ordnance disposal (EOD) operations, may be placed in any suitable package and/or container. Suitable dunnage is to be added as required.

All temporary packaging should be marked with the nomenclature of the contents and have the relevant HCC label attached. Instructions for the handling, isolation and segregation of these types of stores are in IATG 06.50 *Special safety precautions (storage and operations)*.

[4] See IATG 01.50 *UN Explosive hazard classification system and codes*.

[5] See IATG 06.30 *Storage and handling.*

Temporary packaging shall not be used for transportation outside of the unit that generated it.

4.6 Special packaging (LEVEL 2)

On some occasions, explosives stores such as primary explosives, bulk propellant, sensitive electronic circuitry or sensitive Electro Explosive Devices (EED) require special packaging. In such cases, static dissipative packaging shall be used unless justification for not doing so has been accepted by the national technical authority. This is due to the fact that when these items are exposed during processing, they are also exposed to external stimuli including that from packaging. Conductive materials shall not be employed because they retain some risk of static discharge. The national authority shall decide the electrical standard of surface resistance, but it is recommended to be between 1×10^5 and 1×10^{11} Ohms.

Electro Magnetic (EM) and Radio Frequency (RF) hazard protection may be achieved by the use of metal outer packaging fitted with RF gaskets to provide continuous electrical contact around the entire peripheral interface. Other dissipative materials can be used for containers provided they meet the required level of protection over the life of the store.

Where it is not possible to use dissipative materials, containers should be provided with two adjacent earthing studs to ensure effective connection to earth and to facilitate a ‘make-before-break’ test and inspection procedures when required. The need for earthing is to be clearly indicated by labelling the packaging.

It is good practice to cover any exposed primary explosives, bulk propellant, sensitive electronic circuitry or sensitive EED during process work with a suitable temporary shielding to provide an extra barrier to inadvertent electrical discharge.

4.7 Marking of ammunition and its associated packaging (LEVEL 2)

As a minimum, ammunition packaging marking shall follow the requirements in the UN Orange Book and as amplified by IATG 08.10 *Transport of ammunition* and IATG 01.50 UN *Explosive hazard classification system and codes*. Markings, including manufacturing and filling details, are applied to ammunition and its packaging:

A) to provide information to enable the explosives to be stored, handled and transported correctly;

B) to provide ammunition nature identification;

C) to assist in proper accounting and control procedures;

D) to enable the correct nature and type of explosives to be issued when required;

E) to enable ammunition to be correctly identified by the user under all circumstances; and

F) to assist in the tracing of ammunition and aid investigation into incidents and faults.

Ammunition packages shall be marked, where required, with the Hazard Label(s), UN Number, Proper Shipping Name and will have either a UN Mark or be covered by a national authority approval. Subsidiary labelling may also be required where the ammunition nature contains substances other than explosive e.g. toxicity or corrosivity. In this case, the appropriate UN hazard labels should also be attached to the packaging.

Further marking should be applied by the national authority for specific purposes such as:

A) inspection and repair markings;

B) ammunition condition markings;

C) test markings;

D) package sealing; or

E) to denote unserviceable items.

Examples of additional markings are shown below but the examples are not intended as a comprehensive list:

Number	Marking	Meaning
1	REP	This package contains ammunition which has been subject to: a) maintenance to improve or maintain the quality of the ammunition; b) modification of the ammunition or the package; c) a 100% inspection; or d) preparation for disposal.
2	INSP	The ammunition within the package has been subject to one of the types of inspection listed above.
3	PKD	The ammunition package holds ammunition that has been: a) fractioned for issue; or b) contains ammunition or components recovered from a repair task.
4	DES	A desiccant change has been carried out.
5	TESTED	Ammunition that has been subjected to testing by, for example: a) heat tests; b) moisture test; c) acidity test; d) plasticity test; and/or e) electrical test.
6	FAILED TEST	Ammunition that has failed test.
7	COND	The ammunition condition code.[6]

Table 1: Additional packaging markings

After inspection, when repair or testing has taken place, technical personnel should correctly mark the item or package to identify the work that has been carried out, who performed the task and on which date. It is normal that these markings are made in white although black may be used if the item to be marked is of a light colour.

This task can be greatly simplified if individual ammunition technical personnel are issued a Unique Identifier Code (UIC), which is then marked on each package they have carried out work on. Similarly, the location the work was carried out in should be identifiable such as the use of an Identification Monogram of 3 letters and monogrammed ammunition seals. Table 2 illustrates the use of such a system:

	First Letters	UIC	Location	Date
Meaning	Activity carried out.	Unique identifier code of individual responsible for the work.	3 letter monogram of the location at which the work was carried out.	In format MM/YY
Example	REP	JS	BLU	12/20
Final Code	REP.JS.BLU.12/20			

[6] See IATG 03.10 *Inventory management*.

Table 2: Example of marking system

The above example shows the work that was carried out, whom it was carried out by, where it was carried out and when it was carried out.

4.8 Colour coding of ammunition and its associated packaging (LEVEL 2)

Various colour coding systems exist globally. Their aim is to provide a standard identification and marking system that is universally understood by all personnel involved in the handling of ammunition and explosives.

It would be inappropriate to list them all here as this may lead to future confusion if the same colour refers to different ammunition under different systems. There is scope for mistakes to be made and it is essential that only trained ammunition technical personnel shall be involved in the interpretation of ammunition colouring that has not been previously encountered. The national technical authority should develop and direct the national policy to be adopted on the colour coding of ammunition and its associated packaging.

When purchased ammunition is marked with a variety of colour standards, education efforts, at both the technician and user levels, need to focus on making this information, and the associated hazards, well known. Similar consideration may need to be given in coalition operations where more than one colour marking scheme is in effect.

4.9 Fraction packages (LEVEL 2)

Fraction packs of ammunition are packages that are only partly filled. They may be stored and transported using the UN Number assigned to the original package under the following conditions:

a) the original packaged items have been properly classified by the national technical authority. However, fractioning should not be permitted where the original classification was achieved by employing specific packing orientation and/or separation of stores. Fractioning of packages containing stores of UN Numbers 0059, 0439, 0440 or 0441 is therefore not permitted. If fractioning is required, packages carrying these UN numbers shall be re-classified by the national authority;

b) gaps caused by the removal of part of the original package contents should be re-filled with sufficient compatible dunnage to prevent any significant movement of the remaining contents. If items are securely and individually fastened to packaging or contained in separate packaging compartments, these gaps may not need to be filled;

c) no changes shall be made to the inner packaging, packaging orientation or explosives contents other than the quantity of explosives articles included and the filling as necessary of any gaps created;

d) where there is an unavoidable significant instability in the package, this is to be indicated by the attachment of a temporary sign warning such as **WARNING – CENTRE OF GRAVITY NOT CENTRAL (PART FILLED)**; and

e) fraction packages are to be marked as such by application of the wording **FRAC** or **FRACTION** in white, or similar light colour.

f) If empty outer packages are used as gap fillers (as in making up a complete pallet layer), these packages are to be clearly marked as empty.

4.10 Empty ammunition packaging (LEVEL 1)

Empty ammunition packaging, whether it is to be re-used or disposed of, shall be certified as Free From Explosive (FFE)[7]. All dangerous good labels shall be removed and the proper shipping name and UN Number details on each box shall be removed or obliterated. This shall apply to both internal depot and external transportation of packages. An FFE certificate (CFFE) shall be fitted inside each ammunition container unless this is impractical (e.g. for fold flat wooden packages). In this case, a certificate shall accompany the consignment. Mixed consignments should still have individual containers CFFE.

5 Palletisation

5.1 Reasons for palletisation

Where ammunition is required to be stored and/or transported in large quantities, then consideration should be given to building packages on pallets.

A pallet of ammunition may be built up into a Unit Load Specification (ULS) which is a nationally, or regionally,[8] agreed specification for a pallet of ammunition containing the same ammunition type(s). For example, a ULS may be made up containing High Explosive (HE) Shell, Propelling Charges and Fuzes for an artillery system.

Unit Load Containers (ULC) may also be encountered; these are simply containerised loads containing a specific number of rounds of a particular nature of ammunition.

Palletisation, (whether by utilising ULC or ULS or not), if carried out correctly, is a means of ensuring that large quantities of ammunition of the same nomenclature, lot number, batch identification key (BKI) etc can be stored and moved to the user quickly, efficiently and safely.

5.2 Palletisation system requirements

Palletisation of ammunition should not simply involve the placing of ammunition packages onto a pallet and then using banding material to restrain the packages from movement during storage and transportation. Various specifications for pallets should exist and it shall be the decision of the national technical authority to:

A) identify the palletisation system it shall adopt;

B) identify the weight, size and construction specification of the ULS for each ammunition nature; and

C) identify the restraining system e.g. Tensile Steel Strapping (TSS) and the technical specification of the restraining system.

Whichever palletisation system is adopted by the national authority, it shall be compliant with the requirements of the UN Orange Book (see IATG 08.10 *Transport of ammunition*). This will invariably mean that if the national technical authority chooses to adopt a brand-new system of palletisation and not employ a current system then the entire testing regime of pallet construction shall be undertaken.

[7] See IATG 06.50 *Special safety precautions (storage and operations)*.

[8] A regional example is the NATO STANAG 2828 *Military Pallets, Packages and Containers*.

5.3 Ammunition palletisation restrictions

Palletisation may be adopted for all compatibility groups with the exception of Compatibility Groups K and L. White phosphorous (Group H) ammunition may be palletised subject to the conditions laid out in Clause 5.5.3 of IATG 06.30 *Storage and handling*.

Wherever possible, packages containing explosives should be palletised as per the authorised ULS. Where this is not practicable, such as when only small quantities are required for issue, or there is a mixture of different types and size of package, then the following points should be taken into account:

A) if mixing of packages in one load is unavoidable, note shall be taken of the drop height limitations for each separate ammunition nature to ensure that packages with drop height restrictions are not mixed with those that do not;

B) only serviceable pallets, pallets load or post/cage pallets of an approved pattern should be used;

C) weight and size limitations of the pallet should not be exceeded; and

D) packages should be strapped/secured to the pallet to prevent movement or spillage.

5.4 Damaged pallets/banding material (LEVEL 1)

Any damaged pallets should be repaired as soon as possible. If the damage is severe the pallet shall be discarded. Broken, missing or loose banding material should be replaced. No transport of ammunition should take place until these faults are rectified.

5.5 Identification of palletised ammunition (LEVEL 2)

It is the responsibility of the unit building the ULS or ULC to ensure that the contents can be readily identified. This should be done by ensuring the packages are arranged as per the palletisation construction specification so that the standard markings are visible. It may be that fitting of suitable weather resistant labels should be carried out, showing the relevant information. These may be stuck on or placed in a metal holder or other visible restraint.

5.6 Movement of palletised ammunition (LEVEL 2)

Before any assembled ULS, ULC or palletised load is moved or handled, the strapping should be checked for obvious slackness or damage and the pallet itself checked for damage. If slackness or damage be noted, the unit load should be re–banded and the pallet changed if necessary.

Loads containing explosives should normally only be moved singly and not while stacked. Under normal operating conditions, all unit loads should be lifted singly. Two units may be lifted simultaneously provided that the person in charge of the location is personally satisfied that there is no other approved means of positioning the load. A written risk assessment should be completed taking into account the following:

A) pallets being moved should be sound, properly tape banded and produce a stable load;

B) the capacity rating of the mechanical handling equipment (MHE) shall not be exceeded;

C) the floor should be level and should be free from irregularities;

D) the forward tilt of the MHE shall not be used;

E) the driver's vision shall be unrestricted, and the greatest care exercised if there are overhead obstructions (e.g. roof trusses, pipes etc);

F) the MHE shall be fitted with a carriage back guard of adequate size to prevent the upper unit load to slide off the lower when full backward tilt is used;

G) the duration and distance travelled, and the height lifted is to be kept to the minimum necessary; and

H) the operation is to be closely supervised.

6 Sealing of ammunition packaging (LEVEL 1)

To ensure that ammunition is maintained in a serviceable and safe condition, it should be either sealed against any ingress of atmospheric moisture, (i.e. self-sealed), or packed in a suitable hermetically sealed package. The type of sealing may vary but whatever form is employed, it should remain in place until the last possible moment before the ammunition is used.

The life of certain explosives is limited once atmospheric ingression occurs (i.e. when the seal is broken). Other types of explosives may be similarly exposed, but being less vulnerable, they will still have a useful life subject to satisfactory inspection and/or proof and resealing but only when packaged in packaging which provides the necessary degree of protection.

Stores that are unpackaged or are in non-airtight packages but are self-sealed, should only be considered to have been exposed when visual inspection indicates damage to the self-sealing devices. In some instances, monitoring is achieved by the use of humidity indicator systems, which will change, colour or provide some other visual indication of change.

The contents of an opened package may not be fully expended, or the package may be opened for a technical inspection, venting etc. Should this be the case the original method of ensuring the airtightness of the container or inner liner may not be suitable for further use. In these circumstances the airtightness should be achieved as far as possible using plastic adhesive tape or by over-packing the original store in a sealable plastic bag (but see Clause 4.6). This operation should be carried out as quickly as possible in the most favourable conditions.

6.1 Types of ammunition seals

There are two types of sealing for packages containing ammunition and associated non-explosive components.

6.1.1 Authenticity sealing (LEVEL 2)

Authenticity sealing is a security measure, which should be approved by the national technical authority. Its role is to ensure the contents remain as stated on the package and to prevent interference without leaving visible evidence.

Ideally the contractor/manufacturer of the store should apply this security device as a contractual requirement. Should a package be opened at a later stage for use, inspection, repair etc then the same requirement is achieved by means of the unit or depot applying a similar device.

These devices are seals made from materials such as linen, metal or plastic seals and locking wire. Metal or plastic seals are the most common form of sealing device and the quickest to apply but linen sealing devices may still be used and indeed may be required on older packages. Regardless of the type of seal used it should:

a) show the unit or manufacturer/filler identification monogram or other marking required by the national authority; and

b) be a sealing device approved by the national authority.

6.1.2 Technical staff sealing

Should the package be opened by technical personnel, then the package should be sealed using an approved seal and, if necessary, re-marking of the package.

This procedure is, in effect, another form of authenticity sealing but it is carried out by ammunition technical staff. There may be occasions when authenticity sealing is not possible or practicable such as palletised aircraft bombs, immediate use ammunition for guarding and security duties etc. There are also exemptions in the transportation of ammunition, particularly where returning from ranges or in transit between sites. EOD recoveries[9] also fall into this category. Though exempt from formal sealing the aim should always be to secure packages such as by the use of locking wire, etc.

6.1.3 Broken seals

Broken authenticity seals are not necessarily conclusive evidence that the contents have been tampered with. The condition of the contents should be determined from inspection as necessary.

On some occasions it may be necessary for other personnel to seal packages. Examples are:

a) where opened packages are to be consigned by a user unit to a depot or another unit;

b) after verification of the package contents following issue of the stores;

c) after authorised maintenance, repair or modification of the store(s); or

d) when packages are received with broken or damaged seals.

6.1.4 Qualification and authorisation to carry out authenticity sealing

Authenticity sealing other than by the manufacturer is only to be carried out by, or under the supervision of, those personnel qualified by an appropriate technical course to certify the contents of the package and authorised to do so by the national technical authority.

6.1.5 Sealing procedure and authorised tools

Personnel detailed to carry out a sealing task should ensure that the contents are undamaged and correctly packed, that the Contractors and the Unit Packing Note (see Clause 6.1.6) are correctly compiled and affixed and that the package is correctly closed and marked. Unit seals should be affixed to the package in such a manner as to prevent it being opened without leaving visible evidence. The package markings should be amended, if necessary, to correctly describe the contents. Should there be doubt about the condition of the contents, the package shall be segregated and a request for technical inspection submitted.

Sealing tools are to be securely controlled at all times. They should only be issued, against a signature, to a named person. Only the signatory shall use the sealing tools and only for the tasks detailed. Sealing tools may form part of issued tool kits and controlled accordingly.

6.1.6 Packing notes

Packing notes should be affixed to the inside of explosives packages.

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[9] See IATG 06.50 *Special safety precautions (storage and operations).*

The Contractor Packing Note should be a contractual requirement when purchasing new ammunition. It should be developed by the manufacturer/contractor who originally packed the explosive stores. It should identify the packer and date the package was filled, information on the use of any type of hermetic sealing employed and the signature or quality assurance stamp of the person carrying out the sealing task.

A Unit Packing Note should be used by units and depots to record the visual condition of the ammunition in the package and certify that the quantity and nomenclature of the contents equate to the information marked on the outside of the package. It also confirms that the contents are packed in an approved and certified package. The application of an authenticity seal should be required as part of the certification.

7 Ammunition in transit (LEVEL 1)

An Authorised Representative (AR)[10] should be nominated by the national technical authority who is responsible for checking that packages are correctly sealed prior to transport. If a seal has been broken or damaged during transit or handling and no interference with, or damage to, the contents has occurred, the AR may have the damaged seal replaced with a seal bearing the monogram of the particular movement unit, by a person authorised in accordance with and in the manner described above.

If no authorised person is available, then the AR shall secure the package using either locking wire or a suitable fabric seal. The circumstances should then be notified to the consignee. However, if the AR considers that the package or its contents are in any way unsafe then the package shall be segregated. If this is not possible then the AR should arrange for its removal to a place of safety and request immediate technical inspection.

7.1 Staging posts

At places of shipment or temporary storage during shipment there may be no explosives specialist or AR available. In this case, the responsibility for permitting the carriage of explosives packages or their segregation should rest with the person in charge of the consignment. Where movement is by military or commercial aircraft an aircrew member should be responsible. In circumstances where the package is authorised for carriage unsealed, the fact is to be brought to the attention of the consignee. Arrangements should be made for the inspection and collection or destruction of any stores left behind.

7.2 Inspection requirements

In the circumstances above, packages in transit temporarily sealed by an unauthorised person, although fit for normal transport, shall be treated as being “open” by the consignee. If the receiving unit is an ammunition depot the stores shall be subject to technical inspection. If the packages are received at a user unit, the unit commander should ensure that the package and contents are visually examined to ascertain that they are fit for storage.

If there is any doubt that the contents are other than serviceable, they should be segregated or isolated if considered unsafe for normal storage, and technical inspection requested. After inspection the package should be correctly resealed by an authorised person. The examination and sealing task should be carried out as above and recorded.

[10] An AR may not necessarily be ammunition trained and qualified but should have undergone a basic level of training on the requirements of the task.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 03.10 *Inventory management*. UNODA;

d) IATG 06.30 *Storage and handling*. UNODA;

e) IATG 06.50 *Special safety precautions (storage and operations)*. UNODA; and

f) IATG 08.10 *Transport of ammunition*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[11] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[11] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[12]

a) *Handbook of Best Practices on Conventional Ammunition*, Chapter 1. Decision 6/08. OSCE. 2008. www.osce.org/fsc/33371;

b) Joint Service Publication 482, Edition 4, *MOD Explosive Regulations*. Chapter 14. UK MOD. January 2013 – updated 10 April 2017. www.gov.uk/government/publications/jsp-482-mod-explosives-regulations.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[13] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[12] Data from these publications has been used to develop this IATG.

[13] Where copyright permits.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.50

Third edition
March 2021

Special safety precautions (storage and operations)

UN SaferGuard
Securing ammunition, protecting lives

IATG 06.50:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for ‘through-life management’ approach to ammunition management. The IATG can be applied at the guidelines’ **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The most obvious hazard from explosives during storage is an accidental explosion (detonation or deflagration). Explosives may function accidentally due to stimuli such as impact, friction, spark, heat, electrostatic discharge, radio frequencies (RF) induced current, reaction with another substance or inherent chemical instability. The inadvertent initiation of even small quantities of explosives can lead to death or serious injury and may lead to a major catastrophe. The aim of this particular IATG module is to reduce these risks by highlighting specific areas of special risk and describing the reduction and/or mitigation factors.

This IATG module falls within the group for Explosive Facilities (Storage) (Operations). Specific safety precautions during the processing of ammunition are contained under the group for *Ammunition processing operations - Safety and risk reduction (IATG 07.30)*), which should be consulted in parallel to this IATG module as there are some common safety precautions. Some of these risks described in this IATG module are also covered in other IATG modules but are repeated here for ease of reference.

Special safety precautions (storage and operations)

1 Scope

This IATG module introduces and explains special safety precautions that should be taken during ammunition processing operations in explosive facilities.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some, or all, of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘explosive storehouse’ (ESH) refers to *any building or structure approved for the storage of explosive materials. (c.f. magazine)*.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Dangerous chemicals

4.1 Ammunition containing white or red phosphorus or phosphides

4.1.1 Stacking and storage (LEVEL 1)

Ammunition containing white phosphorus (WP), red phosphorus (RP) or phosphide filled munitions should be stacked not more than 1.5m, or one pallet, high, with a passage between each two rows so that any item or box which develops defects can easily be seen and quickly removed. Internal temperatures should be below 40^{0}C as temperatures above 40^{0}C greatly increase the likelihood of leakage and hence of spontaneous ignition.

WP filled munitions shall be stored under the coolest conditions practicable and shall not be exposed to sunlight either directly or through windows. A regular inspection regime shall be instituted for the early detection of leaks in all storage buildings containing white phosphorus filled munitions. The frequency of the inspections will depend on the local conditions. In temperate climates, the inspections should take place at intervals not exceeding seven days. In the past the failure to detect a leaking item has led to catastrophic fires.

Munitions containing red phosphorus may generate phosphine gas during normal storage, which is toxic and flammable (see below). It is therefore necessary to ensure good ventilation.

4.1.2 WP and RP filled ammunition (LEVEL 1)

WP, unless wet, ignites spontaneously in air. It can be extinguished by immersion in water, but steps shall be taken to prevent re-ignition. A suitable container of clean water, large enough to immerse a complete package or item, shall be kept available at stacks, loading points, etc. for immersion of leaking stores if necessary, prior to their disposal. Leaking munitions should only be handled by trained personnel.

4.1.3 Leakage (LEVEL 1)

Leakage of WP filled munitions is indicated by the characteristic smell of phosphorus and the presence of white fumes. Leaking munitions shall be isolated and kept under water until they can be destroyed. The exposed phosphorus shall not be allowed to dry, or it will ignite spontaneously.

4.1.4 First aid instructions for WP (LEVEL 1)

First aid instructions and a contingency plan to deal with casualties from WP burns should be posted at buildings where WP munitions are stored (Annex C details such instructions). The contingency plan should, for instance, consider where water can be obtained to treat the casualty.

4.2 Phosphide-filled munitions (LEVEL 1)

Phosphide munitions are activated by water. They shall be stored under dry conditions and be protected from the ingress of moisture. Leakage of the filling, arising from fracture or slow corrosion of the case, may interact with water in any form and evolve toxic phosphine gas. If evolved in sufficient quantity, the phosphine will ignite and may cause a fire. Slower evolution of phosphine gas will be diluted by the air present such that the concentration in the atmosphere will not reach toxic proportions, unless it is in a confined space. A regular inspection regime shall be instituted to aid the prompt detection of leaking ammunition. Munitions believed to be leaking should only be handled by suitably trained personnel. When a leaking store is found, it shall be moved promptly to an isolated place in the open to await destruction. Suitable respirators should be made available on site for use in an emergency.

5 Metal powders and explosives containing metal powders (LEVEL 1)

Many explosives contain metal powders as they increase the power of the explosion. They are therefore present in explosives storage either as part of the completed ammunition item, as part of the raw explosive pre-fill or as neat powder. Finely divided metal powders may produce hydrogen on contact with water or high humidity. Hydrogen gas can form explosive mixtures with air. Therefore, where these materials are stored precautions should be taken to ensure they do not become wet. Steam or water space heating is therefore not advisable in buildings where they are stored. Explosives that contain metal powders, such as Torpex, shall be kept dry. Tools and containers used to process them should be kept at room temperature to avoid condensation.

6 Health hazards associated with explosives (LEVEL 1)

In addition to the more obvious explosion hazard, many explosives present a health hazard. Absorption of toxic substances may occur by inhalation, ingestion or absorption through skin and eyes.

Organic nitro-compounds such as TNT and Tetryl (also known as Composition Exploding (CE)) are readily absorbed, either through the skin or by inhalation, into the bloodstream. They may cause severe toxic effects and dermatitis. When a person becomes sensitised to a particular substance, dermatitis may reoccur after only a minor re-exposure.

Some nitrate esters such as nitro-glycerine (NG) are also readily absorbed through the same entry routes. They can cause severe headaches and more severe toxic effects in the short term. Long term exposure can cause heart failure (see annex D).

Nitramines such as RDX and HMX are generally less readily absorbed through the skin but can enter the body through ingestion or inhalation of the dust. In severe cases this can prove fatal. Many pyrotechnic substances and associated chemicals present health hazards including both toxicity and dermatitis. A chemical tag is now often added to plastic explosives and this has an associated health hazard.

6.1 Information on the toxic effects of explosives (LEVEL 1)

The risk of harm with such substances varies with concentration, toxicity and duration of exposure. Suppliers of substances with associated health hazards shall be required to provide information regarding these hazards. For explosives this information is normally provided as a clause in the explosives hazard data sheet. Explosives hazard data sheets or nationally issued safety certificates are also available for many older explosives. The occupational exposure limits (OELs) for chemicals including explosives give guidance on permitted concentrations in air. These documents are either published by the national authority or are available from international organisations such as the EU. Although not explosives in themselves, WP, RP and phosphides are used in some munitions. In addition to fire hazards they have toxic properties.

6.2 Safety precautions when handling or storing explosives (LEVEL 2)

A safety assessment shall be carried out before any work is undertaken with explosives, particularly if those explosives have a known health hazard associated with them. The safety assessment shall identify the need for appropriate precautions. A qualified medical practitioner should be consulted regarding the need for pre-work screening and subsequent periodical checks before any work where exposure to toxic explosives and associated chemicals is undertaken. Natural air ventilation or forced local exhaust ventilation may need to be installed.

Personal protective equipment (PPE) in the form of respirators, gloves, barrier creams or special clothing may be required. Hand washbasins or showers may need to be installed. Food and drink shall not be taken into areas where such materials are handled but it may be allowed within the explosives area in specially designated places. It is important that personnel who handle explosives should wash their hands before touching food.

7 Explosives area management precautions (LEVEL 2)[3]

7.1 Certifying free from explosives (CFFE) packages, articles or equipment

The CFFE regime shall be applicable to all packages which have contained explosives, arisings from the firing of ammunition, munitions kept in museums or as souvenirs and displays etc, and for training aids and all arisings from breakdown and disposal of ammunition and explosives. It shall also be applicable to equipment used to process explosives and which subsequently require maintenance or repair. CFFE is required when such items are to be transported as non-explosives or sent to recipients who, because of a lack of knowledge of explosives, would be at risk if explosives were to be inadvertently left in a nominally empty article or package.

7.1.1 High risk categories of personnel

Those at particular risk are untrained personnel and those who receive items for scrap. The same regime should also be used to ensure the absence of other hazardous substances e.g. WP, RP and riot control agents. CFFE is a very important function and shall only be carried out by trained and competent staff who are authorised to do so. Where the initial CFFE has been carried out by field units or under adverse conditions, such as range activities, a second CFFE process or verification check may be required. This is especially important before such items are sent to recipients with a limited knowledge of explosives. The need for a second CFFE or check should be identified during the initial risk assessment.

7.1.2 CFFE process

CFFE should be treated as an explosives process. In particular, the risks must be assessed, and work instructions prepared, before the commencement of work. It should be undertaken in a licensed site or building wherever possible. CFFE should be carried out in a site, building or designated quarantine area that is separate from the main explosives process area. Where the CFFE process involves more than one item, separate areas within the CFFE area are to be designated for:

A) articles and packages awaiting CFFE;

B) processing the articles and packages;

C) the isolation of any live articles found during the process; and

D) articles and packages that have been certified as free from explosives.

All articles and packages shall be inspected, and a thorough examination shall be carried out to ensure that they are free from explosives. For packages this shall include the removal and inspection of all internal packing fitments and furniture, although they can be subsequently replaced if required. If it can be stated with certainty that it is free from explosives a CFFE certificate shall be issued by a trained, competent individual. If it cannot be stated with absolute certainty that an item is completely free from explosives it shall be accompanied by a certificate indicating the level of potential explosives contamination remaining. Where such doubt regarding contamination still exists but there is a need for the item to be repaired or disposed of, it shall be subject to a proving procedure such as burning. Where CFFE is by a proving oven, the procedure shall ensure that the explosives reach a sufficiently high temperature for long enough to completely consume all the explosives present.

Detailed working instructions and procedures should be prepared for each separate task and the work is to be supervised to ensure that instructions are followed.

[3] See IATG 06.10 *Control of explosives facilities*.

Hazard Classification Code markings shall be obliterated as part of the CFFE process and labels applied to clearly show the item to be CFFE.

7.1.3 CFFE certification

CFFE certificates shall be prepared for each item and are to be signed by the person carrying out the inspection. This person shall be present during the whole process. CFFE certificates shall be traceable documents. A copy shall be placed in the CFFE package or attached to the CFFE article. The certificate shall show:

A) the name of the person certifying the item together with his or her appointment printed in capitals letters;

B) the identity of the location where the CFFE process was carried out;

C) a description of the contents, if any, of a package;

D) the date of certification; and

E) the signature of the person named.

A second copy of CFFE certificate should be retained by the organisation issuing the certificate for at least three years. Alternatively, the details from the CFFE certificates of a consignment of CFFE packages should be summarised on a document, such as the consignment note, such that the information in (a) to (e) above may be obtained. Similarly, the consignment note should be kept by the issuing organisation for three years.

7.1.4 Storage of CFFE articles

Once articles and packages have been CFFE they should be sealed and isolated in such a way that there is no possibility of any uncertified article or package finding its way into the CFFE area or storage area or of uncertified articles being placed in CFFE packages.

7.1.5 Explosive ordnance disposal (EOD), range clearance and demilitarisation arisings

Special consideration should be given to the certification of arisings from range clearance, EOD activities and from the demilitarisation of ammunition. Each separate process shall be subject to a risk assessment, which takes into consideration the residues likely to arise from the process method. The demilitarisation process should ensure that all explosives are removed or consumed, and that articles are sufficiently disfigured that they will not be mistaken for live ordnance or be useable for their intended purpose. The certification of such arisings is only to be undertaken by persons who are fully conversant with the demilitarisation process carried out and with the detailed makeup of the original article. It may be necessary to have a second CFFE process where complex articles are demilitarised and the need for this requirement should be identified during the initial risk assessment. Arisings from the disposal of explosives and ammunition by burning or incineration shall be subject to a CFFE procedure prior to final disposal of them as non-explosives.

7.1.6 Munitions in museums or as souvenirs, display items etc.

All munitions kept in museums, displays or as souvenirs should be examined by a competent person to ensure that all components of the munition are entirely free from explosives and other hazardous substances. Any item that may be confused with a live store, such as a training round, will be subject to this process. However, purpose manufactured training aids obtained from official sources are exempt this process.

The CFFE procedures outlined above may need to be used. A formal CFFE certificate should be issued by the person carrying out this examination to the keeper of the munitions. All organisations holding such munitions should keep a register with details of this freedom from explosives certification. These requirements may be waived where it is completely obvious that the item is free from explosives. An example is an empty brass cartridge case without a projectile fitted and with the primer and cap assembly removed so that a clear hole is visible.

The details held in the register should include information enabling each item to be uniquely identified. It is suggested that this requirement is best met by allocating each item a brief description and a unique number. The name of the person who carried out the CFFE certification and the date on which it was carried out should also be included. The item itself should be marked or tagged with the unique number from the register and also be labelled as 'INERT' or 'FREE FROM EXPLOSIVES'.

7.2 CFFE of buildings and land no longer required used for the storage, handling or processing of explosives

Buildings or land that may at any time have been used for the storage, handling and processing of explosives should be made free of all explosive contamination and formally certified as such before being used for other purposes. These buildings and areas of land should be treated as contaminated until proven otherwise. When buildings, or land, previously used for explosives are to be sold or pass out of the immediate custody of the head of the establishment the following procedure shall be implemented.

A thorough visual search of the buildings or areas involved shall be organised to ensure that no explosive items have been overlooked. Additional instrumental searches should be undertaken when considered necessary. Technical staff capable of identifying and disposing of any items discovered shall form part of the search party.

Any places where exposed explosives could have been handled shall be decontaminated and specialist ammunition technical advice should be sought as necessary. A joint inspection by establishment staff and appropriate technical professional shall be arranged as a final check. For Category C buildings[4] an inspection by establishment staff shall be sufficient. CFFE certificates are to be prepared and copies held by the establishment and the appropriate national authority organisations.

When buildings or land previously used for explosives are re-allocated to other functions and remain under the direct control of the head of establishment they should be formally certified in accordance with these procedures. Records of these procedures and other relevant paperwork shall be retained so that only the minimum amount of work is required should the building or land subsequently pass out of the control of the head of establishment.

8 Emergency arrangements (LEVEL 2)[5]

Accidents or incidents involving conventional ammunition are a regular occurrence, even in the best-trained military and security forces, even though most of them are preventable.

The head of the establishment at any facility or location where explosives are processed, handled or stored, shall ensure that adequate emergency arrangements are in place. Such contingencies include incidents and those accidents resulting in property damage, fire, explosion, injury and fatality. Identification of contingencies will be aided by a comprehensive site wide risk assessment.

[4] See Clause 4 IATG 05.40 *Safety standards for electrical installations* for definitions of electrical categories for buildings.

[5] See IATG 02.50 *Fire safety*.

8.1 Incidents

Incidents, for which emergency plans shall be required, can be classed as major, which affect the whole site as well as areas external to the site, or minor, which are local in their effects.

In addition to specifying emergency actions for the building where the primary incident occurs, emergency plans should specify actions for personnel in adjacent buildings. For example, it may be safer for personnel to remain where they are. Personnel shall be made familiar with the actions to be taken in emergency. Notices giving information regarding emergency action in the event of fire, evacuation and first aid shall be displayed at suitable locations throughout the site and these are to include all ammunition process buildings. Emergency instructions shall include details on how to shut processes down safely, how to move to a safe place, and the arrangements for re-entering the explosives area after an emergency incident.

Arrangements shall be made to ensure that any particularly vulnerable persons, such as visitors or any disabled people, are conducted to safety in an emergency. Fire and evacuation drills shall be carried out for ammunition process buildings at least every six months. All available exits shall be used during the evacuation drill. Records of the exercises shall be maintained and where appropriate post exercise reports prepared.

8.2 Accidents

An ammunition accident, irrespective of cause or however minor, is any incident involving ammunition and explosives that results in death or injury to a person(s) and/or damage to equipment and/or property, military or civilian.

A part of the emergency planning process is the consideration of the provision of an external fire fighting force and medical assistance. The latter may encompass first aid parties, nursing staff, qualified medical practitioners, ambulances, medical supplies and facilities. Because of the particular nature of injuries that result from accidents involving explosives these arrangements should normally include the provision of medical personnel who are adequately trained to deal with such injuries. Exceptionally at small sites, where less hazardous classes or small quantities of explosives are involved, specially trained first aiders may suffice. Special consideration shall be given to those working with explosives in remote locations and plans shall be made to provide medical assistance and evacuation to a hospital as quickly as possible. A part of the emergency planning process for sites with the potential for major explosives accidents will include the designation of buildings for use as temporary casualty clearing stations.

9 Safe to move and handle (LEVEL 2)

The requirements for the transportation of dangerous goods by road, rail and sea includes the basic principle that explosives and packaging when consigned for transportation will withstand the stresses encountered during transport and the condition will not prejudice safety. Consignors of explosives for transport are required to assure that the consignment meets the appropriate hazardous movement regulations. In meeting this requirement, the consignor shall require evidence that the explosives are safe to transport. In situations where the condition of the explosives is unknown or the condition of the explosives may have deteriorated, then an assessment of the stores and their condition shall be made. This assessment is to take consideration of both the ‘safe to store’ and ‘safe to transport’ life of the item and the physical condition of both the explosive items and the packaging.

9.1 Certificate of safety

A locally produced certificate of safety shall accompany each consignment of explosives sent for disposal to any place or establishment, including other storage locations. This certificate shall state that all explosives items, as packed, are safe for transport and handling. For serviceable items in their correct packaging this can be given without the need for an examination. Items that are unserviceable, shelf-life expired etc. and which have not been examined within the previous 12 months, should be examined by technical staff before the certificate is given to confirm that they are in fact safe for handling and transportation. Ammunition in this category requires a sample inspection in accordance with guidance provided by ammunition technical staff.

10 Storage temperatures (LEVEL 2)

10.1 Introduction

In an ideal situation explosives storage should be designed and equipped so that the inside temperature rarely falls below 5^0C and rarely rises above 25^0C. Additionally, daily temperature variations should not differ by more than 5^0C and the relative humidity (RH) should be no greater than 75%. It is appreciated that this situation may only be achieved by the installation of heating and/or cooling systems. In practice there are many explosives that can be kept safely in buildings that are not equipped with space heating and/or cooling systems; however, some explosives should not be allowed to get too cold and some should not get too hot. Some types of explosives need to be protected from moisture.

10.1.1 High temperature limit

Deterioration of explosives in terms of physical attributes and performance, and a reduction of the shelf life of propellants and other explosives containing nitrate esters, will occur more rapidly with increasing temperature. Wherever possible the temperature in a storage building should not exceed 30^0C. The chemical stability of explosives in storage should be kept under surveillance in order to avoid problems associated with auto-ignition.

10.1.2 Low temperature limit

To reduce the possibility of nitroglycerine exudation, and to avoid problems arising out of changes in physical properties, gun and rocket propellants containing nitroglycerine or other nitrate esters should not be stored in a building any part of which could remain below 5^0C for a continuous period exceeding one month.

Similarly, water wet explosives should not be stored in any place where the temperature may fall below 0^0C.

The temperature in buildings containing cordite pastes, dynamite or blasting gelatine, unless of the low freezing variety, should be kept from falling below 15^0C. Under no circumstances should the temperature be allowed to fall below 13^0C as below this temperature nitroglycerine freezes.

If freezing does occur then these materials should be allowed to thaw at a natural rate and shall not be moved or handled until they have thawed completely. Once they are thawed, a suitably qualified and experienced person shall make a visual inspection of the munition and its packaging to ensure that no exuded nitroglycerine is present either as liquid or permeated into the packaging. The Technical Authority should consider whether to undertake chemical test on the affected explosive to confirm that it remains safe to store and move.

10.1.3 Humidity conditions and air flow

Conditions of high humidity will produce deterioration in physical and ballistic properties of composite propellants. Certain double-based compositions are adversely affected by high humidity and care should be taken to provide adequate protection against high humidity. Almost all pyrotechnics deteriorate in conditions of high humidity. Phosphide ammunition shall be kept dry as possible because it can generate phosphine gas, which is explosive and toxic. A free passage of air around the ammunition stack is vital and the stack should be raised off the floor by the use of battens. The clearance between the stack and the wall is normally to be at least 0.5m.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.50 *Fire safety*. UNODA;

d) IATG 05.40 *Safety standards for electrical installations*. UNODA.*;*

e) IATG 06.10 *Control of explosives facilities.* UNODA.;

f) IATG 07.10 *Surveillance and proof*. UNODA; and

g) IATG 10.10 *Demilitarization, destruction and logistic disposal of conventional ammunition*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[6] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[6] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[7]

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html; and

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[8] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[7] Data from many of these publications has been used to develop this IATG.

[8] Where copyright permits.

Annex C
(informative)
Treatment of White Phosphorus and Red Phosphorus burns
(LEVEL 1)

WARNING - SYSTEMIC POISONING. PREPARATIONS OTHER THAN WATER ARE NOT TO BE USED AS WP IS SOLUBLE IN OIL OR GREASE AND MAY BE ABSORBED INTO THE SYSTEM RESULTING IN SYSTEMIC POISONING.

C.1 The following items are to be provided in, or at, the building or compartment in which explosives belonging to CG H are stored:

a) A container filled with water large enough to completely immerse the largest ammunition container holding explosives of CG H.

b) A container of clean water or bottles of sterile water together with gauze and a selection of large dressings for First Aid use. Containers of water are to be cleaned and refilled weekly.

c) A suitable tool to cut Tensile Steel Strapping (TSS) in the case of palletised explosives.

d) Goggles or eye shields.

e) Protective apron.

f) Elbow length fire retardant gauntlets.

g) Suitable lifting tool or apparatus.

h) Fire retardant head protective wear.

i) Eyewash equipment.

C.2 It is the responsibility of the head of the establishment to ensure that all persons connected with the handling or storage of WP and RP ammunition are conversant with the method of rendering first aid to any person burnt or contaminated by WP and RP.

C.3 The following first aid treatment shall be given in the event of any person being burnt or contaminated by WP:

j) where practicable, immediately immerse the burn area in water, or alternatively, pour liberal quantities of water over the area. An attempt may be made to remove loose WP particles with forceps while under water. No attempt is to be made to dig out imbedded particles. Do not use the fingers to avoid burning them;

k) apply a large wet dressing and ensure that it is kept wet or burning will recommence;

l) in the event of WP being splashed into the eye of a person, copious quantities of water are to be used to wash the eye and a wet dressing, in the form of a pad, applied. This dressing is to be kept wet by pouring water on to it; it is not to be removed or allowed to dry, as in either instance, burning will recommence; and

m) the contaminated person is to be taken to the nearest medical establishment for treatment as quickly as possible.

C.4 Medical authorities recommend only the above initial treatment. More qualified individuals may consider the use of copper sulphate and hydrogen peroxide as part of first aid treatment for WP burns.

C.5 RP unlike WP is not liable to spontaneous ignition. However, it is friction sensitive and can reignite. RP burns should be treated in the same way as WP burns. RP hazards are most likely to be from the smoke produced by activated ammunition, but some hazard is posed by the substance itself.

C.6 Although RP is not liable to spontaneous ignition there is a possibility of RP reverting to WP on combustion in an oxygen deprived environment. All personnel shall be briefed on the hazards of both solid phosphorus and the smoke produced. Personnel should not enter the smoke cloud at training and should avoid contact with any unburnt solid particles.

C.7 Extinguished RP particles may re-ignite if, during the burning process, WP has been produced. Care should be taken to avoid friction when removing quenched RP particles as this may cause re-ignition.

Annex D
(informative)
Treatment on hazards of Nitroglycerine poisoning

(LEVEL 1)

Nitroglycerine may be absorbed into the body by ingestion through the mouth, inhalation through the nose, or absorption through the skin. Improper handling of explosives containing nitroglycerine may result in personnel suffering adverse reactions, the most common of which are severe headache, nausea, rapid heart rate and shortness of breath. In extreme cases, nitroglycerine poisoning can lead to coma and death.

Undue emphasis should not be made of the harmful effects of nitroglycerine. Rather, personnel should be made aware of the presence of explosives containing nitroglycerine and trained in the following basic handling precautions:

a) Ensure area is well-ventilated before opening sealed packages.

b) Wear appropriate PPE to prevent absorption of nitroglycerine through the skin when directly handling articles.

c) Do not touch eyes, nose or mouth while hands are potentially contaminated.

d) Thoroughly wash hands and exposed skin as soon as possible after exposure.

e) Persons suspected of mild, short-term exposure to nitroglycerine should avoid exertion and be permitted to lie down for one to two hours. A mild stimulant such as coffee or tea may provide some symptomatic relief. Alcohol and aspirin should be avoided as they tend to hasten the onset of headache and increase its severity.

f) Anyone suspected of a severe exposure to nitroglycerine or complaining of respiratory or cardiac problems will be taken immediately to the nearest medical facility for evaluation.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.60

Third edition
March 2021

Works services (construction and repair)

UN SaferGuard
Securing ammunition, protecting lives

IATG 06.60:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for ‘through-life management’ approach to ammunition management. The IATG can be applied at the guidelines’ **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Explosives safety requires that all personnel, including contractors' personnel who are involved in working in an explosives area, are tightly controlled for their own safety and the safety of others. Adequate risk control measures and procedures must be put in place in order to identify and minimise any risk. This IATG module provides guidance on how to carry out these control procedures.

Works services (construction and repair)

1 Scope

This IATG module will describe the procedures for the control of personnel involved in the construction, repair and maintenance of explosives facilities. The control systems apply to establishment staff members and contractors alike.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'explosives facility' refers to *an area containing one or more potential explosion sites.*

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'works services' refers to *the construction, repair or maintenance work done by organisations or staff, usually civilian, who are not an integral part of the ammunition storage unit.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Specific responsibilities (LEVEL 2)

Specific responsibilities for individuals referred to in this IATG module are given below. They are important because they directly affect the health and safety aspects of this IATG module.

4.1 Contractor

For the purpose of this IATG module a 'contractor' shall be regarded as *a person or persons, company or any other organisation entering into a business agreement for the performance of works services or the supply of goods, with the agreement being legally enforceable*.

However, this definition excludes:

a) personnel working outside of the national authority/establishment legal boundary;

b) personnel who are only in the establishment for a short period of time such as postal delivery staff; and

c) any contractors working in the storage, processing and transportation of military explosives who should be controlled by other regulations.

Any contractor regularly engaged in activities within an explosives area should be classed as explosives area support workers.

4.2 Explosives area support workers (EASW)

EASW do not physically work on explosives but are located in their vicinity on a regular or occasional basis as part of their job. Similarly, establishment staff such as security guards should also be classed as EASW. To this end, these groups should receive specific training in order to carry out their tasks safely.[3]

4.3 Head of the establishment and post holder duties (LEVEL 1)

The Head of Establishment, in this particular IATG module, shall be responsible for overall safety in the establishment, including assessing risks, composing safety cases, and control and protection of establishment and contractors' staff and any visitors. The post holder may delegate some of these duties to a nominated, competent staff member but the post holder still retains ultimate responsibility. The duties listed below are not exhaustive but rather indicate the level of control required to ensure that a safe system of work is in place and that a safe working environment is maintained.

4.3.1 Site plan

The head of the establishment shall be responsible for the initial production and updating of two copies of a site plan showing all licensed potential explosion sites (PES) and their inhabited building distances (IBD). The post holder should keep one copy and give the other to the appropriate national authority property management organisation and its contracting staff.

This highlights the need to protect and control contractors inside the IBD. This in turn minimises the risks to the contractors and the possibility of their activities hazarding the explosives in a PES by highlighting the requirement early in the contract tendering process.

4.3.2 Explosives licenses

If necessary, the head of establishment should apply to the national technical authority for non-standard explosives licences or letters of authority to cover the period of any work being undertaken in the establishment.

[3] See IATG 06.10 *Control of explosives facilities*.

4.3.3 Safety briefing and permits to work (LEVEL 2)

The head of establishment shall be responsible for the provision of explosives safety briefs on the PES and areas being worked on. An example of such a brief is at Annex C.

The head of establishment shall also be responsible for the issuing of permits to work (PTW). This document should be drafted and then submitted to the head of the establishment or appointed representative (see Clause 4.3). The document should specify the tools and other equipment that the contractor needs to use and should also detail exactly what work is required. An example is at Annex D and a suggested national authority checklist is at Annex E. This PTW shall be withdrawn immediately if its conditions are not complied with or when explosives safety has been compromised.

4.3.4 Other duties

Other duties of the head of establishment should include:

a) providing the contractor and contractor's staff with any information or advice necessary to ensure that explosives safety is not compromised; and

b) assessing if any monitoring of contractor's staff is required and arranging this monitoring. If necessary, a safety monitor should be appointed and provided with specific written terms of reference (TOR). The task of the monitor is explained in para 4.4.

4.4 Role of the safety monitor (LEVEL 1)

The safety monitor shall be a competent person and should be appointed by the head of the establishment or the appointed representative. The safety monitor should be familiar with working in the area being worked on in order to provide the contractor and contractor's staff with any information or advice deemed necessary to ensure explosives safety. Advice should be sought from the head of the establishment or the appointed representative if the monitor feels that safety or security is threatened. The monitor shall not enter into dispute with the contractor or the staff but refer them up the chain of command.

The monitor shall:

a) make sure that he or she is recognised by all of the contractor's staff;

b) ensure that contractor's staff comply with all safety precautions detailed in the PTW;

c) report immediately to the head of the establishment or the appointed representative any activity by contractor's staff that may compromise explosives safety;

d) initiate evacuation procedures for contractor's staff in the event of a hazardous incident;

e) gather contractor's staff at the designated muster point and report any missing persons to the emergency services and to the head of the establishment or appointed representative; and

f) obtain guidance from the head of the establishment or appointed representative if he or she is unsure of any aspect of his or her duties.

5 Major works (LEVEL 2)

New projects or major modifications in or near explosives facilities may affect both storage and processing capabilities by compromising their explosives licences. This may result in the necessity to relocate stocks and a relicensing operation in order to identify the new explosive licence limits.[4] The term 'major works' encompasses any repair, refurbishment, modification or new construction activities that cannot be classed as minor works (see Clause 6).

5.1 Risk assessment

Three categories of risk are associated with major works in an explosives facility and they should be based on quantity distances and the location of contractor's staff. These distances are classified as:

a) outside the IBD of a PES;

b) between the IBD and the public traffic route distance (PTRD). For Hazard Division (HD) 1.1 this is recommended to be $14.8Q^{1/3}$ or the applicable minimum from a PES; and

c) within the PTRD. For HD 1.1 this is recommended to be $14.8Q^{1/3}$ or the applicable minimum from a PES.

The IBD or PTRD shall be calculated based on the actual net explosive quantity (NEQ) expected to be present in the PES during the period of work.

5.1.1 Outside the IBD

Contractor's staff outside the IBD of a storage PES may work without any restrictions being placed upon them.

5.1.2 Between the IBD ($22Q^{1/3}$) and the PTRD ($14.8Q^{1/3}$)

If contract staff need to work in this area, then the building NEQ should be reduced to a minimum. However, if this is not reasonably practicable then the number of staff and the task duration shall be kept to a minimum.

Annex F is a list of tables detailing the number of contractor's staff and the task duration that should be allowed. It also provides an explanation of the scaled distance concept and its application to various circumstances. The head of the establishment may accept the risk of personnel working within this distance if:

a) the PES and its contents are inspected for explosives safety by a competent person before contractor's staff are allowed within the IBD of the PES;

b) this check is carried out every working day while contractor's staff are on-site;

c) all buildings accessed during the previous day are inspected and a record of these inspections is kept;

d) the PES contains only properly qualified explosives or in-service munitions;

e) handling and processing of explosives at the PES is kept to as low as reasonably practicable during the time that contractor's staff are on site;

f) an explosives safety brief is given and a permit to work system is in place (see below); and

g) a monitoring system is in place prior to the commencement of work (see below).

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[4] See IATG 02.20 *Quantity and separation distances*.

5.1.3 Within the PTRD

This situation presents a higher risk level and the numbers of contractor's staff, scaled distance and task duration as described in Annex E shall be important factors in determining risk acceptance.

Where reasonably practicable, the PES should be emptied, the NEQ reduced, or stocks moved to store less hazardous natures in that particular PES. Should the number of contractors and the task duration fall within the tables at Annex E then the head of the establishment may accept the risk after fully assessing the risks in a safety case and ensuring that the risk is as low as is reasonably practical (ALARP)[5]. Multiple groups of contractors however should require the use of the tables at Annex G.

5.1.3.1 Contractors staff numbers outside those permitted by Annex C tables

Should the number of contractors or task length be outside the scope of the appropriate table in Annex F then the national technical authority shall be consulted, and they should order a quantitative risk assessment (QRA). The IATG software package will assist in this process.

The safety case produced by the establishment should outline the need for the proposed work to be undertaken, how the work will be carried out and the ALARP measures that will be introduced and enforced. If the national authority is satisfied that the risk is tolerable and ALARP they should issue a comprehensive and conditional letter of authority detailing the basis for its approval. The maximum number of contractor's staff permitted at the work site should be specified.

5.1.3.2 Specific ALARP measures

The routine handling of explosives within the PTRD of the contractor's site should not be permitted if reasonably practicable. However, if this proves not to be the case then all PES within 270m minimum distance of an active contractor area should cease all work and remain closed. All movement of explosives should be re-routed as far away from the contractor's site as is reasonably practicable.

5.1.3.3 Quantitative risk assessment (QRA) [7]

A QRA should be carried out before any major work is undertaken and where large numbers of contractor's staff are to be employed within the PTRD of a PES. The societal risk should be the major influencing factor in the QRA. If a QRA study already exists, it may be possible to extrapolate the societal risk calculations and a completely new QRA should not be necessary. The QRA should take note of all the workers in the area, including those engaged in routine operations and maintenance and all PES that contribute to the risk. It is vitally important that the QRA should be based on the maximum NEQs that will be present during the contract period as the use of authorised limits may present a greater risk than actually exists.

6 Minor Works (LEVEL 1)

These can be defined as those tasks that are not major works but are routinely carried out, such as electrical testing, grass cutting and so forth. This work should ideally be carried out when no explosives activities such as movements or processing are being undertaken but this is often impractical. However, routine maintenance work should be temporarily suspended at times when explosives activities are briefly raised to a significantly higher level than is the norm.

[5] See IATG 02.10 *Introduction to risk management principles and processes*.

6.1 One–off tasks

However, there may be occasions when work of a minor one-off nature, involving contractors other than those already regularly on-site, is necessary. It is often not possible or practicable to train these personnel and therefore the head of the establishment or his or her appointed and nominated representative may allow them to work but should ensure that:

a) the number of the contractor's staff exposed to explosives is set at the absolute minimum;

b) the work being undertaken should not take more than five working days;

c) the work is not hot i.e. it does not involve the generation of heat or sparks within a PES;

d) a risk assessment is carried out and the work is perceived as presenting an insignificant risk to the PES contents;

e) it is not reasonably practicable to conduct the work while the PES is empty; and

f) the risks to contractor's staff are shown to be as low as is reasonably practicable (ALARP).

6.2 Staff numbers and length of task

The total number of EASW and contractor's staff employed on minor works should be carefully monitored and controlled in order to minimise the total numbers exposed to a single potential explosives event. If a task is planned to take longer than 5 days then the national authority should be consulted to ascertain if the work is covered within the spirit of the arrangements at Clause 6.1 or if the work should be re-classified as major works.

7 Additional safety requirements

Before work commences the head of the establishment or appointed representative shall ensure that the contractor and contractor's staff have been given an explosives safety brief (including an explanation of demarcated work areas) and possess a valid and authorised PTW. In the case of routine work these documents should form part of the establishment's standing operational procedures (SOP).

7.1 Working in an Explosive Storage Area (ESA) (LEVEL 1)

The following conditions shall apply when contractor's staff work inside an ESA but not actually on or within a PES:

A) work areas shall be clearly defined on a suitable site map;

B) the handling, movement and processing of explosives in the site shall be reduced to a minimum;

C) contractor's work should be stopped during high levels of explosives activities and the contractor's staff should, if appropriate, leave the explosives area;

D) if electrical equipment which does meet the requirements of IATG 05.40 *Safety standards for electrical installations,* or vehicles or MHE do not meet the requirements of IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*, additional firefighting precautions advised by the establishment fire officer should be imposed; and

E) all waste and flammable products shall be quickly moved outside the ESA and shall be a minimum of 25m from any PES.

7.2 Working on or in a PES (LEVEL 1)

The following additional safety measures should be enacted:

a) all explosives except for those in HD 1.4 in their approved packaging shall be removed from the PES if reasonably practicable; but

b) explosives from compatibility groups (CG) A, H, J, K or L, detonators in CG B, bulk propellant charges in CG C, or bulk explosives in CG D shall be removed from any PES to be worked on or in;

c) areas within the PES in which the contractor's staff will work shall be demarcated by a barrier, hazard warning tape or similar means;

d) walls, fixtures and fittings, etc, that require repair shall be inspected and cleaned if necessary, to ensure that no explosives contamination is present. This shall be carried out before the commencement of work;

e) the handling, movement or processing of explosives within the PES shall be forbidden and work of this nature at adjacent PES be reduced to ALARP levels;

f) activity in the PES which could generate flammable or explosive vapours or dust is to be prohibited; and

g) before any electrical work is undertaken on any PES electrical system, including replacement of light bulbs, the main electrical supply to the building shall be isolated.[6]

[6] See IATG 05.40 *Safety standards for electrical installations*.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.10 *Introduction to risk management principles and processes.* UNODA;

d) IATG 02.20 *Quantity and separation distances*. UNODA;

e) IATG 02.30 *Licensing of explosives facilities*. UNODA;

f) IATG 05.40 *Safety standards for electrical installations*. UNODA;

g) IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities.* UNODA; and

h) IATG 06.10 *Control of explosives facilities*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[7] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[7] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[8]

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Promulgation Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html; and

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[9] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[8] Data from many of these publications has been used to develop this IATG.

[9] Where copyright permits.

Annex C
(informative)
Explosives safety brief format

This brief format is for guidance only and other information may need to be included. It is suggested that a brief is produced for each PES and held centrally for issue to contractors and also be held by duty staff for issue to contractors for out-of-hours emergencies.

C.1 Introduction

The work that you have been authorised to undertake is within or near a building containing explosives. You and your employees shall therefore take heed of the following information and instructions.

C.2 Health, safety and environmental concerns

You will receive a separate brief on these topics.

C.3 Explosives Hazard

In the unlikely event of a hazardous incident involving explosives occurring there will be a risk from blast, fragments, radiant heat either individually or in a combination. An explosion may cause severe structural damage and its effects would be proportionate to the amount of explosives involved in the incident.

These effects are limited by the amount of explosives the facilities are licensed to hold but injury and death are possible consequences of an explosive event. Heavy debris may be projected from the building in which the explosion occurs, and the propagation of fire is highly likely. Persons other than those directly working with explosives may be involved. However, it must be emphasised that as a consequence of the limitations placed upon your activities there is a very low probability of any hazardous incident occurring involving explosives. Some working methods adopted by a contractor may increase the risk of an explosion and restrictions will be in place to minimise these risks to a tolerable level.

The nearest Potential Explosion Site to your work area is ...., and it has a separation distance of .... metres.

Before you begin work, you are to obtain a Permit-to-Work. In addition, you, the Contractor shall ensure that all of your employees to be used on this task have received an Explosives Safety Brief before work at the site commences.

In the event of an incident, (Establishment)............................has a disaster plan which will be implemented. Personnel trained in firefighting, rescue and medical facilities are available in the establishment.

C.4 The head of the establishments' explosives safety representative

This establishment staff member will brief you on the location of the explosives facilities and the safety procedures to be adopted should there be an incident. In addition, the explosives safety representative will be responsible for liaising on all safety matters between the work site manager or foreman and the establishment. The explosives safety representative shall have access to the work site as and when required and may immediately suspend all work if it is considered that the safety of the work site or any explosives is being jeopardised.

C.5 Safety Monitor

A safety monitor may be appointed to escort and observe you. This is to ensure your working practices do not increase the risk to, or from, any explosives. The monitor will report any situations or activity considered to compromise explosives safety. In the unlikely event of a hazardous incident occurring, the monitor will take responsibility for initiating evacuation procedures.

C.6 Permits to Work (PTW)

Before starting any work, you should be in possession of a PTW. If you do not have a permit, no working is allowed.

C.7 Work Site Access

The site where you will be working is within an explosives facility and therefore the following additional safety restrictions will apply:

A) Everyone entering the explosives facility shall be in possession of a current pass issued by

…………………………

B) Each person entering an explosives area will be issued with a disc or tag. These are used as a control measure so that, in the event of an incident, the number of personnel in the area is known. They shall be retained by and on the person to whom they are issued and returned to the issuing point when leaving.
C) Prohibited articles such as cigarettes, tobacco or any other smoking material, or any form of ignition, are not to be taken into the area. Radio transmitters including portable telephones and pagers or any battery-operated equipment are not normally permitted within the area without special authority.
D) All persons and vehicles are liable to be searched on entering or leaving the area.
E) Only the tools and appliances authorised on the PTW are allowed in the area.
F) Refuelling of vehicles or other equipment in the area is not permitted unless specific authorisation has been given by the explosives safety representative.
G) Only the minimum repairs, authorised by the explosives safety representative, to a defective vehicle or appliance to enable that vehicle or appliance to be moved outside the area are permitted.
H) All personnel are to be briefed on the fire regulations and precautions that are to be observed.

C.8 Contractor's responsibilities

You, the contractor, shall be responsible for the following:

A) Ensuring that the work is completed and the work site vacated in the minimum reasonable practical time and in any case before the date stipulated on the PTW. Only the numbers of personnel stipulated on the PTW are permitted to be at the work site at any one time.
B) Ensuring that all waste and flammable products are promptly removed to an area which is outside the explosives area or/and at least 25 metres from any explosives facility or any other distance stipulated by the explosives safety representative.
C) Providing the explosives safety representative with all appropriate health and safety information relevant to the contract work.
D) Detailing to the explosives safety representative all of the work procedures that will be adopted and the tools and equipment that will be required.
E) Providing a list of individually named contractor's staff on site each working day to the explosives safety representative.
F) Informing your employees of any conditions of work, including safety procedures imposed by the contract and the PTW.

C.9 Emergency services

If you require emergency assistance you must:

DIAL FOR POLICE, FIRE AND MEDICAL EMERGENCY ASSISTANCE. The telephone number is …………………………….

C.10 Evacuation Procedure

In the unlikely event of a hazardous incident involving explosives, you and your employees are to evacuate the site to the designated assembly area, which is...

Your monitor or the explosives safety representative will co-ordinate the evacuation and take a roll call to establish if any personnel are missing; details of any missing personnel shall be reported to the emergency services. You and your employees shall comply with any instructions given by the monitor, the explosives safety representative, or the emergency services.

C.11 Conclusion

The above requirements are laid down for the safety of personnel and property and it is essential that they are understood and complied with. Furthermore, it is pointed out that it is a condition of contract that establishment regulations shall be fully complied with.

Any queries regarding the content of this statement should be addressed to.................................. or the explosives safety representative who may be contacted at building no .... or on telephone no ....

Annex D
(informative)
Permit to work (PTW) – suggested format

PERMIT TO WORK **IATG Form 06.60**

Serial Number	
Date	

This Permit-To-Work (PTW) shall only be issued by persons nominated and certified as competent to carry out that function and when the job detailed in Parts 1 and 2 is to be carried out within the Inhabited Building Distance (IBD) or notional IBD of buildings/areas containing explosives. All personnel operating under a PTW shall satisfy themselves that it has been properly issued by a nominated competent person before commencing the task to which it refers.

PART 1 - SITE DETAILS

Establishment	
Site / Section / Location	

This PTW relates only to work in the following area and within the time period stated.

Building Numbers	
System / Equipment (if any)	
Valid (From – To)	

PART 2 - TASK TO BE CARRIED OUT

Describe the task or activity	
Time Period (From – To)	

PART 3 - CROSS REFERENCED PERMITS TO WORK

The following PTWs run concurrent with, or are relevant to this task:

PTW Ser No	Cancel (Date/Time)	Manager's Name	Manager's Signature

PART 4 - TOOLS AND EQUIPMENT

List all tools and equipment authorised for use during the task:

Tools	
Equipment	

PART 5 - HAZARD IDENTIFICATION

Identify all hazards involved with this task. Use a continuation sheet if required.

Hazard	Control Measure

PART 6 - PERSONNEL AND COMPETENCY

Details of personnel nominated to carry out the job:

Name	
Safety Personnel	
Supervisors	
Skill Level	
Safety Competency Required	

PART 7 - STATEMENT BY CONTRACTING OFFICIAL

The job indicated at Part 2 of this PTW is within the IBD or notional IBD of explosives facilities. As such, this PTW is to be passed to the establishment explosives safety representative for a full assessment of risk, disclosure of risk and safety brief as appropriate. **Work is not to commence until all sections of this PTW are completed and agreed.**

Name	
Signature	
Date	

PART 8 - STATEMENT BY EXPLOSIVES SAFETY REPRESENTATIVE

I have carried out a full risk assessment relating to the task identified in Part 2 of this PTW _____/_____. Control measures have been specified which are designed to ensure that safety of personnel is ensured and which must be observed throughout the full period of the task. Only the tools listed at Part 4 are authorised for use. In addition, a Safety Brief has been prepared for issue to the Job Supervisor.

The maximum number of contractors' staff permitted at any one time is:	
The task is to be completed by:	
A non-standard explosives licence	is/is not***** required.
A Letter of Authority	is/is not***** required.

Date of Authorisation	
Name	
Signature	
Date	
Tel	

PART 9 - STATEMENT BY THE JOB SUPERVISOR

I certify that the persons nominated at Part 6 of this PTW ____/____ are competent to undertake the work defined in the work method statement attached to this PTW and I understand that it is my responsibility to supervise the work through to its completion.

I am in possession of the Safety Brief relating to the task and I undertake to instruct each and every person identified at Part 6 of this PTW of the contents.

I understand that:

The maximum number of contractors' staff permitted at any one time is:	
As indicated at Part 2 and Part 8 of this PTW Work on this task is to cease by:	
No further work may be carried out, beyond that necessary to contain an emergency, until a new PTW has been authorised and issued.	

Name	
Signature	
Position Held	
Date	
Time	

PART 10 - AUTHORITY TO PROCEED BY EXPLOSIVES SAFETY REPRESENTATIVE or BUILDING CUSTODIAN

I declare that the workplace identified at Part 1 of this PTW _____/_____ has been made as safe as reasonably practicable by measures identified at Part 5 with reference to the listed hazards and their control measures, together with any additional limitations imposed by a non-standard explosives licence, Letter of Authority and/or the work method statement. I further declare that all other PTWs that relate to or interact with the work identified in this permit have been cross referenced at Part 3 of the respective PTWs.

I understand that if the task has not been completed within the time period defined in Part 2, no further activity can take place until a new PTW has been issued and authorised.

The safety monitor allocated to this task is:

Safety Monitor Name	
Tel	
Authority Name	
Signature	
Position Held	
Date	
Time	

PART 11 - SUSPENSION OF WORK CERTIFICATE - JOB SUPERVISOR

The task identified at Part 2 of this PTW _____/_____ has been suspended. Materials and equipment* have/have not been removed from the site. All personnel have left the work site and are accounted for. I understand that no access to the work site is permitted until a new PTW has been issued and that warning signs/barriers considered necessary have been posted.

Name	
Signature	
Position Held	
Date	
Time	

PART 12 - CONFIRMATION OF COMPLETION OF WORK BY THE JOB SUPERVISOR

I confirm that the task indicated at Part 2 of this PTW has been completed, that all tools equipment and personnel are removed from the site and that the site is safe and ready for normal activities to resume.

Name	
Signature	
Position Held	
Date	
Time	

PART 13 - CONFIRMATION OF THE WORK COMPLETION BY SITE MANAGER/BUILDING CUSTODIAN

* I confirm that the work indicated at Part 2 of this PTW ____/____ has been completed, all tool and contract personnel have left the site, and the site is safe and ready for normal activities to resume. This PTW is now cancelled.

* The work identified at Part 1 and 2 of this PTW ____/_____has been suspended. Before any further work can continue, a new PTW is to be issued.

Name	
Signature	
Position Held	
Date	
Time	

PART 14 - CERTIFICATE OF WORK TRANSFER IN CASE OF NON-COMPLETION OF A TASK. (To be completed by a competent person in the event Part 11 is endorsed)

I certify that the outstanding work remaining to complete the task identified at Part 2 has been transferred to PTW ____/____; and that no further work will be carried out until that PTW has been authorised.

Name	
Signature	
Position Held	
Date	
Time	

PART 15 - RECORD OF CROSS REFERENCED PTW CANCELLATIONS (To be signed only by a competent person)

All necessary actions arising from or associated with the PTW have been completed. This PTW is cancelled. The PTWs listed at Part 3 have been amended to reflect this cancellation.

Name	
Signature	
Position Held	
Date	
Time	

Annex E
(informative)
Permit to work (PTW) – suggested checklist

The purpose of this checklist is to assist national authority units to draw up appropriate PTW in line with their national legal requirements. Each permit is different and should be viewed as such – it is task specific and repetitive tasks should ideally form part of the establishment's standard operating procedures (SOPs).

E.1 General

A) Does the current permit procedure in force satisfy all of the legal requirements applying to the establishments' explosives facilities?

B) Are the types of work, jobs and areas where permits are required clearly defined and known to all concerned?

C) Is it clear to whom the permits apply?

D) Is it clearly laid down how permits shall be obtained for specific tasks?

E) Are the personnel who issue permits properly authorised and competent to undertaken the duties required of them?

E.2 Issuing procedures for PTW

A) Does the risk to contractor's employees from the explosives fall within the tolerable level as prescribed at Annex F?

B) Are the operations to be carried out permitted by national explosives regulations?

C) Have adequate firefighting arrangements been made?

D) Have the establishment's health, safety and environmental orders been given to and explained to the contractor?

E) Is there a clear system for requiring a stoppage of working and has it been explained to the contractor?

F) Does the permit procedure contain clear orders about how the task shall be controlled or stopped should a major or establishment emergency occur?

G) Does the permit specify clearly the work to be done?

H) Does the permit specify clearly to whom it is issued?

I) Must the recipients sign the permit or other document to show that they have read the permit and understood the conditions contained in it?

J) Does the procedure provide both for the recipient to retain the permit and for a record of 'live' permits to be maintained at the point of issue?

K) Does the permit specify clearly a time limit for expiry of the permit or for its renewal?

L) Does the permit specify clearly the building or geographical area to which work must be limited?

M) Is a 'hand back' signature required, as appropriate, when the task is complete?

N) Is there a system to review all permits at regular intervals?

O) Is there a checking system that ensures the requirements of the permits are being followed?

P) Is there an incident reporting procedure for reporting any occurrences that have arisen?

Q) Does the permit list the tools and equipment that may be used by the contractor and any conditions imposed upon their use?

R) Does the permit detail the procedure to be followed should explosives be discovered by a contractor?

S) Does the permit cover the special procedures and conditions of work to be used by the contractor if the contractor is working in or on a PES containing explosives or contaminated with explosives?

Annex F
(informative)
Number of contractors' staff permissible within the IBD of a PES

The information contained in this annex covers PES storage of Hazard Division (HD) 1.1, 1.2 and 1.3 and the number of contractors who may be permitted to work inside the IBD of the PES and the length of time work is permitted.

F.1 Scaled distance

In the tables, there is a column marked 'Scaled distance from the PES'. The calculation of scaled distance varies between HD and is based on the NEQ stored. Each column shows the scaled distance Net Explosive Quantity (NEQ) calculation to be used but for clarity they are:

A) HD 1.1 - $NEQ^{1/3}$

B) HD 1.2 - $NEQ^{0.18}$

C) HD 1.3 - $NEQ^{1/3}$

Scaled distance is defined as the actual distance divided by the NEQ calculation for the actual HD being stored e.g. for HD 1.1,

$$\text{scaled distance} = \frac{\text{actual distance}}{NEQ^{1/3}}$$

When using the tables, the following rules shall apply:

A) If calculating contract periods, round up to the nearest value in the tables.

B) For scaled distances, round down to nearest value in the tables.

F.2 Calculation examples

Example 1. A work site is located 100 m from a PES containing a NEQ of 10,000 kg of HD 1.1. The scaled distance is therefore

$$\frac{100}{(10{,}000)^{1/3}} = \frac{100}{21.54} = 4.64 \text{ and when rounded down} = \mathbf{4.5}$$

Table F.1 identifies that 10 people may be employed at the site for 4 months.

Example 2. A contractor wants to employ 8 people for 18 weeks on a site 100 m from a PES containing 10,000 kg HD 1.1. Table F.1 shows that 8 people employed for 18 weeks, which is 5 months when rounded up, provides a scaled distance of 4.5.

$$NEQ^{1/3} = \frac{\text{actual distance}}{\text{scaled distance}} = \frac{100}{4.5} = \mathbf{22.2}$$

The actual NEQ which should be stored should be no more than 22.2^3 which is 10,950 kg so if the NEQ of the PES does not exceed 10,950kg, the work may be authorised without reference to the national technical authority.

HAZARD DIVISION 1.1										
Scaled distance from PES ($NEQ^{1/3}$)	**Period of Contract / Work in Months**									
	12+	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**≤ 3**
14.5	75	90	105	120	130	140	150	200	250	300
14.0	65	72	99	105	114	123	132	175	217	260
13.5	55	68	70	90	98	106	114	150	184	220
13.0	45	57	66	75	82	89	96	125	151	180
12.5	35	46	50	60	66	72	88	100	118	140
12.0	30	35	43	45	50	55	60	74	87	100
11.5	26	30	36	39	43	48	53	66	78	90
11.0	22	26	30	33	36	41	45	58	69	80
10.5	18	22	25	27	29	34	37	49	60	70
10.0	15	17	19	21	24	27	30	40	50	60
9.5	14	15	19	19	22	25	28	37	46	56
9.0	13	14	15	17	20	23	26	35	42	52
8.5	12	13	14	16	18	21	24	32	39	48
8.0	11	12	13	15	17	19	22	29	36	44
7.5	10	11	12	14	16	18	20	26	33	40
7.0	8	9	10	12	14	15	16	21	27	36
6.6	6	8	8	10	11	12	13	17	21	32
6.0	5	6	7	8	9	9	10	13	16	20
5.5	5	6	6	7	8	8	9	11	14	16
5.0	4	5	5	6	6	7	8	10	12	13
4.5	4	4	4	5	5	6	7	8	10	10
≤ 4.0	3	3	3	4	4	5	5	6	8	10

Table F.1: Scaled distances and contract periods for HD 1.1.

HAZARD DIVISION 1.2[10]										
Scaled distance from PES ($NEQ^{0.18}$)	Period of Contract / Work in Months									
	12+	11	10	9	8	7	6	5	4	≤ 3
53	75	90	105	120	130	140	150	200	250	300
50	55	68	79	90	98	106	114	150	184	220
45	35	46	53	60	66	72	88	100	118	140
40	22	26	30	33	36	41	45	58	69	80
35	14	15	17	19	22	25	28	37	46	56
30	11	12	13	15	17	19	22	29	36	44
25	8	9	10	12	14	15	16	21	27	36
20	5	6	6	7	8	8	9	11	14	16
15	4	4	4	5	5	6	7	8	10	10
≤ 10	3	3	3	4	4	5	5	6	8	10

Table F.2: Scaled distances and contract periods for HD 1.2.

HAZARD DIVISION 1.3 (for larger scaled distances use Table 1)										
Scaled distance from PES ($NEQ^{1/3}$)	Period of Contract / Work in Months									
	12+	11	10	9	8	7	6	5	4	≤ 3
4.3	75	90	105	120	130	140	150	200	250	300
4.0	55	68	79	90	98	106	114	150	184	220
3.5	26	30	35	39	43	48	53	66	78	90
3.0	15	17	19	21	24	27	30	40	50	60
2.5	12	13	14	16	18	21	24	32	39	48
2.0	6	8	8	10	11	12	13	17	21	32
≤ 1.0	3	3	3	4	4	5	5	6	8	10

Table F.3: Scaled distances and contract periods for HD 1.3.

[10] If arrangements can be made to evacuate safely, effectively and quickly all personnel at risk inside Scaled Distance 53 within a period not exceeding 15 minutes then the above guidelines may be waived by the head of the establishment.

Annex G
(informative)
Multiple groups, different scaled distances and multiple PES

G.1 Introduction

The following is a simple and straightforward method of calculating the effects of differing groups of workers working inside the Inhabited Building Distance (IBD) of a PES at the same time. In effect the equations work out the total of Contractor Exposed Months (CEM) subjected to a particular explosive hazard. As with a single group of contractors the scaled distance, the actual distance, the Net Explosive Quantity (NEQ) that is being stored and the Hazard Division (HD) being stored all affect the CEM. The NEQ calculations are HD based and are as follows:

A) HD 1.1 - $NEQ^{1/3}$

B) HD 1.2 - $NEQ^{0.18}$

C) HD 1.3 - $NEQ^{1/3}$

G.2 Example

Two different groups of contractors are exposed to a potential hazard by the same PES at the same time but at different Scaled Distances (SD). The total exposure to the PES must be a sum of the two sites personnel's exposure. The PES is filled with HD 1.1. Assume the two groups of contractors are working at different locations and at different distances from the PES. A conversion factor (CF) will be required to allow the two to be compared.

$$\text{Scaled Distance 1} = \frac{\text{Range 1}}{NEQ^{1/3}} \qquad \text{Scaled Distance 2} = \frac{\text{Range 2}}{NEQ^{1/3}}$$

In this example, we will assume SD1 to be 10 and SD 2 to be 7. To derive the CF, it will be necessary to work out two average constants that are the products (C_1 and C_2) of the duration of contract and maximum number of persons permitted to be exposed (Annex F, Table F.1 for HD 1.1). This is the maximum permissible 'contractor exposed months' (CEM). To do the calculation in 'contractor exposed weeks', multiply by 4.3.

No of months	**12+**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**≤ 3**
CEM	12x15 **=180**	11x17 **=187**	10x19 **=190**	9x21 **=189**	8x24 **=192**	7x27 **=189**	6x30 **=180**	5x40 = **200**	4x50 **=200**	3x60 **=180**

$$C_1 = \frac{180 + 187 + 190 + 189 + 192 + 189 + 180 + 200 + 200 + 180}{10} = \frac{1887}{10}$$

C_1 = 189

No of months	**12+**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**≤ 3**
CEM	12x8 **=96**	11x9 **=99**	10x10 **=100**	9x12 **=108**	8x14 **=112**	7x15 **=105**	6x16 **=96**	5x21 **=105**	4x27 **=108**	3x36 **=108**

$$C_2 = \frac{96 + 99 + 100 + 108 + 112 + 105 + 96 + 105 + 108 + 108}{10} = \frac{1037}{10}$$

C_1 = 104

In order to compare or add together the CEMs at the SDs use the following equation:

$$\text{Total CEMs} = \text{CEM at SD 1} + \left(\text{CEMs at SD 2} \times \frac{189}{104}\right)$$

So the CF to compare CEMs at SD 2 with those at SD 1 is 1.82.

This system allows the comparison of personnel exposure at different SDs. However, the total CEM should not exceed that allowed by the respective tables at Annex F.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 06.70

Third edition
March 2021

Inspection of explosives facilities

UN SaferGuard
Securing ammunition, protecting lives

IATG 06.70:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module explains the rationale behind the requirement for a thorough inspection regime of ammunition storage areas and recommended procedures. It is imperative that all aspects of the explosives licence, and the national authority explosives regulatory regime, are being complied with and that explosive facilities are fit for purpose. Compliance with the terms of the explosives licence should be a mandatory requirement with exceptions approved only by the national technical authority.[3]

Should the permitted quantities of explosives be exceeded, or unauthorised procedures or operations be carried out, the risk of propagation of fire or explosion between Potential Explosion Sites (PES) will be significantly increased, as well as to other Exposed Sites (ES). Such an occurrence will have financial, human security, national security and political implications, particularly if a transparent and thorough inspection regime is not in place.

[3] See IATG 02.30 *Licensing of explosives facilities*.

Inspection of explosives facilities

1 Scope

This IATG module describes the recommended procedures for the inspection of explosives facilities and provides a list of inspection points as well as a possible Potential Explosion Site (PES) log book format.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘explosives facility’ refers to *an area containing one or more potential explosion sites*.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Inspecting an explosives facility (LEVEL 1)

The introduction explained the rationale behind the requirements for an inspection process. PES and any blast and fragment mitigation structures such as blast walls, barricades and earth covering should be purpose-built to approved design specifications.[4] Similarly, electrical and other utilities should be constructed to their own set of specifications.[5] Should there be any deterioration of a PES, then logically there will follow an increase in the hazards to the explosives stored in that PES. Additionally, the PES will also pose a greater hazard to personnel and property at an ES. Should deterioration occur, the explosives licence may need to be modified to reduce the explosives licence limit (ELL), or, possibly, suspended or totally withdrawn.

5 Types of inspection

There are two types of inspection carried out on explosives facilities, internal, using staff from the explosives facility, and external, using staff from other facilities or as required by the national technical authority.

5.1 Internal inspection (LEVEL 1)

Informal internal inspections should be carried out as a routine daily task by all staff working in the explosives facility. The safety culture should be such that staff members feel able to report anything they consider is a risk to health, safety or the environment, and that they know their reports will be taken seriously and acted upon in a timely manner.

A formal internal inspection should be carried out by the person in charge of the explosives facility (or a nominated and qualified representative) to ensure that:

a) a continuous, logged, monitoring regime exists to ascertain the condition of each PES, the ammunition contained within, and the overall ammunition storage area (ASA); and

b) explosive limits licences (ELL) are being observed.

The results of the inspection should be recorded on an inspection record sheet. The national technical authority shall set the frequency of inspection, but it is generally accepted as best practice that monthly is sufficient, coupled with some non-routine inspections.

55.1.1 PES logbook and temperature and humidity records (LEVEL 2)

Each PES should maintain a logbook to record the results of the internal inspections described above and other details. A suggested format and compilation instructions for this logbook are at Annex C. A suggested check list is also at Annex C. This logbook should be regularly inspected by the head of the establishment to ensure that it is being completed properly and that required improvements are actually being carried out.

The national technical authority should specify the frequency that the logbook is inspected but international best practice suggests three monthly inspections is adequate. To complement the logbook, each PES should also have a temperature and humidity record sheet and a suggested format is at Annex D.

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[4] See IATG 05.30 *Barricades*.

[5] See IATG 05.40 *Safety standards for electrical installations*.

5.1.2 Firefighting equipment, alarms and drills (LEVEL 2)

Immediate firefighting appliances (IFFA), including fire beaters, pre-positioned engines and motor driven pumps, hose reels and hydrants, should be inspected by the head of the establishment (or his or her nominated representative) at intervals specified by the head of the establishment or in the case of equipment, by the manufacturer's recommendations. IFFA inspections shall be recorded.[6] A suggested format is at Annex C.

Fire alarm systems shall be maintained in accordance with IATG 02.50 *Fire safety* and the manufacturer's recommendations. Electrical fire alarm systems should be tested weekly and the test recorded. A suggested format is at Annex C. All alarm points should be tested during any three-month period.

Details shall be recorded on the reverse of the inspection record sheet for the PES concerned whenever fire or escape drills are practised. Completion of any actions required by the post drill recommendations is also to be recorded. Drills for the whole storage site are to be recorded on the site inspection record sheet. A suggested format is at Annex C.

5.1.3 Security alarm and public address (PA) systems (LEVEL 2)

Security alarms should be inspected and tested regularly[7]. Where specific guidance is not available, the alarms should be tested for serviceability at weekly intervals such that all alarm activation points are tested within a three-month period. A suggested recording format is at Annex C.

Where fitted, public address systems should be tested in accordance with IATG 05.40 *Safety standards for electrical installations*. If no specific guidance is available, a weekly test broadcast should be made.

5.2 External inspection and subsequent grading (LEVEL 2)

External inspections should be carried out by competent bodies appointed by the national technical authority. The aim of these inspections is to ensure continued safe storage, processing and use of explosives in compliance with national technical authority explosives, health, safety and environmental legislation. Realistically it will be impossible for any external inspection to 100% audit the organisation it is inspecting. However, a systemic check is possible by following a single process from start to conclusion, including a quality check on any documentation produced. A suggested check list is at Annex E, whilst a suggested inspection format is at Annex F.

Before leaving the facility/unit, the national technical authority inspector should advise the head of the establishment being inspected of the findings of the inspection together with the grading. The national authority inspector should compile a report and grade the facility as either SATISFACTORY or UNSATISFACTORY.

An unsatisfactory grading should be given when:

a) safety, security or reliability is seriously degraded;

b) low management standards exist; to the extent that explosives safety is threatened; and/or

c) inadequate progress has been made to rectify deficiencies reported in a previous report that did not result in an unsatisfactory grading at that time.

[6] See IATG 02.50 *Fire safety*.

[7] See IATG 09.10 *Security principles and systems*.

5.3 Follow-up inspections

Follow-up inspections are to be provided depending on the case. In many cases, these can be informal and simple if defects can be remedied quickly. In other cases, extensive adjustments or lengthy and expensive infrastructure projects may have to be carried out. The process must be identified, what is being done about the defects, and it must be tracked, or progress made to ensure that the problem is resolved. This can apply to both inspection levels.

If an unsatisfactory grading is awarded, a follow-up inspection should be carried out after three months to confirm that the actions required to rectify the reasons for the grading have been completed.

The national technical authority may require routine progress reports on some outstanding actions pending their satisfactory completion.

5.3.1 Specialist inspections (LEVEL 2)

In addition to the internal and external inspections at Clauses 5.1 and 5.2 some specialist inspections may be required. These include, but are not limited to:

a) lightning protection systems and electrical installations. These should be inspected and tested in accordance with national technical authority standards which should as a minimum be the same as those in IATG 05.40 *Safety standards for electrical installations*;

b) conducting floors, anti-static floors, earthing mats, bonding systems and bonding leads should be inspected and tested in accordance with national technical authority standards which should as a minimum be the same as those in IATG 05.40 *Safety standards for electrical installations*;

c) installed lifting appliances, cranes etc. should be inspected and tested in accordance with appropriate national safety standards and/or manufacturer's recommendations; and

d) building and civil construction inspections in accordance with national safety standards. These should be carried out by a suitably qualified engineer at regular intervals; two yearly intervals are the suggested norm. Professional appraisals should be conducted by a suitably qualified independent engineer; five yearly is accepted international best practice.

The results of all special inspections, including test readings, copies of test certificates and so forth shall be kept in the PES logbook. Copies of all test certificates shall be held in the PES logbook for a minimum of five years.

6 Small units (LEVEL 1)

Small units and facilities may also have licensed PES. However, these units may not have competent inspection personnel, or they may be located a considerable distance away from their parent unit or organisation. In this case, they may have difficulty in complying with the inspection requirements detailed above. Strict control and regular inspection of these sites is essential to ensure that the requirements of the inspection regime are maintained. Safety is of prime importance and so the parent unit, or the national technical authority where appropriate, should ensure suitable alternative arrangements are in place to make sure that the inspection regime of these small units and facilities is of the same standard as for larger establishments.

7 Suspended or withdrawn licences (LEVEL 2)

In the event of an explosives facility having an ELL suspended or withdrawn, written details should be held by the national technical authority and a copy held in the PES log book. Inspections should still take place and the frequency of the inspection will be dependent on the climate, its erosive effects and the type of explosive facilities. The inspection regime should be as above, but the periodicity of inspection may be extended to a maximum of six months. If defects are identified rectification may be delayed. However, if any defects affect the weatherproofing or structural integrity of the PES then repair should take place as if the PES was still in use. After six months, all standard and specialist inspections should be implemented, resources permitting, prior to re-use. A prioritisation protocol for repairs should be developed.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 02.30 *Licensing of explosives facilities*. UNODA;

d) IATG 02.50 *Fire safety*. UNODA;

e) IATG 05.30 *Barricades*. UNODA;

f) IATG 05.40 *Safety standards for electrical installations*. UNODA; and

g) IATG 09.10 *Security principles and systems*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[8] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[8] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:[9]

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives.* NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

b) *Handbook of Best Practices on Conventional Ammunition*, Chapter 5. Decision 6/08. OSCE. 2008. www.osce.org/fsc/33371; and

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[10] used in this guideline and these can be found at www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[9] Data from many of these publications has been used to develop this IATG.

[10] Where copyright permits.

Annex C
(informative)
PES logbook

The following check list of inspection points and records of checks and tests may be used to maintain records.

PES Logbook (Record of Checks and Tests)													IATG Form 06.70A
Items 1 to 18 & 21 to 25 insert ✓ if correct or X if incorrect. Items 19 to 20 insert ✓ when carried out.		Year:				PES:							
		J	F	M	A	M	J	J	A	S	O	N	D
1	State of repair												
2	Cleanliness												
3	Dampness												
4	Windows												
5	Drains, gutters etc												
6	Heating/ventilation/air conditioning												
7	Condition of barricades												
8	Locks, key labelling and rotation												
9	Explosives stored (ELL, NEQ and CG)												
10	Marking/sealing of packaging												
11	Fire appliances and check dates												
12	Fire symbols												
13	Vegetation control												
14	ELL displayed and safety posters												
15	Lifting equipment check and certification												
16	Electrical installations												
17	Lightning protection systems												
18	Conducting/ant-static floor and HAPTM[11]												
19	Fire practice												
20	Evacuation drill												
21	Incident/accident reporting												
22	Designated smoking area												
23	Empty box areas												
24	Outstanding defects												
25	Documentation												
26	Additional –separate report												
Initials:													
Date:													
Head of Establishment Signature (3 Monthly Check).													
Date:													

[11] Hazardous Area Personnel Test Meter.

Notes:

1	**State of repair**	Check the security fence and security lights for damage and corrosion, the building structure for any damage, the state of paint work, and all attachments and fittings for damage and corrosion. Check roads and rail sidings for damage/pitting, rubble, etc and general storm damage. Check if doors are serviceable? Check if designated areas are suitably demarcated.
2	**Cleanliness**	Check the PES and its adjacent area is clean, tidy and free from wind blown combustible material. Check packaging materials been removed or correctly temporarily stacked so as not to present a fire risk. Check that empty boxes, seals, locking wire have been removed. Ensure that flammable liquids, rags, waste paper etc have not been left exposed. Check for accumulations of explosives dust on machinery, gravity rollers etc, Ensure there are separate bins for ferrous & non-ferrous waste. Ensure that a doormat is present and is serviceable.
3	**Dampness**	Check all buildings internally and externally for damp patches. Check if the roof, especially the eaves, is free from mould and fungus. Check if there any water erosion marks especially near any electrical fittings. Ensure the floor area is free from water/condensation. Check if there is damage to the fabric of building that allows ingression of water.
4	**Windows**	Is the glass of an acceptable safety standard? Ensure all stacks are clear of the windows and that sunlight does not impinge on the explosive stores. Check if guard bars are fitted, are serviceable, are free from corrosion and are correctly grouted to the window frames. Check if the glass is free from cracks and if cracked are they protectively covered by tape to prevent ingress of moisture pending repair?
5	**Drains, gutters etc**	Ensure that the building’s drains and gutters are secure and undamaged, free of grass cuttings, leaves, wind-blown foliage and paper and that drains are clear and free from restrictions. Check drains and drain covers in roads, etc, for damage.
6	**Heating/ventilation/air conditioning**	Check if ventilators are normally left open. Ensure ventilators are free from corrosion and that they open and close properly. Check if they require protective painting, oiling or greasing. Check if they have thermal links or an automatic closing device and if these are serviceable. Check for the presence of hygrometers, max-min thermometers and if they are serviceable? Check if any data-loggers are present and if they are approved and serviceable. Check if humidity and temperature readings are recorded. Ensure that any heating and air conditioning is operative. Ensure radiators have sloped
7	**Condition of barricades**	External – check that they are effective. Check for rabbit holes, mole hills and subsidy. Check if any areas require bracing up, need holes filling or grass renewing. Internal – check they are serviceable and are at the correct distances from stacks and walls.
8	**Locks, key labelling and rotation**	Check each bunch for serviceable keys. Check if they are worn and been mustered and rotated with the duplicate/triplicate sets. Ensure locks and padlocks are of an approved pattern, are serviceable, have hasps that are free from corrosion and that they function properly. Check if the locks require lubrication. Ensure that all key bunches are correctly labelled and that individual keys are identifiable.
9	**Explosives stored (ELL, NEQ and CG)**	Check Hazard Division (HD), Net Explosive Quantity (NEQ) and mixing of Compatibility Groups (CGs). Ensure that the appropriate instructions and safety precautions for each type of store stacking system are present and carried out. Ensure that stack tally cards, pallet and Unit Load Container (ULC) labels correctly identify the make, date, Batch Key Identification (BKI)/lot and quantity of each type of ammunition. Check that constrained and banned/black listed stores are correctly labelled and segregated. Check that all unsealed boxes are clearly marked with their remaining quantity, type and lot number (if different from the original markings). Ensure explosive ordnance disposal (EOD) recoveries are correctly packaged and stored separately. Carry out a percentage physical check of packaged and unpackaged stores to check for damage, dampness and corrosion. Ensure no empty packages are present. Check that the correct tools, equipment and first aid kits are available where CG H and Gaseous Tritium Light Sources (GTLS) are present. Ensure that non-palletised stores are on battens or racking. Check gangways and spacing from PES structure are in place and comply with regulations. Ensure that approved tool lists, safety instructions for the operation of machinery and work schedules are in place in process facilities.

10	**Marking/sealing of packaging**	Ensure explosives packages are correctly sealed, labelled with their contents and display and hazard classification code (HCC) symbol, UN serial number and other markings required by the national authority. Ensure that the correct packaging has been used. Check that fraction packages have been marked as such. Check if sufficient dunnage is present.
11	**Fire appliances and check dates**	Ensure that emergency water supplies (EWS) are full, clear and free from wind blown debris. Ensure first aid firefighting equipment (FAFFA), to the appropriate scale, are correctly positioned at each building and that they are serviceable. Check that fire appliances areas are clearly marked and painted. Ensure protective boxes are serviceable. Check for storm damage, water leaks and defective connectors. Check if appliances have recently been functionally checked and certificates are up to date. Check that fire beaters are serviceable and that there are a sufficient number. Check that the pre-fire plan is up to date. Check that fire alarm systems are maintained, tested and that the results are logged.
12	**Fire symbols**	Ensure fire division signs and supplementary fire signs, are prominently displayed, both on the PES and all approach roads, legible and serviceable. Ensure that they correctly interpret the hazard of the stored items. Check that the fire section and local fire brigade have been informed of any major stock change hazards. Check that the fire section and local fire brigade are informed when overnight storage areas are in use
13	**Vegetation control**	Ensure 1m sterile areas round each PES (except earth covered) are clear of grass, foliage, shrubbery, gorse and heather. Check that grassed areas are sufficiently mown and all grass cuttings are removed.
14	**ELL displayed and safety posters**	Check that ELL and mandatory safety posters are displayed. Ensure that all contents are authorised to be stored in the PES and that NEQs present do not exceed the authorised limits. Ensure that all tools, equipment and cleaning utensils are correctly listed and authorised. Check that actions in event of a fire poster are present and correct. Check for any special conditions on license and that these conditions are being obeyed. Check that first aid posters are present and that first aid kits are
15	**Lifting equipment check and certification**	Check all chains and cables for damage and corrosion and ensure that they are lightly lubricated. Carry out a functional check ensuring that the hoist runways have no restrictions and the raising/lowering mechanisms function correctly. Check the hoist has had a mechanical/electrical inspection within the prescribed periodicity and that the results are recorded.
16	**Electrical installations**	Ensure the standard of electrical installation is shown by a wall plate mounted adjacent to master switch. Ensure the power on lights is operative. Physically check all lights/luminaires, Intruder Detection Systems (IDS) alarms, fire alarms, telephones, power supply lines/conduit, switches and electrical switch boxes for corrosion, security of fitment, storm damage, etc. Check all lighting and telephones for correct functioning. Ensure electrical tests results are supplied, are current and the results are entered on reverse of the PES inspection record sheet. Check that Residual Current Device (RCD) and Earth Leakage Circuit Breaker checks are carried out. Check that electrically powered appliances, leads and earthing cables are registered and that they received their periodic check and that they can be easily and quickly promptly identified. Ensure power plugs and sockets are clearly marked for the correct electrical potential. Ensure that they are stored neatly when not in use. Check the periodicity of public address systems tests.
17	**Lightning protection systems (LPS)**	Look for evidence of lightning strikes. Check for integrity of electrical bonding, above and below each switch box, to the air terminals and the ground terminals and to all doors when open and closed. Ensure all internal bonding is properly connected to benches, structures, earth points and electrical hoists. Ensure the lightning protection system (LPS) test is current and that test results are supplied and logged.
18	**Conducting/ant-static floor and HAPTM[12]**	Ensure floors have been electrically (resistance) checked and the results recorded. Check that the floors are free from cracks, large indentations, excessive wear marks, oil and grease. Ensure that a cleaning regime is in place and used. Ensure that any HAPTM present is serviceable and checked and the results recorded.
19	**Fire practices and evacuation drills**	Check that fire practices and evacuation drills are regularly carried out (3 monthly), are recorded on the reverse of the inspection record sheet and that post-drill recommendations have been implemented.
20	**Incident/accident reporting**	Check that mechanisms are in place for reporting incidents and accidents and that staff are aware of these procedures and follow them.
21	**Designated smoking area**	Check that the area in use is authorised, that the ash trays are kept clean and cigarette ends are at a minimum and that all lighting material is of the authorised type.

[12] Hazardous Area Personnel Test Metre

22	**Empty box areas**	Empty box compounds are potentially a fire hazard area. Check for poor stacking, over stacking, untidy areas of boxes and furnishings, loose paints, oils, lubricants, labels and fabrics. Ensure that there are sufficient fire appliances. Check if an excess of wooden boxes are being stored. Check all UN markings, HCC labels etc have been removed or obliterated. Ensure certified free from explosive (CFFE) sealed boxes are physically separated from empty boxes or other items awaiting CFFE.
23	**Outstanding defects**	Check each area/PES record of defects. Check if an outstanding defect is getting worse, becoming a safety hazard, has been repaired to an unacceptable level, or is outstanding for too long.
24	**Documentation**	Ensure that the items on the inspection record sheet have been correctly ticked when acceptable and have been red cross marked when defective or are otherwise unsatisfactory. Ensure that all defective items have been reported and recorded on the record of defects on the rear of the inspection record sheet. Check that all periodic tests have been recorded and any fire or escape drills annotated on rear of inspection record sheet.

PES Logbook (Fault Reports)					IATG Form 06.70B
Date	**Nature of Fault / Failure**	**Reported To / Date**	**Task Number**	**Action Taken to Repair / Rectify the Fault / Failure**	**Name / Signature**

PES Logbook (Electrical Test Record)							IATG Form 06.70C	
Date	Electrical Installations		Lightning Protection		Conducting Floors		Cranes and Lifting Equipment	
	Standard	Result	Standard	Result	Type	Result	Type	Result

PES Logbook (Fire and Evacuation Drills Test Record)						IATG Form 06.70D
Date	Fire Fighting			Evacuation		
	Time of Alarm	Time Fire Appliances Operational	Remarks and Recommendations	Time of Alarm	Time Building and Area Clear	Remarks and Recommendations

Annex D
(informative)
Temperature and humidity recording

PES Logbook (Temperature and Humidity Recording Record)														IATG Form 06.70E
Day	Month/Year:							PES Number:						
	Thermometer Reading		Hygrometer Reading			Ventilated	Initials	Thermometer Reading		Hygrometer Reading			Ventilated	Initials
	Maximum	Minimum	Dry	Wet	Difference			Maximum	Minimum	Dry	Wet	Difference		
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														

PES Logbook (Temperature and Humidity Recording Record)														IATG Form 06.70E
Day	Month/Year:							PES Number:						
	Thermometer Reading		Hygrometer Reading			Ventilated	Initials	Thermometer Reading		Hygrometer Reading			Ventilated	Initials
	Maximum	Minimum	Dry	Wet	Difference			Maximum	Minimum	Dry	Wet	Difference		
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
Mean														

Notes:

1. In the column headed “Ventilated” insert V when the building is ventilated and X when the ventilation is closed.
2. Insert N/A in columns that do not apply.
3. This form should be initialled weekly by the person in charge in the column headed “Initials”.

Annex E
(informative)
National authority inspection guidelines

E.1 **Check** any outstanding actions from the previous inspection report.

E.2 **Health and safety** to national standards including:

a) any policy statements;

b) organisation and responsibilities;

c) audits;

d) training and appropriate qualifications;

e) hazardous substance assessments;

f) control of contractors;

g) manual handling; and

h) risk assessments.

E.3 **Documentation**

a) explosives licenses;

b) work procedures;

c) safeguarding maps and checks where appropriate;

d) directional weapons map where appropriate (for aeroplanes);

e) radiation hazard (RADHAZ) map where appropriate;

f) site map;

g) PES log book;

h) safety posters; and

i) publications for machinery, ammunition, storage etc.

E.4 Security

a) intruder detection system check;

b) control of entry;

c) key control system check;

d) enforcement of prohibited articles regime; and

e) integrity of security fences.

E.5 Fire precautions and fire safety

a) maintenance of immediate fire-fighting equipment (IFFA);

b) control of vegetation;

c) fire breaks;

d) fire plan and fire orders;

e) fire and evacuation exercises;

f) liaison with local fire brigade;

g) fire alarm and fire suppression systems; and

h) display of fire division signs and supplementary fire signs.

E.6 Electro-static precautions

a) conducting and anti-static;

b) bonding system;

c) hazardous area personnel test meters (HAPTM);

d) earth leakage circuit breakers (ELCB); and

e) residual current devices (RCD).

E.7 Infrastructure

a) building structures;

b) glazing;

c) barricades ;

d) electrical appliances;

e) lightning protection system;

f) heating, lighting and air conditioning; and

g) lifting appliances.

E.8 Disaster planning

a) major accident planning in the event of an explosive incident or other incident;

b) provision of first aid;

c) evacuation procedures for the establishment and nearby dwellings;

d) pollution control; and

e) establishment of command and control systems.

E.9 Operation of facilities

a) sealing, marking and labelling of packages;

b) overall cleanliness and tidiness;

c) free from explosives certification;

d) storage conditions;

e) explosives processing, handling and storage;

f) vehicles, MHE and other transportation;

g) safety precautions and first aid provision;

h) disposal of explosives by open burning, open detonation or by industrial processing;

i) disposal of unserviceable stock;

j) segregation, isolation and EOD recoveries; and

k) waste and pollution management.

E.10 Responsibilities for other establishments

E.11 Provision of specialist or competent personnel

E.12 Training of personnel and shortfalls

Annex F
(informative)
ESH inspection checklist

Unit:		**Date:**	
Ammunition Storage Area (ASA):		**Inspector Name:**	
Explosive Storehouse (ESH) #:		**Inspector Signature:**	

F.1 Important Safety Distances

SER	PES[13]	ES[14]	DISTANCE FROM PES (m)	QD REFERENCE[15]	IATG 02.20 ELL LIMIT (KG)	DISTANCE FUNCTION	REMARKS
(a)	(b)	(c)	(c)	(d)	(e)	(f)	(g)
							▪
							▪
							▪
							▪

F.2 Quick Reference[16]

[13] Potential Explosion Site
[14] Exposed Site
[15] See A.2 and footnote below.
[16] Check against IATG 02.20 *Quantity and separation distances*.

HD	OQD					IQD	
	Inhabited Building Distance (IBD)	Vulnerable Building Distance (VBD)	Public Traffic Route Distance (PTRD) (Low Density[17] = 0.5 IBD)	Public Traffic Route Distance (PTRD) (Medium Density[18] = 0.66 IBD)	Public Traffic Route Distance (PTRD) (High Density[19] = IBD)	Inter Magazine Distance (IMD)	Process Building Distance (PBD)
HD 1.1	$22.2Q^{1/3}$	$44.4Q^{1/3}$	$14.8Q^{1/3}$ 0.5 D12	$14.8Q^{1/3}$ D11	$14.8Q^{1/3}$ D13	Various	$8.0Q^{1/3}$
HD 1.2							36% IBD
HD 1.3	60m						
HD 1.4	>10m						

F.3 ESH Types

BUILDING TYPE [20]	LENGTH (M)	WIDTH (M)	HEIGHT (M)	UNITS OF SPACE PER ESH (m^3) [21]	NUMBER OF ESH	REMARKS
Type A						▪
Type B						▪
Type C						▪
TOTALS						

[17] Less than 1,000 Vehicles / 24 Hours.
[18] 1,000 – 5,000 Vehicles / 24 Hours.
[19] 5,000+ Vehicles / 24 Hours.
[20] The type of building will differ dependent on national designs. Type A etc included here for example.
[21] Estimate using IATG 06.20 *Storage space requirements*.

F.4 General Inspection Checklist [22]

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
Health and Safety at Work	Policy Statements	National Responsibility		
	Organisation and Responsibilities	National Responsibility		
	Health and Safety Audits	National Responsibility		
	Health and Safety Training	National Responsibility		
	COSHH[23] Assessments	National Responsibility		
	Risk Assessments	IATG 02.10, Clause 7 and IATG 06.10, Clause 6.7.2		
Explosives Limit Licensing	Explosive Licences	IATG 02.30, Clauses 7 and 8		
	Safety Distances	IATG 02.20, Annexes and IATG 06.10, Clause 6.1		
	Safeguarding of Distances	IATG 02.40, Clause 4 and IATG 06.10, Clause 6.1		
	Directional Weapons Map	IATG 02.40		
	PES Logbooks / Record Cards	IATG 06.70, Clause 5.1.1		
	Signing	IATG 06.70, Annex C		
	Publications	IATG 01.10, Annex D		
Security	Intruder Detection Systems	IATG 06.70, Clause 5.1.3 and IATG 09.10, Clause 8.6.4		
	Control of Entry	IATG 06.10, Clause 5.2 and IATG 09.10, Clause 8.5		
	Control of Keys	IATG 09.10, Clause 8.5.1		
	Exclusion of Prohibited Articles?	IATG 06.10, Clause 5.3		
	Security Fences	IATG 09.10, Clause 8.7.1		

[22] Complete once for each ASA. Developed from contents of Annex E to IATG 06.70 *Inspection of explosives facilities.*
[23] Control of Substances Hazardous to Health.

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
Fire Precautions	Maintenance of Fire Fighting Equipment	IATG 02.50, Clause 11.3 - 11.4 and IATG 06.10, Clause 7.2		
	Control of Vegetation	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 - 6.9		
	Fire Breaks	IATG 02.50, Clause 8		
	Fire Plan and Fire Orders	IATG 02.50, Clause 6.1 and IATG 06.10, Clause 7		
	Fire and Evacuation Exercises	IATG 02.50, Clause 9		
	Liaison with Local Authority Fire Service	IATG 02.50, Clause 6.1		
	Fire Alarm Systems	IATG 02.50, Clause 7		

F.5 ESH Inspection Checklist [24]

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
Infrastructure - State of Repair	Breaches in security fence?	IATG 09.10, Clause 8.7.1		
	Damaged or corroded security lights?	IATG 09.10, Clause 8.7.2		
	Building structure damaged?	IATG 05.20, Clause 8		
	State of paint work?	N/A		
	Damage or corrosion of fittings?	N/A		
	Damage to roads / railway?	IATG 06.10, Clauses 6.4 - 6.5		
	Doors serviceable?	IATG 09.10, Clause 8.6.1		
	Broken windows?	IATG 09.10, Clause 8.6.2		
	Lightning protection?	IATG 05.40, Clause 8		
Infrastructure - Cleanliness	Wind-blown combustibles outside?	IATG 06.10, Clause 9.1		
	Loose packaging or rubbish inside?	IATG 06.10, Clause 9.1		

[24] Complete for each ESH.

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
	Empty boxes, pallets etc removed?	IATG 06.10, Clause 9.1		
	Rags and waste removed?	IATG 06.10, Clause 9.1		
	Accumulation of explosive or propellant dust?	IATG 05.40, Clause 4 and IATG 06.10, Clause 9.1		
	Separate bins for ferrous and non-ferrous waste?	N/A		
Infrastructure - Dampness (Structural / Condensation)	Damp patches external?	N/A		
	Damp patches internal?	N/A		
	Roofs free of mould and fungus?	N/A		
	Water erosion marks?	N/A		
	Floor dry and free from condensation?	IATG 06.10, Clause 9.1		
	Water ingress possible due to structural damage?	N/A		
Infrastructure - Windows	Glass of acceptable standard?	IATG 09.10, Clause 8.6.2		
	Cracked or broken panes?	IATG 09.10, Clause 8.6.2		
	If broken, protected by tape until repair?	IATG 09.10, Clause 8.6.2		
	Sunlight onto explosive stores?	N/A		
	Guard bars fitted and free of corrosion?	IATG 09.10, Clause 8.6.2		
	Grouting OK?	N/A		
Infrastructure - Drains and Gutters	Secure and undamaged?	N/A		
	Free of grass cuttings, leaves, wind-blown foliage, rubbish etc?	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 – 6.9		
Infrastructure - Heating, Ventilation and Air Conditioning	Ventilators (normally) left open?	IATG 06.50, Clause 11.13		
	Ventilators free from corrosion?	IATG 06.50, Clause 11.13		
	Ventilators open and close properly?	IATG 06.50, Clause 11.13		
	Do ventilators require protective paint, oil or grease?	IATG 06.50, Clause 11.13		
	Thermal links or automatic opening device present? Serviceable?	IATG 06.50, Clause 11.13		

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
	Hygrometers / Thermometers present? Serviceable?	IATG 06.10, Clause 11.13 and IATG 06.70, Clause 5.1.1		
	Heating / Air Conditioning present? Serviceable?	IATG 05.40, Clause 5.4.1		
	Radiators have sloped guards?	IATG 05.40, Clause 5.4.1		
Infrastructure – Barricades	External – Effective?	IATG 05.30, Clause 4		
	Subsidence?	IATG 05.30, Clause 4		
	Internal – Effective?	IATG 05.30, Clause 4		
Security - Keys	Keys serviceable and rotated?	IATG 09.10, Clause 8.6.3		
	Condition of locks?	IATG 09.10, Clause 8.6.3		
Safety – Explosive Contents	Check mixing of Compatibility Groups.	IATG 01.50, Clause 7.1		
	UN Hazard Division marking system?	IATG 01.50, Clause 6		
	National Hazard Division marking system?	IATG 01.50, Clause 6 Equivalent?		
	Marking system shows HCC, HD, UN Serial Number, Ammunition Type, Lot/Batch Number and Quantity?	IATG 06.40, Clause 4.7		
	ESH stacking system (cards) in place?	IATG 03.10, Clause 15 and IATG 06.30, Clause 7		
	Stack tally cards contain HD, Batch/Lot Number, Quantity?	IATG 03.10, Clause 14.5 and IATG 06.30, Clause 7		
	Constrained or unserviceable stock clearly marked and segregated?	IATG 06.10, Clause 11.6.2 and IATG 06.10, Clause 11.10		
	Unsealed boxes clearly marked with remaining quantity?	IATG 06.40, Clause 4.5 and IATG 06.40, Clause 6		
	Unsealed boxes – contents free of corrosion, damage or dampness?	IATG 06.40, Clause 6		

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
	Tools and first aid available where CG 'H' is being stored?	IATG 06.10, Clause 9.5		
	Non-palletised stores on battens or racking or equivalent?	IATG 06.30, Clause 5.4		
	Gangways between stacks in place and adequate?	IATG 06.30, Clause 5.2		
Safety – Fire Fighting (Equipment)	Emergency Water Supply (EWS) present?	IATG 02.50, Clause 11.1		
	EWS full, clear and free of wind-blown debris?	IATG 02.50, Clause 11.1.5		
	Fire hydrants present?	IATG 02.50, Clause 11.1.2		
	Fire hydrants serviceable and correct water pressure?	IATG 02.50, Clause 11.1.2		
	Immediate firefighting equipment present in ESH (extinguishers, sand etc)?	IATG 02.50, Clause 11.3		
	Immediate firefighting equipment regularly function checked and recorded?	IATG 02.50, Clause 11.3 and IATG 06.70, Clause 5.1.2		
	Fire appliances and equipment accessible, clearly marked and painted?	IATG 02.50, Clause 11.3		
	Fire beaters serviceable and in sufficient quantity?	IATG 02.50, Clause 11.3		
Safety – Fire Fighting (Response)	Is there a fire plan?	IATG 02.50, Clause 6.1		
	Fire alarms systems maintained, tested and recorded?	IATG 06.70, Clause 5.1.2		
	Regular exercises with local fire authority?	IATG 02.50, Clause 9		
	Fire Division Signs and Supplementary Fire Signs displayed, legible and serviceable?	IATG 02.50, Clause 11.2		
	Do Fire Division Signs and Supplementary Fire Signs correctly reflect the stocks?	IATG 02.50, Clause 11.2		
	Do the local authority fire service know what is stored in depot and what inherent risks are?	IATG 02.50, Clause 6.1		

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
	Are the local authority fire service informed of any major changes to storage conditions or types of ammunition being stored?	IATG 02.50, Clause 6.1		
	Regular fire practices held and recorded?	IATG 02.50, Clause 9 and IATG 06.70, Annex C		
	Empty boxes are a potential fire hazard. Is there a designated area for them? Are they free of paints, oils, greases, solid waste, wood scraps etc?	IATG 02.50 and IATG 06.10, Clause 9.1		
	Have all labels been removed from empty boxes?	IATG 06.40, Clause 4.10		
Safety – Fire Fighting (Vegetation)	Is there a 1m sterile area around each ESH?	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 – 6.9		
	Is it clear of grass, foliage, shrubbery, gorse and heather?	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 – 6.9		
	Are grassed areas inside and outside the depot sufficiently mown and all grass cuttings removed?	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 – 6.9		
	How often is grass cut during spring/summer months?	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 – 6.9		
	Are there trees inside the depot for camouflage?	IATG 02.50, Clause 8 and IATG 06.10, Clauses 6.7 – 6.9		
Safety – Operations (Documentation)	All Explosives Limits Licences (ELL) displayed?	IATG 02.30, Clause 8.3		
	Do ELL reflect stocks?	IATG 02.20, Annexes and IATG 02.30, Clause 7.1		
	Are all tools, equipment and cleaning utensils allowable correctly listed and authorised?	IATG 06.10, Clause 9.5.1		

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
	Contraband notice at entry to Explosives Area?	IATG 06.10, Clause 5.3.1		
	Designated smoking area? Clearly signed and ashtrays available?	IATG 06.10, Clause 5.3.2		
	Actions on event of fire posters or instructions?	IATG 02.50, Clause 11.2		
	Mechanisms for reporting accidents and incidents?	IATG 11.10, Clause 8		
Safety – Equipment (Lifting Equipment)	Are mechanical hoists present?	IATG 05.50, Clause 4 and IATG 06.30, Clause 8		
	If yes, are chains and cables in good condition and lubricated?	IATG 05.50, Clause 5 IATG 05.50, Clause 7.1		
	Are electrical hoists present?	IATG 05.50, Clause 4 and IATG 06.30, Clause 8		
	If yes, are chains and cables in good condition and lubricated?	IATG 05.50, Clause 5 IATG 05.50, Clause 7.1		
	If yes, is it to a Category C equivalent standard?	IATG 05.40, Clause 4		
	Have the hoists had a mechanical / electrical inspection within the last 12 months? Is it recorded?	IATG 05.50, Clause 7.1		
Safety – Equipment (Electrical Installations)	Is safety standard (e.g. Category C) shown next to the Master Switch?	IATG 05.40, Clause 4		
	Master Switch serviceable?	IATG 05.40, Clause 6.2.11		
	Check all lights, alarms, telephones, switches and electrical switch boxes for corrosion, security of fitment, storm damage etc.	IATG 05.40, Clause 6.2.10		
	Check all lighting and telephones for correct functionality.	IATG 05.40, Clause 6.2.10		
	Are formal electrical tests regularly carried out? Are they formally recorded? Can each component be easily identified from the record of tests?	IATG 05.40, Clause 6.2 and IATG 06.70, Annex C		

INSPECTION AREA	SPECIFIC	IATG REFERENCE	REMARKS	ACCEPTABLE / REQUIRES WORK
	Loudspeaker / Public Address System present? Tested?	IATG 05.40, Clause 6.2.10		
	Earth Leakage Circuit Breakers present? Functional and tested?	IATG 05.40, Clause 6.2.9		
Safety – Equipment (Lightning Protection)	Lightning conductors present?	IATG 05.40, Clause 8		
	Integrity of bonding of lightning conductors? (Above and below each switch box to the air and ground terminals).	IATG 05.40, Clause 6.2.6		
	Evidence of lightning strikes?	IATG 05.40, Clause 6.2.6		
	Internal bonding correctly connected to benches, terminals, structures, earth points and electrical hoists?	IATG 05.40, Clause 6.2.6		
	Systems tested and recorded?	IATG 05.40, Clause 6.2 and IATG 06.70, Annex C		
Safety – Equipment (Conducting and Anti-Static Floors	Have all floors being electrically (resistance) checked and results recorded?	IATG 05.40, Clauses 6.2.7 – 6.2.8 and IATG 06.70, Annex C		
	Floors free of cracks, large indentations, excessive wear, oil or grease?	IATG 05.40, Clauses 6.2.7 – 6.2.8		
	Cleaning plan in place and used?	IATG 06.10, Clause 9.1		

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 07.10

Third edition
March 2021

Surveillance and in-service proof

UN SaferGuard
Securing ammunition, protecting lives

IATG 07.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Surveillance of ammunition is the gathering and assessment of all data on an item of ammunition to determine its condition throughout its life. It includes physical inspection, proof, chemical testing and taking into account reports on its use, ie its accuracy, safety, any accidents or incidents, its age, components and the conditions and climates in which it has been used or stored.

It is undertaken to ensure that the ammunition continues to meet the required quality standards throughout its life. Quality, from this perspective, includes the performance of ammunition during use and its safety and stability during storage and handling. The chemical, electrical and mechanical properties of ammunition change and degrade with time, leading to a finite serviceable life for each munition. The accurate assessment of munition life is of paramount importance in terms of both safety and cost effectiveness.

All ammunition and explosives should be formally classified as to their condition, which requires a surveillance and in-service proof system. The ammunition is then allocated a condition code[3], which defines the degree of serviceability of the ammunition and any constraints imposed on its use.

Surveillance is the systematic method of evaluating the properties, characteristics, and performance capabilities of ammunition throughout its life cycle. It is used to assess the reliability, safety, and operational effectiveness of stocks. Proof is the functional testing or firing of ammunition and explosives to gather data on performance and reliability, ultimately to ensure safety and stability in storage and intended use.

Effective surveillance and proof of ammunition requires a systems approach that will optimise the useful life of ammunition, whilst also significantly improving safety in storage and use towards the end of the life of the ammunition. Such an approach will ensure that optimal return is gained for the significant financial investment that the ammunition represents.

[3] See IATG 03.10 and 07.20.

Surveillance and in-service proof

1 Scope

This IATG module introduces and explains the concept and requirements for a technical surveillance and in-service proof programme to support the safe, effective and efficient storage of conventional ammunition.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module. .

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘proof’ refers to *the functional testing or firing of ammunition and explosives to ensure safety and stability in storage and intended use*.[4]

The term ‘service life’ (or alternatively ‘shelf life’) refers to *the period for which an explosive or device can be stored or maintained under specific conditions before use or disposal without becoming unsafe or failing to meet specified performance criteria*.

The term ‘stability’ refers to *the physical and chemical characteristics of ammunition and explosives that impact on their safety in storage, transport and use*.

The term ‘storage life’ refers to *the time for which an explosive item in specified storage may be expected to remain safe and serviceable within the envelope of service life*.

The term ‘surveillance’ refers to *a systematic method of evaluating the properties, characteristics and performance capabilities of ammunition throughout its life cycle in order to assess the reliability, safety and operational effectiveness of stocks and to provide data in support of life reassessment*. *The constant review of accumulating test results will ensure that the overall quality remains acceptable. The term is also applied to the continuing examination of the stores themselves.*

Within ammunition surveillance and proof, the 'chemical shelf life' determines the maximum period in which a specific ammunition nature remains chemically stable and hence safe for storage and logistical handling under the given storage conditions, whereas the 'operational shelf life' determines the maximum period in which the same ammunition nature remains safe for use and achieves the specified accuracy, performance and reliability requirements. The chemical shelf life normally significantly exceeds the operational shelf life because degradation processes other than chemical ageing may constitute the limiting factor (e.g. physical integrity of solid rocket motors, micro-fissures in propellant grains, corrosion in fuzing systems). The assessment of chemical shelf life is essentially conducted with laboratory analysis of the contained explosive components while the operational shelf life is assessed with physical inspection, live firing and ballistic testing.

[4] In-service proof is really a particular type of surveillance, but it is usually referred to as a separate issue as it requires the live firing of munitions rather than the other technical inspection and chemical analysis components of surveillance.

Example: A tested lot of small arms ammunition may show satisfactory propellant stability and sufficient stabiliser content but may still be banned from operational use due to abnormally high weapon chamber pressures during in-service proof firing tests.

When ammunition producers provide an expiry date, they normally refer to the operational shelf life within the warranty period and under ideal storage condition

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Rationale for surveillance and in-service proof

The safety and stability of ammunition and explosives in storage can only be established by a comprehensive ‘ammunition surveillance’ system that uses a methodology of both physical inspection by trained personnel and chemical analysis. The surveillance is carried out systematically by evaluating the characteristics and properties the ammunition type possesses and measuring how the ammunition performs throughout its entire life cycle. This will in turn allow assessment of the safety, reliability and operational effectiveness of the ammunition. Only then can safety in storage be properly assessed. The use of ‘ammunition surveillance’ can then be used to extend ‘shelf life’ if appropriate. Shelf life extension if appropriate may provide significant financial savings as there will no longer be a requirement to procure new ammunition.

The introduction of a surveillance and in-service proof system mid way through the service life of a munition should always be considered, as results from such a system may enable an extension of the initial in-service life. The life cycle costs of the munition would therefore be reduced with sub-sequential financial benefits as procurement of new stock could then be delayed.

Ammunition is subjected to technical surveillance and in-service proof for a wide range of reasons. It is a vitally important component of responsible ammunition stockpile management and is the only way that the safety and stability of ammunition stockpiles can be properly addressed. Major reasons include:

a) to ensure the safety and stability of ammunition during storage, handling and transportation;

b) to ensure the safety, reliability and performance of ammunition during use;

c) the requirement to predict, and therefore prevent, ammunition failures that are inherent in their design or are the result of ageing;

d) to monitor the environmental conditions the ammunition has been stored in;

e) to ensure that the first point of detection of catastrophic failures is not the user;

f) to predict failure and degraded performance, thereby supporting effective ammunition procurement cycles;

g) to predict future performance and service life and limitations;

h) to extend the in-service life of ammunition beyond that which would be possible without such a system; and

i) to identify and monitor critical characteristics of the ammunition that change with age and exposure to the environment.

States should therefore allocate the same level of priority to the development and implementation of an effective surveillance and proof system programme as they do, for example, to the physical protection of ammunition stocks.

5 Requirements for effective surveillance and in-service proof

An effective system of surveillance and in-service proof requires an integrated range of capabilities and mechanisms to ensure overall system efficiency and effectiveness. These are:

a) an effective ammunition management plan;

b) trained, qualified and experienced technical staff;

c) a capable explosives laboratory;

d) effective sampling mechanisms; and

e) an efficient ammunition accounting system.

Once these capabilities and mechanisms are combined with knowledge of the likely failure mechanisms of an item of ammunition, then decisions may be taken on the extension of the in-service life of a munition, or the need for early use at training, demilitarization or destruction.

6 Responsibilities for in-service proof and surveillance (LEVEL 2)

The appropriate national technical authority should be responsible for:

a) the development and promulgation of an in-service proof and surveillance plan for each munition type in the national inventory;[5]

b) ensuring that the plan is carried out;

c) the analysis of results and tests;

d) ensuring that ammunition is allocated the appropriate condition code;[6]

e) the rapid identification of stocks that are unsafe to either use or store; and

f) ensuring that the disposal of life-expired stocks takes place within an expedient time period following in-service proof and surveillance.

g) The surveillance and proof tasks can be mandated to different entities to carry out specific tasks at different stages of TLM. The overview of tasks linked to the phases of TLM can be found in *01.35 Organizational Capabilities, chapter 3.5*

[5] This could be included in the Ammunition Management Policy Statement (AMPS), or equivalent document. See IATG 03.10 *Inventory management*, Clause 6.2.4 and Annex C for further details of AMPS.

[6] See IATG 03.10 *Inventory management*, Clause 18 for further details of Condition Codes.

7 Ageing and degradation of ammunition

For most ammunition, one or two of the degradation mechanisms will limit its available life. Some of the more common failure mechanisms are (but are not limited to):

a) energetic materials:
   - de-bonding between the material and inert surfaces;
   - stabiliser depletion within the energetic material, (see Clauses 7.3 and 12);
   - migration of compounds within the energetic material;
   - cracking of brittle materials; and/or
   - compatibility problems.

b) electronics:
   - component ageing; and/or
   - component shock damage.

c) structure:
   - mechanical damage (impact, corrosion);
   - vibration; and/or
   - failure of seals.

In addition to the physical damage caused by shocks and vibration, munitions can degrade chemically. The energetic items that cause the explosive effect are invariably of organic chemical composition and, in common with all other chemical compositions, breakdown, migrate or change over time. This change is normally accelerated with increased temperatures. Degradation will also be hastened by:

a) large variations in temperature (diurnal cycling, e.g. night-to-day, cycling from hot to cold);

b) low temperatures;

c) high or low humidity;

d) vibration;

e) shock; and/or

f) pressure.

The conditions in that a munition is stored, maintained and transported during its normal in-service life will eventually have an impact on the munition and a critical failure mode will be reached, which will be the service-life limiting factor.

7.1 Design evaluation

Potential life-limiting features of a munition may be predicted during the design evaluation stage of its development. Fatigue and corrosion of components parts can be predicted, and small-scale laboratory testing of energetic materials should be used to determine baseline properties that will affect the in-service life. This should usually be undertaken by the manufacturer, who should provide this information to the appropriate national technical authority. This information should also be supplied as a standard requirement to the national technical authority of a country to which ammunition is exported.

7.2 Baseline data

Baseline data should be obtained from research, studies and tests to estimate potential failure modes of a munition. This data is very useful for comparative purposes during a subsequent in-service proof and surveillance system. Data may be obtained from:

a) manufacturer's test results;

b) manufacturer's proof results;

c) explosive safety assessment data;

d) accelerated aging tests;

e) component fatigue tests;

f) measurement against known norms, such as propellant master standards;

g) test results from other nations, including proof and test results; accident reports; defect and other incident reports;

h) explosive hazard data sheets; and

i) compatibility data.

Without access to much of this data subsequent in-service proof and surveillance cannot be optimised, which may reduce the in-service life of the munition as safety during storage and use cannot be as efficiently assessed.

7.3 Climatic impact on the degradation of explosives

The effects of weather, hot temperatures, direct solar radiation, daily temperature changes (diurnal cycling) and high humidity may rapidly degrade the performance and safety of explosives. Ammunition is designed for use under stated climatic conditions, and its service life will be significantly reduced if it is stored under climatic conditions that it was not designed for. In some cases, the ammunition may rapidly become unserviceable and dangerous to use.

In the Middle East recorded temperatures have ranged from -1^{0}C to +31^{0}C in the winter months and from +22^{0}C to +51^{0}C in the summer months. This means that the ammunition can be exposed to daily diurnal cycles of up to +32^{0}C in the winter months and +29^{0}C in the summer months. These are usually considered as extreme ranges for ammunition, and a reduction in service life shall be expected. Yet, these temperatures are ambient air temperatures and do not take into account the effects of direct solar radiation on ammunition or on packaged ammunition.

Tests have shown that when fully exposed to the sun that the temperature on the external surface of the ammunition can be as much as 50^{0}C higher than the ambient air temperature. This means that ammunition could theoretically reach external surface temperatures of 101^{0}C in the Middle East. It should be noted that the melting point of TNT based explosives is approximately 80^{0}C; the very real danger of using TNT ammunition at this temperature cannot be overstated.

An example of the impact that such storage conditions have on ammunition is the chemical deterioration of propellant. During prolonged periods of storage, the rate of chemical deterioration of propellant is at least doubled[7] for every 10°C rise in temperature above 30°C. Most propellants, dependent on design, have a shelf-life of at least 15 to 40 years when stored at a constant 30°C, and will last much longer in temperate climates. In high heat environments, the stabiliser is depleted far quicker and the probability of spontaneous combustion due to autocatalytic ignition becomes much higher. It has to be emphasized, that surveillance of propellants according to AOP-48 does not provide data on the operational shelf life. The result of a surveillance test on a propellant following AOP-48 (stabilizer depletion) or STANAG 4582 (heat flow calorimetry) provides guidance, if criteria are met for a safe ten-years-interval for next inspection or not.

Propellant lots shall not be given a predicted overall chemical shelf life based on one single testing campaign. Instead, the residual stabiliser content and prevailing storage temperature shall be used to determine the safe time interval until the next surveillance campaign for this specific lot must occur. Higher storage temperatures shall invariably lead to a shorter time interval in order to prevent accidental auto-ignition between scheduled surveillance campaigns.

Where no initial safe interval is available, the stabilizer depletion rate for a specific propellant should be established with a set of two testing campaigns within a limited time period and then corrected to the prevailing storage conditions.

There is some evidence that suggests that the reduction in shelf life versus temperature is as shown in Table 1. There are two columns with different assumptions on the acceleration of aging induced by increased storage temperature. An acceleration factor three is recommended for conservative strategy. Values in this table have to be regarded as an illustrative rule of thumb and planning tool for inspection periods of propellants exposed to climatic stress.

Temperature	**Safe interval for next inspection with a determined interval of 10 years at 25°C [days]**	
	Acceleration factor/10°C: 2	Acceleration factor/10°C: 3
30°C	2581	2107
35°C	1825	1217
40°C	1290	702
45°C	913	406
50°C	645	234
55°C	456	135
60°C	323	78
65°C	228	45
70°C	161	26
75°C	114	15
80°C	81	9
85°C	57	5
90°C	40	3

Table 1: Propellant degradation due to high temperature

Ammunition could theoretically reach external surface temperatures of 101^{0}C in the Middle East, although internal temperatures would be substantially less. Propellant degradation and stabiliser depletion is not linear, and the decay rate reduces during the night when the ammunition cools. Inappropriate storage conditions for propellant in these types of temperature extremes is detrimental and will require extensive surveillance to ensure stability in storage. States with hot climates should therefore ensure that effective systems are in place in explosive storehouses to keep ammunition within acceptable 'temperate' limits.

8 Ammunition quality standards

The national technical authority should assess, on a regular basis, the appropriate quality level required for the national stockpile and ammunition that falls below this quality level should be destroyed. The quality should be assessed using all data from surveillance programmes (ie, inspection, proof etc) and any reported incidents concerning the ammunition, eg accidents, faults etc.

Table 2 contains example ammunition quality standard levels that the national technical authority may wish to adopt:

a) the Standard Acceptance Limited Quality (SALQ) is the minimum quality standard for ammunition accepted into operational service;

b) the Functional Limited Quality level (FLQ) is the minimum quality standard for ammunition that may be used operationally. Any ammunition used operationally below this quality level will have a significant impact on operational efficiency; and

c) the Operational Limited Quality level (OLQ) is the minimum quality standard for ammunition to remain in service for either operations or training. Any ammunition that falls below this quality standard should be removed from service and destroyed.

Ammunition Type	SALQ	FLQ	OLQ
Small Arms Ammunition (SAA)	99%	96%	92%
High Explosive (HE) Ammunition	97.5%	92%	85%
Ammunition for Training	92.5%	85%	75%

Table 2: Suggested ammunition quality standards

Note: The national authority may choose much lower limits depending on local factors, eg if new stocks cannot be purchased due to lack of funding.

9 In-service proof

9.1 Background

In-service proof is a technique that is applied to many weapon systems. For example:

a) guns, mortars and small arms have their muzzle velocity, chamber pressure, firing interval, range, target penetration and accuracy assessed;

b) grenades and mines have their delay time and reaction to functioning stimulus assessed; and

c) pyrotechnics and rocket motors have their time of burning, chamber pressure and thrust assessed.

The proof assessment of direct fire weapons should be based on the ability of the munition to hit and function in a satisfactory manner against the agreed standard targets at the required ranges. For indirect fire weapons the assessment should be based on the effectiveness of observed fire measured against standard criteria. In both cases, the munition will usually be conditioned to a standard temperature prior to firing to ensure consistency of results and to allow for cross comparison of results.

In-Service proof should be used to provide an assurance of the continued satisfactory performance of an ammunition type. It should also assist in predictions of how long it will be before the performance falls below the level at which operational efficiency will be significantly impaired. This can then be used to inform procurement decisions. The measured performance is plotted against time and an estimate made of when the performance will no longer be acceptable. This may be sooner than the design life would predict or, more usually, later (because the original estimates of life are often conservative).

Proof results and data should not be used in isolation to determine the serviceability of ammunition stocks. Other surveillance results, such as stabiliser content of propellant, should also be considered before making decisions to extend or reduce the service/shelf life of a munition.

The national technical authority should have the authority to extend the service life of a munition after analysis of test results has indicated that the munition still falls within acceptable performance parameters.

9.2 Proof schedule (LEVEL 3)

A schedule should be developed and implemented for each generic type of munition in the national inventory. Table 3 contains such a schedule with explanatory notes:

Schedule Requirement	Explanatory Notes
Safety	▪ Additional specific safety requirements that may be necessary.
Sample size and selection	▪ The sample size shall be dependent on the lot or batch size. It shall be selected to ensure statistical validity. ▪ The sample size should be as small as possible consistent with the level of safety, performance and reliability assurance required. ▪ Sampling shall be in accordance with the appropriate ISO sampling standards contained within Annex A.[8] ▪ The proof sample shall be taken at random from the selected lot or batch.
Sequence of testing (if appropriate)	▪
Pre-proofing inspection	▪ Physical inspection requirements.
Preparation and conditioning of ammunition prior to test	▪ Ammunition held at what temperature and for how long?
Proof procedure and parameters to be recorded	▪ Detailed operating procedures.
Post-proofing inspection	▪ Physical inspection requirements for the particular type of ammunition. (See Annex C).
Authority and criteria for acceptance, reproof or rejection	▪ This shall be clear and unambiguous. Where reproof is allowed the exact authority for reproof shall be clearly stated.
Criteria for suspension of proof and retention of defective components	▪ As above.
List of proof equipment required	▪
Proof equipment control	▪ Calibration requirements.
Tolerance on parameters and measurements	▪
Evaluation of results	▪
Disposal instructions for items remaining after proof tests	▪

Table 3: Example in-service proof schedule

[8] Sample selection is a complex issue, which requires a high level of expertise in statistical analysis. The level of detail required for accuracy is beyond the scope of this IATG and professional statistical analysis advice shall be sought when developing the sample size.

9.3 Recording proof results (LEVEL 3)

The results of in-service proof should be recorded on a standard form designed to contain all the information required by the proof schedule. The format should be included in the proof schedule; an example form is at Annex D.

10 Surveillance (LEVEL 2)[9]

Surveillance can be summarised as the process of conducting regular checks on the actual condition of the munition inventory. It can then be used to confirm initial in-service life predictions and enable extensions to the in-service life.

Surveillance requires the gathering of data, the physical inspection of munitions and sometimes the chemical testing of energetic material properties. The testing can involve techniques such as x-ray inspection or other non-destructive testing methods. Alternatively, it may simply be a visual inspection. Because failure to ensure chemical stability can lead to disastrous consequences, it is treated separately, and guidance is given below. An effective surveillance system should be able to confirm or assess:

a) the environmental conditions to which munition systems have been exposed during their storage and deployment to date. This information can be used to confirm either munition stock records or data from environmental data loggers;

b) any physical degradation of the condition of the munition;

c) any degradation of munition and component performance, which is possible through:

   - recording and monitoring reliability and defect reports concerning in-service usage of the munition system;
   - carrying out functional proof (performance) firings; and/or
   - gathering performance data during training use.

d) changes in the physical and chemical characteristics of energetic materials and non-energetic materials judged to affect the life of the munition.

The design of the surveillance programme should be determined by the complexity of the munition and the likely failure mechanisms. Analysis of these factors should then determine the types and frequency of inspections and tests that are required to make assessments of future in-service life.

11 Selection of munitions for in-service proof or surveillance

The selection mechanism for the surveillance of munitions should be included in the in-service proof and surveillance plan, or equivalent document, for each type of munition. It should be primarily based on the following criteria:

a) age;

b) exposure to adverse climatic conditions;

c) length of time held by units and not by specialist ammunition depots;

d) ammunition that has displayed unusual performance during training;

[9] Surveillance should be initiated at Level 2 to determine whether any propellant in storage is in an unstable condition. Full surveillance may be a Level 3 activity.

e) number of times handled or transported; and/or

f) number of tests already conducted on the munition.

Ammunition should be selected from the stockpile that has been stored in the most adverse climatic conditions and hence should be the worst case in terms of degradation and ageing effects. Statistical analysis will be required to ensure that a representative and statistically viable number of ammunition items are selected for surveillance.

In many developing countries, where records have either been lost or not kept, the condition of the explosives cannot be effectively assessed. There is then a high risk of undesirable explosive events within ammunition storage areas. In such cases, where stability must be in doubt, then the criteria for assessing such munitions shall be based on:

a) munitions that have been exposed to high temperature during their previous life;

b) age;

c) munitions of unknown origin;

d) munitions of unknown composition;

e) munitions where there is suspected deterioration; and

f) munitions that exhibit unusual characteristics such as discoloration or staining.

Consideration shall be given to the immediate destruction of such explosives. Alternatively, they should be sampled and subjected to appropriate stability tests as soon as possible. However, until the results of these tests are known, the explosives should be regarded as presenting an increased risk of auto-ignition and as far as practicable should be segregated from other explosives or flammable materials.

WARNING. In the final stages of decomposition, some propellants can give off brown fumes of nitrogen dioxide. This is an extreme situation and indicates that auto-ignition is imminent and that a fire could occur at any time.

Ammunition recovered during post-conflict operations from abandoned stockpiles should be destroyed and not considered for inclusion in a stockpile under any subsequent security sector reform programmes. Unless an effective surveillance and in-service proof system has survived the conflict, the time and costs of implementing one are unlikely to be a cost benefit when compared to the procurement of new ammunition with known safety standards.

12 Environmental monitoring and recording (LEVEL 3)

Environmental monitoring should be conducted to accurately record the environmental conditions that a munition is subjected to during its service life. The more accurate the monitoring, the more accurate predictions can be made of safe in-service life, and hence the best value for money can be gained for that particular ammunition type. Results from environmental monitoring can be used to develop and update ageing algorithms as more data is obtained.

This data also provides benefits to the state by:

- Safety & Performance: giving a greater understanding of current munition conditions in relation to their capability to safely and reliably meet mission objectives. The acquired data and knowledge will in turn be used to assess the safety and suitability of munitions as well as provide recommendations on the employment, shipment, and reconstitution of munitions.

- Hazard Mitigation: identifying early potential hazards, such as high humidity or high temperature, enabling the timely implementation of preventive measures that will reduce or stop munition environmental degradation or incidents. Additionally, the type of qualification tests required can be identified to assess the munition against the identified hazards. For example, if certain types of munitions are exposed to high temperatures for long periods of time, High Performance Chromatography tests can be conducted to assess the safety of the propellant

- Availability – providing improved knowledge of remaining munition systems safe service life.

Effective environmental monitoring should be conducted using electronic data loggers in the explosive storehouses, although time-temperature indicator strips may be used as a less expensive option.

The level and frequency of monitoring should be assessed as early as possible in the service life of the munition and included in the Ammunition Management Policy Statement (AMPS). The type of munition and likely failure mechanisms should influence the level and frequency of monitoring. For simple and inexpensive ammunition held in large quantities with a high consumption rate, such as small arms ammunition, the surveillance requirement may be considered to be low. In contrast, for expensive and complex munitions with a low consumption rate, such as guided weapons, more detailed surveillance could result in significant long-term cost benefits.

Environmental data should be stored in a central system within the appropriate national technical authority as part of a Munitions Life Assessment Database (MLAD). This system should be made available to all stakeholders in the surveillance and in-service proof system.

13 Chemical stability of propellant[10]

13.1 Chemistry of propellant

The most extreme example of chemical degradation of stability is that of nitrate ester based propellants, which at the end of their safe lives, will become chemically unstable, possibly causing auto-ignition; often resulting in the loss of a storehouse. Most gun and many rocket propellants contain nitrate esters such as nitrocellulose and nitroglycerine. Whereas batch to batch differences can be blended out during manufacture to give satisfactory proof results, this cannot be done for chemical stability and the safe life shall be determined by the stability of the least stable single grain of propellant in a charge. Chemical stability is also critically dependent on the storage conditions undergone by any particular munition. Hence, sampling for chemical stability testing shall be much more rigorous than for proof. Every lot or batch should be sampled when it reaches its first test date.

Propellants in the ammunition of many developing countries are likely to be either Single Base, containing only nitrocellulose as the energetic component, or Double Base, containing both nitrocellulose and nitro-glycerine as energetic components. Even if the propellant is kept in ideal storage conditions, these components will begin to decompose over time to form oxides of nitrogen, mainly dinitrogen tetroxide. If these oxides of nitrogen are not removed from the propellant as they are formed, they will catalyse further degradation. This is an example of autocatalytic decomposition since the free radicals being formed accelerate the chemistry creating more free radicals, which, therefore, causes further degradation and so on.

One factor that can increase the rate of chemical reaction is temperature. Thus, any increase above 20ºC will have an adverse effect on the storage life of propellant. (See Clause 7.3).

This autocatalytic decomposition of propellants is a serious safety issue, as it is known to lead to spontaneous ignition during storage, usually resulting in the loss of one or more explosive

[10] See Druet L and Asselin M. *A Review of Stability Test Methods for Gun and Mortar Propellants; The Chemistry of Propellant Ageing.* DRE Valcartier, Quebec, Canada in *Journal of Energetic Materials*, 6: 1, 27-43. 1988.

storehouses. To prevent this occurrence, chemical additives are introduced into the propellant formulation and are known as stabilisers. They slow the degradation process of the nitrocellulose and nitro-glycerine by removing the oxides of nitrogen, which would cause it to happen. The stabiliser reacts chemically with these oxides removing them from the system. Of course, in doing this, the stabiliser will slowly be consumed.

Thus, the reduction in stabiliser content will lead to a point where it becomes insufficient to guarantee chemical stability and this should be a measure of the safe storage life of that propellant. Both chemical analysis and instrumental methods can be employed to measure the stabiliser content, the latter being a more recent advance in propellant analysis.

There are several chemicals which are used routinely as stabilisers. One example is diphenylamine (DPA), which has been used in Single Base propellants (and some double based propellant and SAA) from the early years to the present time. Chemically it behaves as a base, reacting with the initial decomposition products of nitrocellulose, initially to form nitrosodiphenylamine, which is then converted into various nitro-derivatives of diphenylamine. This stabiliser is too basic to be used if nitro-glycerine is present and therefore is only sometimes used in Double Base propellants. Instead an example of the stabiliser used is diphenyldiethylurea such as carbamite or ethyl centralite. This acts as a weak base reacting with the decomposition products, again to form nitro- and nitroso-derivatives. The overall chemistry of the action of stabilisers is extremely complex but the end result is to keep the propellant chemically stable.

13.2 Propellant stability tests[11] (LEVEL 2)

Traditional chemical methods of analysing for stabiliser content of propellants by accelerated ageing are relatively slow requiring a day to carry out the test. Thus, the total number that can be done will be completely dependent on the number of apparatus available and the size of laboratory in which to house them. Accelerated ageing is achieved by carrying out tests at elevated temperature and this is can be done by several methods used in different countries, as summarised in Table 4. These tests should be carried out by trained chemists in a properly constituted laboratory. As some of these tests take many hours a back-up power system should be immediately available to the explosives laboratory.

Test	Requirements / Comments
Abel Heat	▪ Qualitative Assessment of stabiliser content levels. ▪ Requires that samples of between 1 and 2 g are heated at temperatures in the range 60-85ºC (depending on the specific source of the test and which propellant is being tested). ▪ The results are obtained in a matter of minutes, typically no longer than 15 minutes. Sentencing for retest is then obtained from tables, for example, if the time for the test is over 10 minutes then retest in 3 years. The time is the number of minutes from the start of the test until a colouration is seen on a standard test paper. ▪ This may seem simple; however, to obtain reliable results requires a high degree of skill at carrying out this particular test.
Bergmann-Junk	▪ Easily within the capabilities of chemical analysts and can be carried out in one day. ▪ In this test, the sample is heated at 132ºC for 5 hours for Single Base propellants or at 115ºC for 8 or 16 hours for Double Base propellants. The gases evolved are absorbed into a hydrogen peroxide solution and then the acidity is titrated against a standard sodium hydroxide solution. ▪ Practically, this is a reasonably simple test to perform.

[11] See Annex B for background references on specific tests.

Test	Requirements / Comments
Colour	▪ Used to rely on visual inspection and assessment of the propellant against standard colour solutions. ▪ Recently spectrophotometry techniques have been developed which have improved effectiveness of this test.
German	▪ Propellant is heated at 134.5C (single base) or 120C (double base). ▪ The operator constantly observes the propellant to identify; 1) when nitrogen oxides detected using detector paper; 2) nitrogen oxides visually observed; and 3) deflagration of the sample. ▪ Tables are then used to determine results.
Methyl Violet	▪ The sample is heated under standardised conditions in a test tube until nitrogen oxides above the sample are detected by means of a standard methyl violet paper. The time elapsed from the start of heating until the detection is then recorded as a chemical stability value.
NATO 65.5^{0}C	▪ A primary tool for stability testing. It is an accelerated aging process, known as the 'fume test'. ▪ It is designed to pre-empt the auto-ignition of propellant in storage by forcing it to happen much earlier in a laboratory. When a tested propellant lot's 'days to fume' reaches a defined minimum level, all quantities of that lot, wherever stored, should be immediately destroyed.
Silvered Vessel	▪ The time for a sample, maintained at 80°C, under specified conditions to produce brown fumes or to self-heat to give a 2°C rise in temperature is recorded. This occurs when the effective stabiliser has been consumed and autocatalytic reactions have commenced.
Vielle	▪ Assesses rate of decomposition. A very lengthy procedure in which a sample is heated at 110ºC for 8 hours or until a standard tint is seen on a litmus test paper. The sample is then left overnight on a tray in the open. This is repeated day by day until it takes only one hour until the standard tint is seen. At this point, all the times from each day are added and the total time recorded used to assess the period before retest from standard tables. ▪ This test, therefore, can take weeks before a result is obtained. If at any time during the elevated temperature phase of the test there is a loss of heating such that the temperature falls more than a few degrees for a short time then the whole test becomes invalid. This could happen after a long period as the test duration is so long and thus much time would be wasted in the test programme.
VST (Vacuum Stability Test)[12]	▪ The vacuum stability test is used to assess the thermal stability of an explosive or propellant by measuring the volume of gas evolved on heating the explosive or propellant under specified conditions. ▪ A sample of the explosive compound is heated at a constant specified temperature for 40 hours in an evacuated tube. The volume of gas evolved is determined by measuring the variation of the pressure in the tube. ▪ The test is applicable to solid high explosives, propellants and pyrotechnics used in conventional armaments
HFC (Heat Flow Calorimetry)[13]	▪ The aim of this method is to test the stability for single base (SB), double base (DB), and triple base (TB) propellants using heat flow calorimetry. ▪ This STANAG describes a method for establishing the chemical stability of the propellants for a minimum of 10 years when stored at 25°C

Table 4: Propellant stability chemical tests

[12] Annex B: STANAG 4556 (Explosives: Vacuum Stability Test) ed. 1 from 22.11.1999

[13] Annex B: STANAG 4582 (Explosives, nitrocellulose bases propellants, stability test procedure and requirements using Heat Flow Calorimetry) ed. 1 from 09.03.2007

A more efficient method to increase the analysis of stabiliser content should be to move to a physical method, as summarised in Table 5. The High Performance Liquid Chromatography (HPLC) tests should be carried out by trained chemists in a properly constituted laboratory, whilst the Near Infra Red (NIR) and Thin Layer Chromatography (TLC) tests both have field expedient equipment available that is capable of adequate testing.

Test	Requirements / Comments
High Performance Liquid Chromatography (HPLC)	▪ A sample of the extracted stabiliser(s) is passed through a micro-bore column eluted by a solvent and the time taken by different materials to pass through the column separates them at the exit. A detector can then measure quantitatively the amount of stabiliser in that sample. ▪ To obtain the sample, a known weight of propellant under test has the stabiliser extracted by solvent in an ultrasonic bath. ▪ The time for the HPLC to carry out an analysis is approximately 10 minutes and the sampling of the prepared solutions can be carried out by an auto-sampler, thus, the throughput is 6 samples per hour. The ultrasonic bath will easily keep pace with the HPLC. It is estimated that one HPLC system would be capable of analysing 10,000 samples in a year. ▪ Requires a comprehensive, effective and efficient means of taking propellant samples from depot and unit storage and transporting to a central propellant surveillance laboratory.
Near Infra Red (NIR)[14]	▪ A non-destructive system that can test approximately 10 samples an hour. It consists of a spectrometer, a laptop computer and an uninterruptible power supply. ▪ The operator loads propellant into a removable cell and places the cell into the unit's transport module. The optical window-side of the cell faces a tungsten-halogen light source as the cell moves through the light. Any differences in the sample, such as colour, size, shape, or grain orientation, are averaged. The light is reflected onto detector elements of silicon and lead sulphide. Differences in the reflected light patterns (spectra) indicate varying stabiliser levels. These spectra are compared to predictive chemo-metric models of the same propellant type that are stored in the computer. ▪ The results of these comparisons indicate if the sample's stabiliser level is at or below the cut-off level that requires more extensive analytical testing. ▪ The disadvantage of the system is that it requires the chemical characteristics of the propellant to be pre-loaded into the system, and therefore it currently covers only US manufactured propellants.
Thin Layer Chromatography[15]	▪ A miniaturised wet laboratory system with single-person portability. The TLC test kit can be used to test for safe levels of stabiliser in solid propellants that are stabilised with diphenylamine, 2-nitrodiphenylamine, ethyl centralite, or Akardite II. The ability to analyse all four of the most-used stabilisers makes it a useful system. ▪ Unlike column chromatography approaches, such as HPLC, that can only process single samples sequentially, a single TLC plate can accommodate and analyse multiple samples and standards. Samples are chromatographed simultaneously in a solvent tank, separating the stabiliser analytes from the sample matrix. Semi-quantitative assessments with nanogram detection limits are readily obtained by inspection of the plates. The kit is designed and equipped with sufficient supplies and equipment for the analysis of up to 30 individual samples by a single operator per day. ▪ Once the chromatography is completed, the resolved propellant stabiliser components that appear as separated spots on the TLC plates are further enhanced by colouring with a unique reagent if the samples are

[14] US Ammunition Peculiar Equipment (APE) 1995. See Elena M Graves. *Field-Portable Propellant Stability Test Equipment*. Army Logistician, PB-700-08-04, Volume 40, Issue 4. USA. July – August 2008.

[15] US TLC Propellant Stability Test Kit.

Test	Requirements / Comments
	diphenylamine or 2-nitrodiphenylamine stabilised propellant types. If stabilised with ethyl centralite or Akardite II, the spots are viewed under the ultraviolet light that is fitted to the camera box. A further quantitative analysis could be performed using the digital imaging box, camera, and data acquisition equipment, such as for the HPTLC. ▪ The major advantages of the TLC method are simultaneous chromatography of multiple samples and standards, extremely low detection limits, the ability to calculate within a given range, and simplicity of operation.

Table 5: Propellant stability physical tests

14 Chemical stability of explosives

Most high explosive compositions have good chemical stability over long periods and give no cause for concern, but satisfactory results of performance, e.g. proof testing of stores, are not related to, and give no indication of, the stability of the explosives involved.

Nitrate ester-based explosives are liable to decomposition (see Clause 13) but many other explosives are extremely stable under normal storage conditions. Thus TNT, RDX, TATB, etc. and many other pyrotechnics and primary explosives will remain stable for many years, particularly if they have been manufactured to a high standard of purity and have been stored correctly in a controlled environment. However, it is essential that all new unfamiliar explosives and explosive compositions are assessed for chemical stability and changes in sensitiveness.

15 Stability surveillance system (LEVEL 2)

15.1 Information requirements

Proper sampling techniques should be used so that representative samples of the explosive stocks are obtained. For any system to operate successfully it is essential that the information on which it is based is reliable. The following information should be recorded for each quantity of explosives in order to maintain the necessary surveillance over the stability of the explosives concerned:

a) date of manufacture of the explosive;

b) batch or lot number, including manufacturer's monogram;

c) nomenclature of explosive composition;

d) form in which the explosive is held;

e) quantity held;

f) date by which next stability test or destruction required;

g) type of stability test required; and

h) the current storage location of the explosive.

Explosives that have been subjected to high temperatures should also be clearly identified within the recording system.

15.2 Stability test schedule

The test schedule should be determined by the type of explosive compositions present in the national inventory. The test schedule shown in Table 6, although an example, is based on the best current information available. It ensures that the tests are credible, whilst reducing the amount of work required for effective stability testing to the minimum necessary for explosive safety.

Explosive / Propellant	First Test	Test Type	Retest Interval[16]
Nitroglycerine (NG) and other Liquid Nitrate Esters[17]	At manufacture	Abel Heat	3 months
Casting Liquid with Stabiliser	At manufacture	Abel Heat	12 months
Dry Nitrocellulose (NC) or Dry NC/NG Pastes[18]	Within 1 month of drying	Abel Heat and Bergmann Junk	3 months
Wet Nitrocellulose	6 months	Abel Heat	6 months
Wet NC/NG Pastes	At manufacture	Abel Heat	3 months
Dynamite and Blasting Gelatin	12 months	Abel Heat on extracted NG	12 months
Triple Base Gun Propellants	As determined during qualification[19]	Stabiliser Depletion[20]	10 years
Extruded Double Base Propellants	As determined during qualification	Stabiliser Depletion	10 years
Double Base Powders	As determined during qualification	Stabiliser Depletion	10 years
Single Base Powders	As determined during qualification	Stabiliser Depletion	10 years
Experimental and other Foreign Propellants	As determined during qualification	Stabiliser Depletion	10 years
Rocket Propellants	As determined during qualification	Stabiliser Depletion	10 years
Casting Powders	At manufacture	Stabiliser Depletion	10 years

Table 6: Propellant stability test schedule (example)

[16] Although this shall be determined by test results. The time shown is that expected, although this may be significantly reduced for older explosive compositions.

[17] NG should not be stored for any length of time in the pure form. If it fails the Abel Heat Test at manufacture (less than 10 minutes) it shall be immediately destroyed.

[18] Dry NC should not be stored for any length of time. It should be wetted with water or alcohol to reduce the hazard. The storage temperature is critical below 15^{0}C as the NG freezes below 13^{0}C and shock sensitivity then becomes a significant issue.

[19] Qualification is the process by which an explosive is tested after manufacture and prior to acceptance into service. It involves a further range of sensitivity and stability testing that is usually a manufacturer's responsibility.

[20] Select appropriate test from Table 4 or 5.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA. 2015;

b) IATG 03.10 *Inventory Management*. UNODA. 2015;

c) IATG 06.40 *Packaging and marking.* UNODA. 2015:

d) ISO 2859 *Sampling procedures for inspection by attributes;*

e) ISO 3951 *Sampling procedures for inspection by variables;*

f) ISO 8422 *Sequential sampling plans for inspection by attributes;*

g) ISO 8423 *Sequential sampling plans for inspection by variables for percent nonconforming (known standard deviation);*

h) ISO/TR 8550 *Guide for the selection of an acceptance sampling system, scheme or plan for inspection of discrete items in lots;*

i) ISO/TR 10017 *Guidance on statistical techniques for ISO 9001:2000;*

j) ISO 11453 *Statistical interpretation of data - Tests and confidence intervals relating to proportions;*

k) ISO 13448 *Acceptance sampling procedures based on the allocation-of-priorities principle (APP);*

l) ISO 14560 *Assessment and acceptance sampling procedures for inspection by attributes in number of nonconforming items per million items;*

m) ISO 16269 *Statistical interpretation of data;*

n) ISO 18414 *Accept-zero sampling schemes by attributes for the control of outgoing quality;*

o) ISO/TR 18532 *A Guide to the application of statistical methods to quality and standardization; and*

p) ISO 21247 *Quality plans for product acceptance - Combined accept-zero and control procedures.*

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UN ODA) holds copies of all references[21] used in this guide. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UN ODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[21] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guide:[22]

a) AOP 48. *Explosives - Nitrocellulose Based Propellants, Stability Test Procedures and Requirements Using Stabilizer Depletion*. NATO Standardization Office (NSO);

b) AOP 62. *In-Service Surveillance of Munitions General Guidance.* NATO Standardization Office (NSO);

c) AOP 63. *In-Service Surveillance of Munitions Sampling And Test Procedures.* NATO Standardization Office (NSO);

d) AOP 64. *In-Service Surveillance of Munitions Condition Monitoring of Energetic Materials.* NATO Standardization Office (NSO);

e) *Conventional Ammunition in Surplus - A Reference Guide.* Small Arms Survey. ISBN 2-8288-0092-X. Geneva. January 2008.

f) Joint Service Publication 762, *Through Life Munitions Management*. MOD. UK. 2005;

g) STANAG 4117 (Edition 3). *Stability test procedures and requirements for propellants stabilised with Diphenylamine, Ethyl Centralite or mixtures of both*. NATO Standardization Office (NSO);

h) STANAG 4315, *The Scientific Basis for the Whole Life Assessment of Munitions*. NATO Standardization Office (NSO);

i) STANAG 4527 (Edition 1). *Explosives - Chemical, Stability, Nitrocellulose based propellants, procedure for assessment of chemical life and temperature dependence of stabiliser consumption rates*. NATO Standardization Office (NSO);

j) STANAG 4541 (Edition 1). *Explosives - Nitrocellulose Based Propellants Containing Nitroglycerine and Stabilized with Diphenylamine, Stability Test Procedures and Requirements*. NATO Standardization Office (NSO);

k) STANAG 4556 (Edition 1) *Explosives - Vacuum Stability Test*. NATO Standardization Office (NSO);

l) STANAG 4581. *Explosives - Assessment of Ageing of Composite Propellants Containing an Inert Binder*. NATO Standardization Office (NSO);

m) STANAG 4582. *Explosives - NC Based Propellants Stabilised with DPA - Stability Test Procedure and Requirements using HF – Calorimetry*. NATO Standardization Office (NSO);

n) STANAG 4620. *Explosives - Nitrocellulose based Propellants - Stability Test Procedures and Requirements Using Stabilizer Depletion*. NATO Standardization Office (NSO);

o) STANAG 4675. *In-Service Surveillance (ISS) of Munitions.* NATO Standardization Office (NSO);

[22] Data from many of these publications has been used to develop this IATG.

p) UK Defence Standard 05-101, Part 1, *Proof of Ordnance, Munitions, Armour and Explosives: Requirements*. UK Defence Standardization. 24 November 2006;

q) UK Defence Standard 05-101, Part 2, *Proof of Ordnance, Munitions, Armour and Explosives: Guidance*. UK Defence Standardization.

r) UK Defence Standard 05-101, Part 3, *Proof of Ordnance, Munitions, Armour and Explosives: Statistical Methods for Proof*. UK Defence Standardization.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UN ODA) holds copies of all references[23] used in this guide. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UN ODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[23] Where copyright permits.

Annex C
(informative)
Guidance on physical inspection of ammunition (LEVEL 2)

C.1 Introduction

The physical (visual) inspection of ammunition is an important component in ensuring the overall safety of the ammunition stockpile. It should be carried out by trained ammunition technical staff who are conversant with the design principles of the ammunition and its modus operandi. This Annex summarises Inspection Points that should be addressed during the physical inspection of ammunition.

C.2 Inspection of ammunition packaging

It is important that the ammunition packaging is inspected as part of the in-service proof as the packaging is a means of: 1) accurately identifying the ammunition; and 2) protecting the ammunition during storage and transport. The following inspection points should be used:

a) the packaging should be marked with the correct details of the ammunition;[24]

b) the metal fitments should be free from oxidation (rust);

c) the package should be intact with minimal external damage; and

d) the seals should be intact.

C.3 Inspection of ammunition

Table C.1 contains inspection points to be checked for the main generic types of ammunition.

[24] See IATG 06.40 *Packaging and marking.*

Generic Type	Determine Rust Level[25]	Correct Markings	Percussion Cap / Primer	Undamaged Cartridge Case	Round/Shell Secure in Cartridge Case	Round/Shell/Munition Body Undamaged	Undamaged Primary and Secondary Cartridges	Undamaged Fins	Undamaged Fuze (If Fuzed)	No Exudation of Explosive/Pyrotechnic Filling	Propellant Uncongealed and Well Distributed	No Discolouration of Charge Container	No Foreign Items In Charge Container	Safety Pin/Wire Secure (If Fuzed)	Fuze Cavity Clear and Clean (If Unfuzed)	Explosive Charge Intact and Unbroken	Good Plasticity (If Applicable)	Wax on Fuze Body (Pyrotechnic Time Fuzes)	No Segment Rotation (Mechanical Time Fuzes)	Ignition System Undamaged	Nose Cap Intact	Base Cap Intact	
Small Arms Ammunition	X	X	X	X	X	X																	
Mortar Ammunition	X	X	X			X	X	X	X	X													
Artillery Ammunition (Fixed)	X	X	X	X	X	X			X	X					X								
Artillery Ammunition (SL)	X	X	X			X			X	X					X								
Artillery Propelling Charges											X	X	X										
Fuzes	X	X				X				X				X				X	X				
Grenades	X	X				X				X				X	X								
Anti-Tank Mines	X	X				X			X	X				X	X								
Pyrotechnics	X	X	X			X				X													
Demolition Charges		X								X		X	X		X	X	X						

[25] See Table C.2.

Generic Type	Determine Rust Level[25]	Correct Markings	Percussion Cap / Primer	Undamaged Cartridge Case	Round/Shell Secure in Cartridge Case	Round/Shell/Munition Body Undamaged	Undamaged Primary and Secondary Cartridges	Undamaged Fins	Undamaged Fuze (If Fuzed)	No Exudation of Explosive/Pyrotechnic Filling	Propellant Uncongealed and Well Distributed	No Discolouration of Charge Container	No Foreign Items In Charge Container	Safety Pin/Wire Secure (If Fuzed)	Fuze Cavity Clear and Clean (If Unfuzed)	Explosive Charge Intact and Unbroken	Good Plasticity (If Applicable)	Wax on Fuze Body (Pyrotechnic Time Fuzes)	No Segment Rotation (Mechanical Time Fuzes)	Ignition System Undamaged	Nose Cap Intact	Base Cap Intact	
Rockets and Missiles	X	X				X		X	X	X										X	X	X	

Table C.1: Inspection points

Rust levels often represent a useful indicator of the overall condition of ammunition. Table C.2 provides an example system that may be used to compare ammunition serviceability against visible rust.

Rust Level (R_L)		% of Rust on Surface Area	Serviceability Assessment	Recommended Action
Code	Summary			
R_L = 1	Little visible rust levels	<5	Serviceable	None
R_L = 2	Medium rust levels	>5	Serviceable	Expend at Training
R_L = 3	Heavy rust levels	>10	Limited Serviceability	Repair Request In-Service Proof
R_L = 4	Very heavy rust levels	>40	Unserviceable	Destroy

Table C.2: Rust identification levels

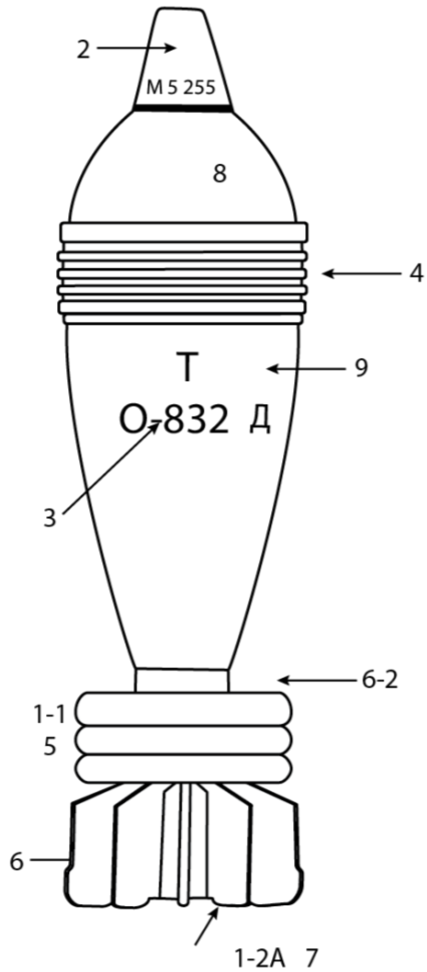
C.4 Inspection and Repair Instruction (I&RI) Example

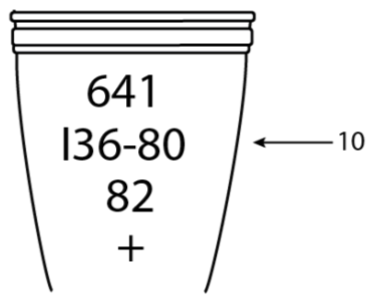
Mortar, 82mm, HE, Model O-832Д fitted with Fuze, PD, M-5

Sub-Process: Inspection of Unpacked Mortar Cartridge

1	Confirm unfired condition and that munition is not a misfire: 1-1 Propellant increments present and/or primary cartridge unfired; 1-2 Percussion cap undented; 1-3 Immediately report any fired or misfired munition to supervisor.	
2	Fuze: 2-1 Confirm fuze is present; 2-2 Check markings of fuze for readability: 2-3 Confirm fuze is of M-5 type; 2-4 Check for signs of exudation or crystallisation, especially around thread; 2-5 Check fuze for splits, dents, cracks and corrosion; 2-6 Confirm that fuze is well fixed to the munition; 2-7 Confirm that there is no gap between fuze body and main body.	
3	Model Designation: 3-1 Check stencilled markings on main body for readability; 3-2 Confirm that model designation is O-832Д; 3-3 Confirm that model designation is not Д -832Д (SMK WP).	
4	Gas Check Bands:	

	4-1 Check gas check band for splits, dents, cracks and corrosion; 4-2 Remove any protective lacquer or grease (where applicable); 4-3 Confirm each ring for exact calibre with calibre gauge; 4-4 Apply protective lacquer or grease.	
5	Propellant increments: 5-1 Remove propellant increments; 5-2 Confirm number of propellant bags; 5-3 Check propellant bags for tear, holes and exiting propellant dust; 5-4 Check propellant for any signs of cracks or physical deterioration; 5-5 Check propellant bags for signs of fungi or biological decomposition; 5-6 Check whether propellant bags feel damp or show any change of colour; 5-7 Check primary cartridge through flash holes for any signs of deterioration; 5-8 Confirm that all flash holes are open and unobstructed; 5-9 Refit propellant bags and check for secure seat.	
6	Tail Boom Assembly: 6-1 Confirm that tail boom is fixed securely to main body; 6-2 Confirm that there is no gap between tail boom and main body; 6-3 Check tail boom and fins for splits, dents, cracks and corrosion; 6-4 Check each fin for straightness and alignment; 6-5 Check fin assembly for outer dimensions with calibre gauge.	
7	Percussion Cap: 7-1 Confirm percussion cap is present and undented; 7-2 Check percussion cap for correct seat; 7-3 Check percussion cap for splits, dents, cracks and corrosion;	
8	Main Body: 8-1 Check body for splits, dents, cracks and corrosion; 8-2 Check body for missing protective paint, mark for later remediation; 8-3 Confirm alignment of components with straightness gauge.	
9	Explosive Filler: 9-1 Check stencilled markings on main body for readability; 9-2 Check type of explosive filler; 9-3 Separate by type of explosive filler.	





10	Production Lot: 10-1 Check stencilled markings on main body for readability; 10-2 Check Lot number and year of filling 10-3 Separate by year of filling	

Annex D
(informative)
Example proof report (LEVEL 3)

In-Service Proof Reporting Form			
Serial			**IATG Form 07.20**
1	**Ammunition Details**		
1.1		ADAC	**34638-27A**
1.2		Description	**Shell 155mm HE L15A2**
1.3		Lot/Batch	**GD 0897 020**
1.4		Date of Manufacture or Filling	August 1997
1.5		Associated Products	Nil
2	**Proof Details**		
2.1		Results of Pre-proof Inspection	Shell was clear of rust with no explosive exudation apparent. In good condition.
2.2		Details of Proof Apparatus	155mm Howitzer Self Propelled 35GA46 155mm Gun Serial Number 23877543
2.3		Climatic Conditions	Ammunition conditioned at 15^{0}C for 8 hours Temperature at time of firing 12^{0}C Fine weather with no wind.
2.4		Proof Results	See Attachment 1 containing: 1. Muzzle Velocities. 2. Chamber Pressures. 3. Projectile Range. 4. Projectile Accuracy.
2.5		Results of Post-proof Inspection	Not Applicable as all Shells functioned as designed.
3	**Certification**		
3.1		This form certifies that the in-service proof has been carried out in accordance with the proof schedule and instructions listed.	Proof Schedule 2009/10/A
3.2		Certifying Individual	Major A D Smith
3.3		Certifying Authority	Proof and Experimental Establishment 12
3.4		Signature	
4	**Distribution**		
4.1		Appropriate National Technical Authority	
4.2		Contractor (where appropriate)	

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 07.20

Third edition
March 2021

Inspection of ammunition

UN SaferGuard
Securing ammunition, protecting lives

IATG 07.20:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module introduces recommended procedures for the inspection of generic types of ammunition. Such inspections may be required; 1) where ammunition has been damaged; 2) where faults and defects in the ammunition type are suspected; 3) as part of a routine inspection or surveillance programme; 4) as a 'Safe to Move' inspection. This IATG module should be consulted in parallel with IATG 07.10 *Surveillance and in-service proof*, which provides more useful information on the rationale for a surveillance regime and the impact of climatic and environmental conditions on ammunition shelf life.

Inspection of ammunition

1 Scope

This IATG module describes the recommended procedures for the inspection of generic types of ammunition. Such inspections may be required; 1) where ammunition has been damaged; 2) where faults and defects in the ammunition type are suspected; 3) as part of a routine inspection or surveillance programme;[3] 4) as a 'Safe to Move' inspection for ammunition that has been involved in an explosion.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Types of inspection

There may be three types of ammunition inspection:

a) Routine, as part of a planned inspection or surveillance programme in the ammunition processing area of an explosives facility. Routine tasks can include:

   i) initial acceptance from the manufacturer;

   ii) preparation of the ammunition for in-service proof firing;

[3] Also see IATG 07.10 *Surveillance and in-service proof*.

iii) prior to issue, including fractioning of the contents of containers;

iv) on receipt of ammunition from unit storage (Returned Ammunition Group task); or

v) special inspection to confirm condition or quality. This may also be a type of Technical Inspection.

A simple inspection checklist is at Annex C for information.

b) Technical, where faults or defects in the ammunition type are suspected. This should usually either; 1) take place in the ammunition processing area of an explosives facility; or 2) during the investigation of an ammunition accident in the field;[4] or

c) 'Safe to Move' (STM), where ammunition has been damaged or subjected to unusual external forces and stimuli (such as an explosion within an ammunition storage area), or where ammunition is to be returned from units to ammunition depots.

All ammunition processing (inspection) operations, with the exception of those undertaken as an EOD task, shall only take place in a building approved for the purpose, IATG 05.20 *Types of buildings for explosives facilities* and 06.50 *Special safety precautions (storage and operations)*.

5 Safety during processing

A risk assessment shall be carried out prior to starting any ammunition processing activity; visual inspection shall count as a processing activity. This should be in accordance with the guidelines contained within IATG 02.10 *Introduction to risk management principles and processes* and the specific requirements of this IATG.

The minimum information of the hazardous properties of the explosive article for processing should be available for the individual carrying out the risk assessment:

a) design drawings;

b) previous processing technical instructions for the type of explosive article;

c) sensitiveness data;[5]

d) chemical stability information;[6]

e) hazard classification codes;[7] and

f) health hazards.[8]

Any risk assessment should start from the perspective of remote processing or testing wherever possible, but if this is considered not to be necessary, or reasonably practicable, then established and tested processes should be used. The risk assessment should direct the selection of the most appropriate tools, equipment and processing to be used. Examples are shown in Table 1:

---

[4] See IATG 11.10 *Ammunition accidents and incidents*.

[5] This should be available from an Explosives Hazard Data Sheet, which is available from the manufacturer.

[6] This should be available from the records maintained in accordance with IATG 07.10 *Surveillance and in-service proof.*

[7] This should be available from the records initiated under IATG 03.10 *Inventory management*.

[8] See Footnote 6.

Findings	Details	Appropriate tools, equipment or process
Explosive dust risk	Bare, exposed explosive will be present during the process; hence explosive dust may be present.	▪ Category B Ammunition Process Building required.[9]
Low sensitiveness[10]	The hazard data sheet suggests that the explosive is very vulnerable to initiation by static electricity.	▪ Anti static measures required. ▪ Non-sparking tools. ▪ Anti-static floor. ▪ Personal earthing equipment.
Explosion risk	Disassembly requires high force to gain access to munition, hence the risk of explosion.	▪ Remote process needed. ▪ Operator protected behind armoured screen.
Irritant fumes	The re-painting process requires the use of paint that produces irritant fumes.	▪ Protective face masks to be worn.

Table 1: Example risk assessment findings

The findings of the risk assessment should be formally recorded, and other documentation amended as necessary, for example:

a) the explosive limits licence[11] may require a temporary reduction in permitted net explosive quantity (NEQ) during the period of the processing task; or

b) standard inspection and repair instructions (I&RI) may require amendment.

All processes used for the inspection and repair of ammunition shall be covered by an inspection and repair instruction (I&RI) (see Annex D to IATG 07.30 *Ammunition processing operations – Safety, risk reduction and mitigation*).

6 Condition classification of ammunition (LEVELS 2 AND 3) [12]

All ammunition and explosives should be classified[13] or reclassified as to their condition, during any inspection process. The ammunition condition is used to define the degree of serviceability of the ammunition and the degree of any constraints imposed on its use.

National authorities should be aware that the declared ammunition 'shelf life' is an indication of the performance capability of the ammunition and not necessarily just its safety or stability in storage; only physical inspection and ammunition surveillance can determine this.

National authorities should therefore develop a system that allows the condition of the ammunition to be clearly defined, as it is only in this way that safe storage conditions may be maintained, and subsequent disposal or destruction can be prioritised.

[9] See Clause 4 of IATG 05.40 *Safety standards for electrical installations* for definition of building electrical categories.

[10] This is not the same as sensitivity. See definitions in IATG 01.40 *Glossary of terms, definitions and abbreviations*.

[11] See IATG 02.30 *Licensing of explosives facilities*.

[12] Also included in IATG 03.10 *Inventory management*.

[13] Best ammunition management practice further recommends that ammunition should also be classified by their Dangerous Goods Classification and UN Serial Number, Hazard Division, Compatibility Group and Hazard Classification Code. (See IATG 01.50 *UN Explosive hazard classification system and codes* for further details).

6.1 Ammunition condition groups and codes

The following groupings and codes at Table 2 could be used as a means of classifying the condition of ammunition stocks:

Condition Type Code	Condition Sub-Type Code	Ammunition Status
A		▪ **Serviceable stocks available for use.**
	A1	▪ Available for issue.
	A2	▪ Available for issue, but subject to a minor constraint.
	A3	▪ Available for issue subject to national technical authority approval.
B		▪ **Stocks banned from use pending a technical investigation.**
	B1	▪ Banned for use but cleared for routine storage and movement.
	B2	▪ Banned for issue and use, and not cleared for movement.
	B3	▪ Awaiting manufacturer's quality assurance reports.
	B4	▪ Shelf life expired.
C		▪ **Stocks unavailable for use pending technical inspection, repair, modification or test**
	C1	▪ Minor processing or repair only required.
	C2	▪ Major processing or repair required.
	C3	▪ Awaiting inspection only ex-unit.
	C4	▪ Manufacturers processing or repair awaited.
	C5	▪ Force regeneration processing required.
D		▪ **Stocks for disposal.**
	D1	▪ Surplus, but serviceable stocks.
	D2	▪ Unserviceable stocks.
	D3	▪ Surplus, serviceable or unserviceable, for demilitarization

Table 2: Ammunition condition classification groups

When ammunition is subject to inspection and surveillance[14], which should be good stockpile management practice, it is inevitable that defects will be found. These defects shall determine within which 'Condition Type' the ammunition item is placed, the Effect Code allocated to it, and how it is categorised according to Table 3:

Defect Type	Effect Code	Ammunition Status
Critical	1	▪ Defects affecting safety in storage, handling, transportation or use.
Major	2	▪ Defects that affect the performance of the ammunition and that require remedial action to be taken.
Minor	3	▪ Defects that do not affect the safety or performance of the ammunition, but are of such a nature that the ammunition should not be issued prior to remedial action having been taken.

[14] The economical surveillance of ammunition and accurate assessment of the quality, within known confidence levels, is achieved by taking a relatively small, random sample from a large bulk quantity.

Defect Type	Effect Code	Ammunition Status
Insignificant	4	▪ Any defect that does not fall into any of these categories, but which could conceivably deteriorate into one of them if no remedial action is taken.
Technical	N/A	▪ Any defect that requires further technical investigation.

Table 3: Types of ammunition defect

Therefore, it is possible that ammunition classified as B4, (shelf life expired), is not an urgent priority for disposal as further technical investigation may well extend its shelf life, and hence it would be re-classified as A for a further period of time.

7 Markings

After any ammunition processing the ammunition (if required) and the packaging shall be clearly marked in accordance with the requirements of IATG 06.40 *Ammunition packaging and marking.* The marking shall identify the work that has been carried out on the ammunition, and the classification code allocated as a result of that work. Additional process markings as at Table 4 may be used:

Marking	Meaning
A	To be added before the components' lot/batch number or BKI if the components are replaced but the batching of the ammunition is unaffected.
R	To be added before the lot/batch number or BKI.
REP	The ammunition container holds ammunition that has been subjected to one of the following: ▪ Maintenance to improve the quality of the ammunition ▪ Modification of the ammunition or ammunition container. ▪ 100% inspection. ▪ Preparation for disposal.
INSP	The ammunition has been subjected to a type of inspection as at Clause 4.
PKD	The ammunition container holds ammunition that has been fractioned for issue or rounds or components have been removed for a repair task.
DES	The ammunition or container has been subjected to a desiccant change.
COND	Any ammunition that is NOT classified as Condition A1 is to be marked on the packaging with COND followed by the condition code.
US/T	Ammunition that has been ultra-sonic tested.
TESTED	Ammunition that has been either: ▪ Heat tested; ▪ Moisture tested; ▪ Acidity tested; or ▪ Plasticity tested.
FAILED TEST	Ammunition that has failed the prescribed test.

Table 4: Additional process markings

8 Seals

All packages containing ammunition or components that have been opened should be sealed with Sealfast or Linen Labels marked with the monogram of the ammunition unit carrying out the task. The national authority should authorise ammunition units to undertake such tasks and provide a list of unique monograms for each unit.

Ammunition that has been sealed by the manufacturer or an authorised ammunition unit should be assumed to have contents within as described on the packaging. This means that unnecessary opening of packaging and resealing is not necessary during stock checks of ammunition.

9 Common inspection points (LEVEL 2)

9.1 Lot / Batch Numbers

Lot and/or batch numbers are to be checked against the lot and/or batch numbers on the ammunition packaging.

9.2 Rust identification

Rust levels often represent a useful indicator of the overall condition of ammunition. Table 5 provides an example system that may be used to compare ammunition serviceability against visible rust.

Rust Level (R_L)		% of Rust on Surface Area	Serviceability Assessment	Recommended Action
Code	Summary			
$R_L = 1$	Little visible rust levels	<5	Serviceable	None
$R_L = 2$	Medium rust levels	>5	Serviceable	Expend at Training
$R_L = 3$	Heavy rust levels	>10	Limited Serviceability	Repair Request In-Service Proof
$R_L = 4$	Very heavy rust levels	>40	Unserviceable	Destroy

Table 5: Rust identification levels

9.3 Fuze covers

Fuze covers are designed to protect the fuze during processing and, if they are not inherent to the standard packaging, they shall be placed over the fuze immediately as the projectile is removed from its packaging

9.4 Fuze plugs

Fuze plugs usually have their bases coated with varnish and do not require over-painting. Plugs that are found unvarnished or with chipped varnish shall be painted with a Lacquer Shellac Lead Free or similar substance.

9.5 Gauging

The following dimensions shall be checked by gauging, using specialist gauges designed, manufactured and maintained for the task:

a) cartridge case diameter;

b) cartridge case engagement in chamber. This shall be done by inserting the cartridge case into a purpose designed chamber gauge, and then passing a steel rule across the base of the cartridge in two directions at right angles to one another. The depth of cap below the face of the chamber gauge shall then be, measured and be within design limits;

c) exploder cavity depth;

d) fuze cavity depth;

e) primer engagement in cartridge case. As for 9.5b above; and

f) projectile diameter.

9.6 Luting[15]

Luting may be applied to fuze threads before the fuze is inserted into the shell or mortar bomb. This provides a moisture seal and assists in locking the fuze in place.

9.7 Torque

The correct torque shall be applied to screw-threaded components when they are inserted into ammunition to ensure that; 1) all threads are engaged and the component is correctly fitted; 2) the components cannot be removed by hand; and 3) they do not become loose during transit or use.

Few components require the use of a specific torque level, so components shall be inserted using an approved tool to a level where they cannot be removed by hand.

10 Specific to type inspection points

Specific inspection points for generic ammunition types are at the following Annexes as shown in Table 6:

Generic Ammunition Type	Annex
Burning Fuses	D
Cartridges Propelling	E
Cartridges Signal	F
Charges Propelling	G
Cord Detonating	H
Demolition Charges	J
Detonators	K
Exploder Pellets	L
Explosives Bulk	M
Free Flight Rockets (<70mm)	N
Fuzes and Gaines	P
Grenades Hand	Q
Igniters	R
Mines (Blast)	S
Mines (Fragmentation)	T

[15] Luting is a mouldable substance to seal a space or to secure two components together.

Generic Ammunition Type	Annex
Mortar Bomb Augmenting Cartridges	U
Mortar Bomb (HE)	V
Mortar Bomb (Smoke and Illum)	W
Mortar Bomb Primary Cartridges	X
Primers and Tubes	Y
Pyrotechnics	Z
Rockets Anti-Tank	AA
Shell HE (Base Fuzed)	AB
Shell HE (Nose Fuzed or Plugged)	AC
Shell (Smoke and Illum)	AD
Shot (APFSDS, APDS and Practice DS)	AE
Small Arms Ammunition	AF
Tank Ammunition (Separate) (APFSDS, HESH)	AG
Tank Ammunition (Fixed) (APFSDS, HE)	AG

Table 6: List of annexes for generic ammunition inspection points

11 Safe to Move (STM) inspections

Ammunition should usually be required as being certified as safe to move (STM), with the provision of an appropriate STM certificate, written or verbal declaration:

a) when being routinely transported in accordance with the requirements of IATG 08.10 *Transport of ammunition*;

b) during routine EOD operations (which fall beyond the scope of this IATG); or

c) during EOD clearance operations after ammunition storage area explosions. (See IATG 11.20 *EOD clearance of ammunition storage area explosions.*

11.1 STM certification – post explosion hazards (LEVEL 3)

The certification of ammunition that has been involved in an explosion will be complicated by some, or even all, of the following hazards:

A) ammunition may have been projected some distance from the explosion site, (e.g. there have been examples of free flight rockets travelling up to 20km). If the ammunition has been stored in a fuzed state, then it is very possible that the forces imparted to the ammunition during the explosion are similar to the forces required to arm the fuze. Normal evidence of firing such as driving band engravement etc will NOT be present. Therefore, all fuzed ammunition, either within or at any distance from the explosion site, shall be regarded as unexploded ordnance (UXO) and dealt with appropriately;

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

C) ammunition may have been broken open leading to exposed explosives, electrical leads or sensitive components; and/or

D) propellant may not have burnt during the explosion and fires, therefore exposed propellant may be present. This may spontaneously ignite during EOD clearance operations or subsequent movement; such ignition will be dependent on the chemical condition of the propellant and the ambient temperature.

The decision as to whether ammunition is STM post explosion shall only be taken by an individual deemed by the clearance organization to be a Level 5 Ammunition Inspector[16] or an IMAS EOD Level 3+ Operator (Depot Explosions).[17,18] Due consideration should be given to the external stimuli experienced by the fuze during 'kick out' from the explosion(s). The movement by hand of fuzed ammunition post-explosion shall only be permitted if:

a) the Level 5 Ammunition Inspector or an IMAS EOD Level 3+ Operator (Depot Explosions) has personal knowledge of the fuze design and modus operandi, access to the technical drawings and is certain that the fuze could not have been armed by the external stimuli it has experienced (for example an Electronic Time Fuze); or

b) should there be any doubts then diagnostic techniques such as X-Ray shall be used to determine the fuze condition of a statistically representative sample.

Notwithstanding the competence level of the individuals determining which type of ammunition is safe to move post explosion, a formal risk assessment for each clearance operation shall be carried out in accordance with IATG 02.10 *Introduction to risk management principles and processes.* This is because once the STM decision has been taken the ammunition will be moved and handled by staff at a lower competence level; it is a duty of care issue. The risk assessment shall include an evaluation of the types of fuzing systems and explosives that may present particular hazards for the clearance operation.

12 Documentation

National authorities should implement an effective documentation system that can be used to task ammunition inspection and repair programmes and then identify the action taken during the programme. One method may be to use a combination of:

a) Ammunition Surveillance and Repair Task Order (ASRTO);

b) Fault report;

c) Job Card; and

d) ASRTO Adjustment Form, (used after the task to provide information for the accountant to adjust the ammunition account with records of new condition codes etc).

[16] See IATG 01.90 *Ammunition management personnel competences*.

[17] See Clause 4.2d to IMAS 09.30 *EOD.* Second Edition Amendment 5.

[18] The Level 3+ (EOD) replaces the previous called out Level 4 designation. IMAS 09.30 now specifies the EOD Level 3+ qualification for specialist EOD operators who have been trained in areas that address specific hazards; the skills that are not routinely required in mine action (e.g., planning, supervision and conduct of EOD clearance of post explosion ammunition depots).

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

b) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

c) IATG 01.90 *Ammunition management personnel competences.* UNODA;

d) IATG 02.10 *Introduction to risk management principles and processes*. UNODA;

e) IATG 03.10 *Inventory management*. UNODA;

f) IATG 03.20 *Lotting and batching*. UNODA;

g) IATG 05.20 *Types of buildings for explosives facilities*. UNODA;

h) IATG 06.40 *Ammunition packaging and marking.* UNODA;

i) IATG 06.50 *Special safety precautions (storage and operations)*. UNODA;

j) IATG 07.10 *Surveillance and in-service proof*. UNODA;

k) IATG 07.30 *Ammunition processing operations – safety, risk reduction and mitigation*, UNODA;

l) IATG 08.10 *Transport of ammunition*. UNODA;

m) IATG 11.10 *Ammunition accidents and incidents*. UNODA;

n) IATG 11.20 *Clearance of ammunition storage area explosions.* UNODA; and

o) IMAS 09.30 *EOD*. Second Edition, Amendment 5. UNMAS. October 2014. www.mineactionstandards.org.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[19] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[19] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this module:[20]

A) Ammunition and Explosive Regulations, *Volume 3 - Technical Information Surveillance and Repair, Pamphlet 41 – Inspection and Repair of Ammunition*. MOD. UK. July 2005; and

B) Joint Service Publication 762, *Through Life Munitions Management*. MOD. UK. 2005.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[21] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[20] Data from many of these publications has been used to develop this IATG.

[21] Where copyright permits.

Annex C
(informative)
Guidance on physical inspection of ammunition (LEVEL 2)

C.1 Introduction

The physical (visual) inspection of ammunition is an important component in ensuring the overall safety of the ammunition stockpile. It should be carried out by trained ammunition technical staff who are conversant with the design principles of the ammunition and its modus operandi. This Annex summarises Inspection Points that should be addressed during the physical inspection of ammunition.

C.2 Inspection of ammunition packaging

It is important that the ammunition packaging is inspected as part of the routine surveillance/inspection /in-service proof as the packaging is a means of: 1) accurately identifying the ammunition; and 2) protecting the ammunition during storage and transport. The following inspection points should be used:

A) the packaging should be marked with the correct details of the ammunition;[22]

B) the metal fitments should be free from oxidation (rust);

C) the package should be intact with minimal external damage; and

D) the seals are intact.

C.3 Inspection of ammunition

Table C.1 contains inspection points to be checked for the main generic types of ammunition.

[22] See IATG 06.40 *Ammunition packaging and marking.*

Generic Type	Determine Rust Level[23]	Correct Markings	Percussion Cap / Primer	Undamaged Cartridge Case	Round/Shell Secure in Cartridge Case	Round/Shell/Munition Body Undamaged	Undamaged Primary and Secondary Cartridges	Undamaged Fins	Undamaged Fuze (If Fuzed)	No Exudation of Explosive/Pyrotechnic Filling	Propellant Uncongealed and Well Distributed	No Discolouration of Charge Container	No Foreign Items In Charge Container	Safety Pin/Wire Secure (If Fuzed)	Fuze Cavity Clear and Clean (If Unfuzed)	Explosive Charge Intact and Unbroken	Good Plasticity (If Applicable)	Wax on Fuze Body (Pyrotechnic Time Fuzes)	No Segment Rotation (Mechanical Time Fuzes)	Ignition System Undamaged	Nose Cap Intact	Base Cap Intact	Any Safety clip/cover/cap serviceable and correctly fitted
Small Arms Ammunition	X	X	X	X	X	X																	
Mortar Ammunition	X	X	X			X	X	X	X	X					X								X
Artillery Ammunition (Fixed)	X	X	X	X	X	X			X	X					X								X
Artillery Ammunition (SL)	X	X	X			X			X	X					X								X
Artillery Propelling Charges		X									X	X	X										X
Fuzes	X	X				X				X				X				X	X				X
Grenades	X	X				X				X				X	X								X

[23] See Table 5, Clause 9.2.

Generic Type	Determine Rust Level[23]	Correct Markings	Percussion Cap / Primer	Undamaged Cartridge Case	Round/Shell Secure in Cartridge Case	Round/Shell/Munition Body Undamaged	Undamaged Primary and Secondary Cartridges	Undamaged Fins	Undamaged Fuze (If Fuzed)	No Exudation of Explosive/Pyrotechnic Filling	Propellant Uncongealed and Well Distributed	No Discolouration of Charge Container	No Foreign Items In Charge Container	Safety Pin/Wire Secure (If Fuzed)	Fuze Cavity Clear and Clean (If Unfuzed)	Explosive Charge Intact and Unbroken	Good Plasticity (If Applicable)	Wax on Fuze Body (Pyrotechnic Time Fuzes)	No Segment Rotation (Mechanical Time Fuzes)	Ignition System Undamaged	Nose Cap Intact	Base Cap Intact	Any Safety clip/cover/cap serviceable and correctly fitted
Anti-Tank Mines	X	X				X			X	X				X	X								X
Pyrotechnics	X	X	X			X				X													X
Demolition Charges		X								X		X	X		X	X	X						X
Rockets and Missiles	X	X				X		X	X	X										X	X	X	X

Table C.1: Inspection points

Annex D
(normative)
Specific to type inspection points – Burning fuses

Burning Fuses			
Inspection Point	**Action**	**Effect Code[24]**	**Condition Code[25]**
1. Damp, discoloured or frayed	1.1 Sentence	2	D
2. Perished, brittle, split, kinked or distorted	2.1 Sentence	1	D
3. Ends unsealed	3.1 Cut off 300mm and seal	3	NC[26]
4. Physical condition of the fuse is below standard but does not warrant an unserviceable sentence.	4.1 Sentence for special proof	3	C2

[24] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[25] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

[26] No Change

Annex E
(normative)
Specific to type inspection points – Cartridges propelling

Cartridges Propelling			
Inspection Point	**Action**	**Effect Code[27]**	**Condition Code[28]**
1. Cartridge Clip			
1.1 Missing	1.1 Fit new clip	1	NC[29]
1.2 Missing	1.2 Repair	4	NC
1.3 Damaged	1.3 Replace	4	NC
1.4 Corroded (Light)	1.4 Clean	4	NC
1.5 Corroded (Heavy)	1.5 Replace	3	NC
1.6 Colour identification on one arm missing or requires restoring	1.6 Repaint	3	NC
2. Cartridge Case (QF Separate)			
2.1 Corroded (Light)	2.1 Clean	4	NC
2.2 Corroded (Heavy)	2.2 Replace	3	NC
2.3 Discolouration	2.3 Report	4	NC
2.4 Flaking or Pitting	2.4 Replace case	2	NC
2.5 Cracked or Split (Up to 6mm from Mouth)	2.5 Nil	4	NC
2.6 Cracked or Split (Over 6mm from Mouth)	2.6 Replace case	2	NC

[27] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[28] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

[29] No Change

Cartridges Propelling			
Inspection Point	**Action**	**Effect Code[27]**	**Condition Code[28]**
2.7 Slight Dent	2.7.1 Chamber Gauge (Pass)	4	NC
	2.7.2 Chamber Gauge (Fail) – Replace case	2	NC
2.8 Severe Dent	2.8 Replace case	2	NC
2.9 Chamber Gauge	2.9.1 Pass – Acceptable	4	NC
	2.9.2 Fail – Rub down – Regauge – Pass	4	NC
	2.9.2 Fail – Rub down – Regauge - Fail	2	NC
2.10 Rim Damage (Slight)	2.10.1 Chamber Gauge (Pass)	4	NC
	1.10.2 Chamber Gauge (Fail) – Replace case	2	NC
2.11 Rim Damage (Severe)	2.11 Replace case	2	NC
2.12 Bell Mouthed	2.12.1 Chamber Gauge (Pass)	4	NC
	2.12.2 Chamber Gauge (Fail) – Replace case	2	NC
2.13 Primer Hole Thread Damage	2.13 Damaged beyond repair – Replace case	3	NC
3. Cartridge Case (QF Fixed)			
3.1 Corroded (Light)	3.1 Clean	4	NC
3.2 Corroded (Heavy)	3.2 Sentence	2	D
3.3 Discolouration	3.3 Report	4	NC
3.4 Flaking or Pitting	3.4 Sentence	2	D
3.5 Cracked or Split (Up to 6mm from Mouth)	3.5 Nil	4	NC
3.6 Cracked or Split (Over 6mm from Mouth)	3.6 Replace case	2	D
3.7 Slight Dent	3.7.1 Chamber Gauge (Pass)	4	NC
	3.7.2 Chamber Gauge (Fail) – Sentence	2	D
3.8 Severe Dent	3.8 Sentence	2	D

Cartridges Propelling			
Inspection Point	**Action**	**Effect Code[27]**	**Condition Code[28]**
3.9 Chamber Gauge	3.9.1 Pass – Acceptable	4	NC
	3.9.2 Fail – Rub down – Regauge – Pass	2	NC
	3.9.2 Fail – Rub down – Regauge - Fail	2	D
3.10 Rim Damage (Slight)	3.10.1 Chamber Gauge (Pass)	4	NC
	3.10.2 Chamber Gauge (Fail) – Replace case	2	NC
3.10 Rim Damage (Severe)	3.10 Replace case	2	NC
3.11 Bell Mouthed	3.11.1 Chamber Gauge (Pass)	4	NC
	3.11.2 Chamber Gauge (Fail) – Replace case	2	NC
3.12 Primer Hole Thread Damage	3.12 Damaged beyond repair – Replace case	3	NC
4. Propellant Charge – QF Fixed			
4.1 Missing	4.1 Sentence	2	B1
4.2 Incorrect Amount (Approx)	4.2 Sentence	2	D
4.3 Broken Propellant Sticks (>10%)	4.3 Sentence	2	D
4.4 Exuding	4.4 Segregate for Propellant Testing	2	D
4.5 Discoloured	4.5 Segregate for Propellant Testing	2	D
4.6 Damp	4.6 Segregate for Propellant Testing	2	D
4.7 Contaminated with Luting or Grot	4.7 Sentence	4	D
5. Propellant Charge Bags – QF Fixed			
5.1 Missing	5.1 Sentence	2	C2
5.2 Split or Damaged	5.2.1 No apparent loss – Repair using waterproof tape adhesive	3	NC
	5.2.2 Apparent loss - Sentence	2	C2
5.3 Damp	5.3 Sentence	2	C2

Cartridges Propelling			
Inspection Point	**Action**	**Effect Code[27]**	**Condition Code[28]**
5.4 Inspection point	5.4.1 Incorrectly positioned – Rectify	4	NC
	5.4.2 Foil incorrectly placed (where applicable) - Sentence	2	C2
6. Closing Cup or Lid			
6.1 Missing or damaged	6.1 Replace	3	NC
6.2 Loose	6.2 Secure	3	NC
6.3 Cloth Disc	6.3.1 Missing – Replace	3 or 4	NC
	6.3.2 Loose - Secure	3 or 4	NC
6.4 Sleeve	6.4 Loose - Secure	2	NC
6.5 Holder Charge	6.5.1 Damaged – Sentence	2	C2
	6.5.2 Loose - Secure	3	NC

Annex F
(normative)
Specific to type inspection points – Cartridges signal

Cartridges Signal			
Inspection Point	**Action**	**Effect Code**[30]	**Condition Code**[31]
1. Cap			
1.1 Misfired or damaged	1.1 Sentence for local disposal	1	D
1.2 Corroded or missing	1.2 Sentence	2	D
2. Cartridge Case including Cartridge Head			
2.1 Dented	2.1.1 Superficial – Cartridge will load and is not perforated – Acceptable 2.2.2 Other than 2.1.1 - Sentence	4 2	NC D
2.2 Split, torn, pierced, corroded, swollen or damp	2.2 Sentence	2	D
2.3 Cartridge head loose or distorted	2.3 Sentence	1	D
3. Closing Cup or Disc			
3.1 Missing, loose or damp	3.1 Sentence	2	D
3.2 Corroded	3.2.2 Light – Acceptable 3.2.2 Heavy or moderate - Sentence	2	D

[30] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[31] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex G
(normative)
Specific to type inspection points – Charges propelling

Charges Propelling			
Inspection Point	**Action**	**Effect Code**[32]	**Condition Code**[33]
1. Charge Bag – Gunpowder Igniter			
1.1 Torn or split	1.1 Sentence	1	D
1.2 Damp or caked	1.2 Sentence	3	D
1.3 Insecure	1.3 Secure	4	NC
1.4 Missing	1.4 Sentence	2	D
2. Charge Bag			
2.1 Exudation from propellant	2.1 Segregate batch and request Stability Test		
2.2 Torn or split	2.2.1 No propellant lost – Tape or sew secure 2.2.2 Propellant lost - Sentence	3 2	NC D
2.3 Damp, wet or rotted	2.3 Sentence	2	D
2.4 Propellant sticks broken >10%	2.4 Sentence	2	D
2.5 Tapes	2.5.1 Loose – Secure 2.5.2 Missing – Fit new tape	4 4	NC NC
3. Combustible Cartridge Cases			
3.1 Broken	3.1 Sentence	2	D

[32] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[33] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Charges Propelling			
Inspection Point	**Action**	**Effect Code[32]**	**Condition Code[33]**
3.2 Cracked or split	3.2.1 <38mm in length – Repair with waterproof tape	3	NC
	3.2.2 >38mm in length - Sentence	2	D
3.3 Cap or end cover loose or separated	3.3.1 If practicable secure and seal with waterproof table	2	NC
	3.3.2 If not practicable - sentence	2	C2
3.4 Tape cotton medium	3.4.1 Loose – Secure	4	NC
	3.4.2 Missing – Fit new tape	4	NC
3.5 Lacquer coating or equivalent	3.5 Damaged – Re-lacquer	4	NC
4. Increment Propelling Charge			
4.1 Torn or split	4.1.1 No propellant lost – Tape secure	3	NC
	4.1.2 Propellant lost - Sentence	2	D
4.2 Damp, wet or rotted	4.2 Sentence	2	D
4.3 Propellant	4.3.1 Damp – Sentence	3	D
	4.3.2 Broken >10% - Sentence	2	D
	4.3.2 Exuding – Sentence	2	D
	4.3.4 Missing - Sentence	2	D

Annex H
(normative)
Specific to type inspection points – Cord detonating

Cord Detonating			
Inspection Point	**Action**	**Effect Code[34]**	**Condition Code[35]**
1. Leakage of HE Core	1.1.1 Cut out affected portion to 300mm either side	1	NC
	1.1.2 Reseal ends and join if possible		
	1.1.3 If defect can not be localised - Sentence	1	NC
			D
2. Damp, Discoloured, Split, Kinked, Unsealed or Loss of Flexibility	1.2.1 If repairable then 1.1.1 and 1.1.2 above	2	NC
	1.2.2 If defect can not be localised - Sentence	2	D

[34] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[35] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex J
(normative)
Specific to type inspection points – Demolition charges

Demolition Charges			
Inspection Point	**Action**	**Effect Code[36]**	**Condition Code[37]**
1. Plasticising Agent			
1.1 May be present in droplets or an oily substance	1.1.1 Test for explosive – Positive – Sentence	1	B1
	1.1.2 Test for explosive – Negative - Acceptable	1	NC
1.2 May be present in pools	1.2.1 Test for explosive – Positive – Sentence	1	B1
	1.2.2 Test for explosive – Negative – Pools form when tilted through 90 degrees - Sentence	1	B1
2. Body			
2.1 Paint damaged	2.1 Clean and repaint	4	NC
2.2 Contamination	2.2.1 Test for explosive – Positive – Sentence	1	B1
	2.2.2 Test for explosive – Negative - Acceptable		
2.3 Cracked, pierced or spilt	2.3 Sentence	1	D
2.4 Corroded	2.4.1 Light or moderate – Clean and repaint	3	NC
	2.4.2 Heavy - Sentence	2	D
3. Transit Cap			
3.1 Missing	3.1 Replace	3	NC
3.2 Set fast	3.2 Sentence	2	D

[36] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[37] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Demolition Charges			
Inspection Point	**Action**	**Effect Code[36]**	**Condition Code[37]**
3.3 Corroded	3.3.1 Light or moderate – Clean and repaint	4	NC
	3.3.2 Heavy - Sentence	3	D
4. Discs or Washers			
4.1 Missing, damaged or distorted	4.1 Replace	3	NC
5. Detonator Cavity			
5.1 Obstructed	5.1 If not easily cleared - Sentence	2	D

Annex K
(normative)
Specific to type inspection points – Detonators

Detonators			
Inspection Point	**Action**	**Effect Code**[38]	**Condition Code**[39]
1. Tube			
1.1 Corroded, dented, split or distorted	1.1 Sentence	1	D
2. Filling			
2.1 Yellow staining or crystalline deposit on surfaces of those detonators filled with ASA composition	2.1 If clearly visible as a continuous film on surfaces - Sentence	1	D
2.2 Loose	2.2 Sentence	1	D
2.3 Damp or contaminated	2.3 Sentence	2	D
3. Cavity			
3.1 Obstructed	3.1 If not easily and safely removed - sentence	2	D
4. Electrical Leads			
4.1 Missing	4.1 Sentence	2	D
4.2 Insulation perished	4.2 Sentence	2	D
4.3 Insulation stripped	4.3 Remove damaged portion - If insufficient cable left - Sentence	2	D
4.4 Broken	4.4 Remove damaged portion - If insufficient cable left - Sentence	2	D
5. Plug Conducting Rubber			
5.1 Missing	5.1 Fit new plug	3	NC
5.2 Perished	5.2 Replace	3	NC

[38] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[39] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Detonators			
Inspection Point	**Action**	**Effect Code[38]**	**Condition Code[39]**
6. Neoprene Plug or Rubber Sleeve			
6.1 Missing, loose or perished	6.1 Sentence	2	D
7. Cover Polythene			
7.1 Missing or distorted	7.1 Fit new cover	4	NC
8. Crimp			
8.1 Insufficient or excessive	8.1 Sentence	2	D
9. Shorting Clip or Dust Cover			
9.1 Missing	9.1 Replace with new	3	NC

Annex L
(normative)
Specific to type inspection points – Exploder pellets

Exploder Pellets			
Inspection Point	**Action**	**Effect Code[40]**	**Condition Code[41]**
1. In Pellet Form			
1.1 Damp or Distorted	1.1 Sentence	2	D
1.2 Crumbling or Broken	1.2 Sentence	1	D
1.3 Paper Wrapping Damaged and Filling Exposed	1.3 Sentence	1	D
1.4 Contaminated or Exuding	1.4 Sentence	1	D
2. Canned			
2.1 Lifting Becket Missing or Unserviceable	2.1 Fit new becket	3	NC
2.2 Felt Disc – Missing or Damaged	2.2 Fit new felt disc	2	NC
2.3 Felt Disc - Loose	2.3 Secure	2	NC
2.4 Corroded, Dented or Damaged	2.4 Sentence	2	D
2.5 Split	2.5 Sentence	1	D
2.6 Under or Oversize	2.6 Sentence	2	D
2.7 Loose Closing Disc	2.7 Sentence	1	D
3. In Bag Form			
3.1 Damp	3.1 Sentence	2	D
3.2 Split, Torn or Perished	3.2 Sentence	1	D

[40] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[41] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex M
(normative)
Specific to type inspection points – Explosives bulk

Explosives bulk			
Inspection Point	**Action**	**Effect Code[42]**	**Condition Code[43]**
1. Sheet Explosive			
1.1 Exuding	1.1.1 Test for RDX – Present - Sentence 1.1.2 Test for RDX – Not Confirmed - Acceptable	1 4	D NC
1.2 Split, Broken or Adhesion between Sheets	1.2 Acceptable	4	NC
1.3 Brittle or Hard	1.3 Sentence	2	D
2. Plastic Explosive			
2.1 Exuding	2.1.1 Test for Presence of Explosive – Present - Sentence 2.1.2 Test for Presence of Explosive - Confirmed - Acceptable	1 4	D NC
2.2 Wrapper – Missing or Torn	2.2 Fit new wrapper	3	NC
2.3 Broken Cartridge	2.3 Remake Cartridge	3	NC
2.4 Staining from Wrapper	2.4 Acceptable	4	NC
2.5 Loose Explosive forced through Wrapper	2.5 Acceptable	4	NC
2.6 Loss of Plasticity	2.6.1 Plasticity Test – Pass – Acceptable 2.6.2 Plasticity Test – Fail – Submit Defect Report	4	NC

[42] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[43] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex N
(normative)
Specific to type inspection points – Fuzes and gaines

Fuzes and Gaines			
Inspection Point	**Action**	**Effect Code**[44]	**Condition Code**[45]
1. General			
1.1 Fuze or magazine threads damaged	1.1.1 Not affecting insertion - Acceptable	4	NC
	1.1.2 Affecting insertion - Sentence	2	D
1.2 Booster or gaine threads damaged	1.2.1 Not affecting insertion - Acceptable	4	NC
	1.2.2 Affecting insertion - Sentence	2	D
2. Percussion DA and Graze Fuze			
2.1 Safety cap	2.1.1 Missing or damaged - Replace	3	NC
	2.1.2 Set fast - Sentence	2	D
	2.1.3 Spring - Missing, broken or loose - Replace Cap	3	NC
	2.1.4 Corroded – Light – Clean	3	NC
	2.1.5 Corroded – Heavy or moderate - Sentence	2	NC
2.2 Safety pin or clip	2.2.1 Missing or broken – Sentence	1	D
	2.2.2 Corroded – Sentence	2	D
	2.2.3 Set fast – Manipulate gently to loosen, but do NOT remove	2	NC
	2.2.4 Not taped to fuze in forward position - Rectify	4	NC
2.3 Striker cover	2.3 Missing, dented, split or perforated - Sentence	2	D

[44] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[45] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Fuzes and Gaines			
Inspection Point	**Action**	**Effect Code**[44]	**Condition Code**[45]
2.4 Corroded	2.4.1 Cracked - Sentence	2	D
	2.4.2 Light or Moderate - Acceptable	4	NC
	2.4.3 Heavy - Sentence	2	D
2.5 Guide bush, head fairing, body magazine or bottom cap	2.5.1 Cracked - Sentence	2	D
	2.5.2 Corroded - Light - Acceptable	4	NC
	2.5.3 Corroded - Moderate – Sentence	2	D
	2.5.4 Corroded - Heavy - Sentence	1	D
2.6 Guide bush, head fairing or nose cap	2.6 Loose - Sentence	1	D
2.7 Set screw	2.7 Missing - Replace	3	NC
2.8 Magazine or magazine bottom cap loose	2.8 Hand tighten - Sentence		
2.9 Closing disc	2.9.1 Loose, pierced, split or cracked – Sentence	2	D
	2.9.2 Dented - Acceptable		
2.10 Head loose in ogive, ogive loose in body	2.10 Sentence	2	D
2.11 Setting sleeve retainer	2.11 Missing or damaged - Sentence	2	D
2.12 Head or ogive body or booster	2.12 Cracked - Sentence	1	D
2.13 Metal peeling or flaked	2.13 sentence	1	D
3. Mechanical Time Fuze			
3.1 Safety cap	3.1.1 Missing - Replace	3	NC
	3.1.2 Set fast - Sentence	2	D
	3.1.3 Spring - Missing, broken or loose - Replace Cap	3	NC
3.2 Head closing disc	3.2.1 Corroded – Sentence	2	D
	3.2.2 Pierced or perforated - Sentence	2	C2

Fuzes and Gaines			
Inspection Point	**Action**	**Effect Code[44]**	**Condition Code[45]**
3.3 Head, nose, locking ring, body or dome	3.3.1 Cracked – Sentence	2	D
	3.3.2 Corroded – Light – Acceptable	4	NC
	3.3.3 Corroded – Medium to Heavy - Sentence	2	D
3.4 Nose, head loose in dome or locking ring loose in body	3.4 Sentence	1	D
3.5 Gaine	3.5 Loose - Secure	1	NC
3.6 Base plug	3.6.1 Loose - Secure	2	ND
	3.6.2 Protruding and set fast – Sentence	2	D
	3.6.3 Closing disc – Corroded, loose, missing, perforated or split - Sentence	2	D
3.7 Magazine or gaine cap	3.7 Loose – Tighten - Sentence	2	C1
3.8 Set or securing screw	3.8 Loose or missing – replace or secure	2	NC
3.9 Fuze set at other than SAFE	3.9 Rest to SAFE position	3	NC
4. Fuze Nose Proximity or Electronic Time			
4.1 Setter contacts	4.1.1 Missing – Sentence	1	D
	4.1.2 Damaged – Sentence	1	D
	4.1.3 Corroded - Sentence	1	D
4.2 Head or base corroded	4.2.1 Light – Acceptable	4	NC
	4.2.2 Heavy or medium - Sentence	2	D
4.3 Safety pin	4.3 Missing - sentence	1	D
4.4 Fuze set at other than SAFE	4.4 Reset to SAFE position	3	NC

Annex P
(normative)
Specific to type inspection points – Grenades hand

Grenades Hand			
Inspection Point	**Action**	**Effect Code[46]**	**Condition Code[47]**
1. Detonator			
1.1 Fitted	1.1.1 Call for Supervisor and do nothing until advised by Process Manager or an Ammunition Inspector		
	1.1.2 Detonator removed	1	NC
	1.1.3 Detonator set fast – Sentence and dispose of soonest	1	D
2. Body			
2.1 Contamination in area of Fuze or Plug joint	2.1.1 Test for explosive – Not Confirmed – Clean	3	NC
	2.1.2 Test for explosive – Confirmed - Clean	1	NC
2.2 Corroded	2.2.1 Light or Moderate – Clean	3	NC
	2.2.2 Heavy - Sentence	2	D
2.3 Split, cracked, pierced or perforated	2.3 Sentence	1	D
3. Fuze Well			
3.1 Obstructed	3.1.1 Easily cleared – Remove obstruction	3	NC
	3.1.2 Not easily cleared - Sentence	2	D
3.2 Corrosion	3.1 Corroded, damaged or undersize threads – Sentence	1	D
4. Striker Mechanism Assembly (When designed to be fixed)			

[46] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[47] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Grenades Hand			
Inspection Point	**Action**	**Effect Code[46]**	**Condition Code[47]**
4.1 Missing	4.1 Sentence	2	D
4.2 Loose	4.2 Secure	2	NC
5. Striker Mechanism Assembly (When designed to be removed)			
5.1 Missing	5.1 Replace	2	C
5.2 Set fast	5.2 Sentence	2	D
5.3 Threads	5.3 Damaged or distorted - Sentence	2	S
6. Striker Mechanism Assembly (Ring Pull)			
6.1 Missing or damaged	6.1 Replace	2	C
7. Striker Mechanism Assembly (Pin Safety)			
7.1 Missing, corroded or damaged	7.1 Replace	1	NC
7.2 Set fast	7.2 Sentence	2	D
8. Striker Mechanism Assembly (Housing)			
8.1 Loose	8.1 Secure	2	NC
9. Striker Mechanism Assembly (Pin Hinge Sleeve)			
9.1 Missing	9.1 Fit new striker mechanism assembly	2	NC
9.2 Corroded	9.2.1 Light or Moderate – Clean 2.2.2 Heavy - Sentence	3 2	NC D
10. Striker Mechanism Assembly (Spring)			
10.1 Missing, weakened or corroded	10.1 Fit new striker mechanism assembly	2	NC
11. Striker Mechanism Assembly (Striker)			
11.1 Missing, weakened or corroded	11.1 Fit new striker mechanism assembly	2	NC

Grenades Hand			
Inspection Point	**Action**	**Effect Code**[46]	**Condition Code**[47]
12. Cap or Plug			
12.1 Loose	12.1 Sentence	2	D

Annex Q
(normative)
Specific to type inspection points – Igniters

Igniters			
Inspection Point	**Action**	**Effect Code**[48]	**Condition Code**[49]
1. Missing	1.1 Sentence	2	D
2. Loose	2.1 Igniter cup not fitted correctly - Sentence	1	D
3. Igniter Cup or Flash Tube	3.1 Missing, split or broken - Sentence	1	D

[48] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[49] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex R
(normative)
Specific to type inspection points – Mines

Mines			
Inspection Point	**Action**	**Effect Code[50]**	**Condition Code[51]**
1. Body including Base			
1.1 Cracked, pierced or split	1.1 Sentence	1	D
1.2 Dented	1.2.1 Damage does not affect correct assembly or functioning	4	NC
	1.2.2 Damage does affect correct assembly or functioning	2	D
1.3 Corroded	1.3.1 Light or Moderate – Clean and Repaint	4	NC
	1.3.2 Heavy - Sentence	2	D
1.4 Contamination	1.1.1 Test for explosive – Not Confirmed – Clean	3	NC
	1.1.2 Test for explosive – Confirmed - Sentence	1	C2
2. Becket or Cord Lifting	2.1.1 Missing, broken or rotted - Replace	1	NC
3. Detonator Well or Channel			
3.1 Obstructed	3.1.1 Remove obstruction	3	NC
	3.1.2 Obstruction set fast - Sentence	1	D
3.2 Corroded	3.2.1 Superficial and allows detonator fitting	4	NC
	3.2.2 Other than 3.2.1 - Sentence	1	D
4. Exploder or Pellet			
4.1 Crumbling or broken	4.1.1 Remove pellet completely – Clean – Sentence	1	C2
	4.1.2 If whole or part can not be removed - Sentence	1	D

[50] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[51] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Mines			
Inspection Point	**Action**	**Effect Code[50]**	**Condition Code[51]**
4.2 Missing	4.2 Sentence	1	C2
5. Detector Ring			
5.1 Missing	5.1 Replace	3	NC
5.2 Corroded	5.2.1 Light or Moderate – Clean and Repaint 5.2.2 Heavy - Sentence	3 3	NC NC
6. Transit Plug			
6.1 Missing, broken or damaged threads	6.1 Replace	3	NC
7. Safety Clips			
7.1 Missing or broken	7.1 Replace	3	NC
8. Sealing Rings			
8.1 Missing or broken	8.1 Replace	3	NC
9. Dust, Transit or Waterproof Covers			
9.1 Missing	9.1 Replace	3	NC
9.2 Missing, split, pierced or perished (waterproof covers only)	9.2 Sentence	2	D
10. Fuze Well	10.1.1 Gauge – Fail – Clean – Regauge – Pass 10.1.2 Gauge – Fail – Clean – Regauge – Fail - Sentence	3 2	NC D
11. Base Plug			
11.1 Loose	11.1 Secure using luting or equivalent	3	NC
11.2 Missing	11.2 Replace	3	NC

Annex S
(normative)
Specific to type inspection points – Mortar bomb augmenting cartridges

Mortar Bomb Augmenting Cartridges			
Inspection Point	**Action**	**Effect Code[52]**	**Condition Code[53]**
1. In Bulk			
1.1 Split or Broken	1.1.1 Clear ammunition container of loose propellant – Sentence	1	D
1.2 Dented	1.2.1 Undamaged after reshaping – Acceptable	4	NC
	1.2.2 Damaged after reshaping – Unacceptable	2	D
2. Fitted to Bombs			
1.1 Split or Broken	1.1.1 Clear ammunition container of loose propellant	1	
	1.1.2 Cartridge – Sentence	1	D
	1.1.3 Bomb Body - Sentence	2	C2

[52] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[53] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex T
(normative)
Specific to type inspection points – Mortar bomb (HE and Practice)

Mortar Bomb (HE and Practice)			
Inspection Point	**Action**	**Effect Code**[54]	**Condition Code**[55]
1. Body – External			
1.1 Contamination in area of Fuze or Plug joint	1.1.1 Test for explosive – Not Confirmed – Clean	3	NC
	1.1.2 Test for explosive – Confirmed - Sentence	1	C2
1.2 Varnish Damaged	1.2 Clean and re-varnish	3	NC
1.3 Corroded	1.3.1 Light or Moderate – Clean	3	NC
	1.3.2 Heavy - Sentence	2	D
1.4 Damaged	1.4.1 Body not weakened – Gauge – Pass	4	NC
	1.4.2 Body not weakened – Gauge – Fail – Sentence	1	D
	1.4.3 Body weakened - Sentence	!	D
1.5 Identification Groove	1.5 Missing - Sentence	1	D
2. Obturating Ring			
2.1 Missing, split oversize or broken	2.1 Sentence	1	D
2.2 Gauge	2.2.1 Pass - Acceptable	3	NC
	2.2.2 Fail – Remove paint high spots – Re-gauge - Pass	3	NC
	2.2.3 Fail – Try other obturating rings – Re-gauge - Pass	3	NC
	2.2.4 Fail – Try other obturating rings – Re-gauge – Fail - Sentence	2	D

[54] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[55] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Mortar Bomb (HE and Practice)			
Inspection Point	**Action**	**Effect Code[54]**	**Condition Code[55]**
3. Straightness Gauging			
3.1 Fail	3.1.1 Due to condition of Tail Unit – Replace Tail Unit 3.1.2 Not due to condition of Tail Unit - Sentence	2 2	NC D
4. Adaptor Nose			
4.1 Loose or not fully home	4.1 Secure using Luting or equivalent	3	NC
4.2 Set Fast or Protruding	4.2 Sentence	2	D
4.3 Corroded	4.3.1 Light or Moderate – Clean 4.3.2 Heavy - Sentence	3 2	NC D
5. Replacement Component Required			
5.1 Fuze, primary cartridge or augmenting cartridges	5.1 Sentence	1	C2
6. Tail Unit			
6.1 Missing, incorrect or broken	6.1 Replace	2	NC
6.2 Corroded	6.2.1 Light or Moderate – Clean 6.2.2 Heavy - Sentence	3 2	NC D
6.3 Loose or not fully home	6.3.1 Loose – Secure 6.3.2 Set fast – Sentence 6.3.3 Damaged Tail threads – Replace 6.3.4 Adaptor tail or spigot threads damaged - Sentence	2 2 2 2	NC D NC D
6.4 Misaligned	6.4.1 Replace – Gauge – Pass – Acceptable 6.4.2 Replace – Gauge – Fail - Sentence	2 2	NC D
6.5 Fins	6.5.1 Missing or loose – Replace Tail Unit 6.5.2 Damaged – Replace Tail Unit – Gauge – Pass – Acceptable 6.5.2 Damaged – Replace Tail Unit – Gauge – Fail - Sentence	2 4 2	NC NC D

Mortar Bomb (HE and Practice)			
Inspection Point	**Action**	**Effect Code[54]**	**Condition Code[55]**
6.6 Grub Screw	6.6.1 Missing – Replace	2	NC
	6.6.2 Loose - Secure	3	NC
6.7 Adaptor Spigot Tail	6.7.1 Missing – Replace	2	NC
	6.7.2 Loose - Secure	3	NC
7. Tail Accessories			
7.1 Cap Retaining Primary Cartridge	7.1.1 Missing, cracked or loose – Replace	2	NC
	7.1.2 Corroded, moderate or heavy - Replace	2	NC
7.2 Projector Assembly Cartridge	7.2.1 Missing or incomplete – Replace	1	NC
	7.2.2 Distorted, broken or cracked – Replace	1	NC
	7.2.3 Strap Carrying missing or damaged – replace	1	NC
	7.2.4 Cup Assembly missing, broken or perished	1	NC
	7.2.5 Tape adhesive or rubber band missing - Replace	3	NC
8. Fuze or Plug/Shell Joint			
8.1 Fuze damaged	8.1.1 Safety and efficient functioning OK – Acceptable	4	NC
	8.1.2 Safe for handling, movement and storage – Sentence	2	C2
	8.1.3 Unsafe for handling, movement or storage - Sentence	1	D
8.2 Fuze or plug not fully tightened	8.2.1 Fuze threads damaged – Sentence	2	C2
	8.2.2 Plug threads damaged – Sentence	4	NC
	8.2.3 Fuze threads damaged – Reset using tap cleaning fluid	2	NC
	8.2.4 Fuze intrusion outside limits – Sentence	2	C2
	8.2.5 Plug intrusion outside limits – Replace	3	NC
	8.2.6 Depth of cavity below limit and not adjustable by removal of discs - Sentence	1	D

Mortar Bomb (HE and Practice)			
Inspection Point	**Action**	**Effect Code[54]**	**Condition Code[55]**
8.3 Fuze or plug set fast	8.3.1 Fuze visually serviceable – Acceptable	4	NC
	8.3.2 Fuze not visually serviceable – Deal with as per 8.11 8.13		
	8.3.3 Plug set fast - Acceptable	4	NC
8.4 Luting	8.4.1 Missing – Apply luting or equivalent	3	NC
	8.4.2 Insufficient – Remove and replace	3	NC
8.5 Fuze Hole Threads	8.5.1 Corroded - Light or Moderate – Clean	3	NC
	8.5.2 Corroded - Heavy – Sentence	2	D
	8.5.3 Damaged – Reset using tap cleaning fluid	2	NC
	8.5.4 Test for explosive – Not Confirmed – Clean	1	NC
	8.5.5 Test for explosive – Confirmed - Sentence	1	D
9. Cavity			
9.1 Brown liquid and ammonia smell present	9.1.1 Ammonium Nitrate confirmed – Sentence	1	D
	9.1.2 Ammonium Nitrate not confirmed – Sentence as exudation in early stage	2	D
9.2 Corroded	9.2.1 Light – Clean	3	NC
	9.2.2 Moderate or heavy - sentence	2	D
9.3 Collar Paper	9.3.1 Missing, damp or contaminated - Replace	3	NC
9.4 Exploder	9.4.1 Undamaged	4	A1/NC
	9.4.2 Damaged - Replace	1	NC
	9.4.3 Set fast and not damaged – Acceptable	4	NC
	9.4.4 Set fast and damaged - Replace	1	NC
9.5 Runnels or smears of HE filling	9.5 Clean		
9.6 Exudation	9.6.1 Test for explosive – Not Confirmed – Clean	3	NC
	9.6.2 Test for explosive – Confirmed - Sentence	1	D

Mortar Bomb (HE and Practice)			
Inspection Point	**Action**	**Effect Code[54]**	**Condition Code[55]**
7.5 Paper Tube – Loose, damaged or Damp	7.5 Replace	3	NC
7.6 Cavity Damaged	7.6.1 Light – Repair	3	NC
	7.6.2 Heavy or moderate – Sentence	1	D
7.7 Cavity Damp	7.7.1 Remove exploder, paper tube and other inert items – Dry	2	D
	7.7.2 Replace items if necessary		
7.8 Cavity Swollen	7.8.1 Fuze still fits – Acceptable		
	7.8.2 Insertion of Fuze affected - Sentence	2	D
7.9 Cloth paper, felt, discs or glaze board	7.9 Missing, damaged or stained - Replace	2	NC
1.10 Outside Limits	7.10 Adjust by insertion or removal of discs	2	NC

Annex U
(normative)
Specific to type inspection points – Mortar bomb (smoke and illuminating)

Mortar Bomb (smoke and illuminating)			
Inspection Point	**Action**	**Effect Code[56]**	**Condition Code[57]**
1. Bomb Body			
1.1 Filling – White Phosphorus only	1.1 Leaking – Immerse in water and dispose of soonest	1	D
1.2 Varnish Damaged	1.2 Clean and re-varnish	3	NC
1.3 Corroded	1.3 Clean	3	NC
1.4 Front or rear body loose	1.4 Sentence	1	D
1.5 Shear Pins	1.5.1 Missing or broken – Sentence 1.5.2 Corroded – Moderate or Heavy - Sentence	1 1	D D
1.6 Damaged	1.6.1 Body not weakened – Gauge – Pass 1.6.2 Body not weakened – Gauge – Fail – Sentence 1.6.3 Body weakened - Sentence	4 1 !	NC D D
1.7 Closing Lid of Illuminating Bomb	7.1.1 Missing – Sentence 7.1.2 Contents appear serviceable – Secure lid using resin cement 7.1.2 Contents appear unserviceable - Sentence	2 3 2	D NC D
2. Fuze and Bomb Joint			

[56] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[57] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Mortar Bomb (smoke and illuminating)			
Inspection Point	**Action**	**Effect Code[56]**	**Condition Code[57]**
2.1 Fuze damaged	2.1.1 Safety and efficient functioning OK – Acceptable	4	NC
	2.1.2 Safe for handling, movement and storage – Sentence	2	C2
	2.1.3 Unsafe for handling, movement or storage - Sentence	1	D
2.2 Fuze not fully tightened	2.2.1 Fuze threads damaged – Sentence	2	C2
	2.2.2 Fuze threads damaged – Reset using tap cleaning fluid	2	NC
	2.2.3 Fuze intrusion outside limits – Sentence	2	C2
	2.2.4 Depth of cavity below limit and not adjustable by removal of discs - Sentence	1	D
2.3 Fuze set fast	2.3.1 Fuze visually serviceable – Acceptable	4	NC
	2.3.2 Corrosion - Sentence	2	D
2.4 Luting	2.4.1 Missing – Apply luting or equivalent	3	NC
	2.4.2 Insufficient – Remove and replace	3	NC
2.5 Fuze Hole Threads	2.5.1 Corroded - Light or Moderate – Clean	3	NC
	2.5.2 Corroded - Heavy – Sentence	2	D
	2.5.3 Damaged – Reset using tap cleaning fluid	2	NC
	2.5.4 Test for explosive – Not Confirmed – Clean	3	NC
	2.5.5 Test for explosive – Confirmed - Sentence	2	D
3. Cavity			
3.1 Corroded	3.1.1 Light – Clean	3	NC
	3.1.2 Moderate or heavy - sentence	2	D
3.2 Cavity Damaged	3.2.1 Light – Repair	3	NC
	3.2.2 Heavy or moderate – Sentence	1	D
3.3 Cavity Damp	3.3.1 Remove exploder, paper tube and other inert items – Dry	2	D
	3.3.2 Replace items if necessary		

Mortar Bomb (smoke and illuminating)			
Inspection Point	**Action**	**Effect Code**[56]	**Condition Code**[57]
3.4 Cloth paper, felt, discs or glaze board	3.4 Missing, damaged or stained - Replace	2	NC
3.5 Outside Limits	3.5 Adjust by insertion or removal of discs	2	NC
4. Adaptor Nose			
4.1 Loose or not fully home	4.1.1 For White Phosphorus – Immerse in water and dispose of immediately 4.1.2 Secure using Luting or equivalent	1 3	D NC
4.2 Set Fast or Protruding	4.2 Sentence	2	C1
4.3 Corroded	4.3.1 Light or Moderate – Clean 4.3.2 Heavy - Sentence	3 2	NC D
5. Obturating Ring			
5.1 Missing, split oversize or broken	5.1 Replace and gauge	3	NC
5.2 Gauge	5.2.1 Pass - Acceptable 5.2.2 Fail – Remove paint high spots – Re-gauge - Pass 5.2.3 Fail – Try other obturating rings – Re-gauge - Pass 5.2.4 Fail – Try other obturating rings – Re-gauge – Fail - Sentence	3 3 3 2	NC NC NC D
6. Tail Unit			
6.1 Missing, incorrect or broken	6.1 Replace	2	NC
6.2 Corroded	6.2.1 Light or Moderate – Clean 6.2.2 Heavy - Sentence	3 2	NC D
6.3 Loose or not fully home	6.3.1 Loose – Secure 6.3.2 Set fast – Sentence 6.3.3 Damaged Tail threads – Replace 6.3.4 Adaptor tail or spigot threads damaged - Sentence	3 2 3 2	NC D NC D

Mortar Bomb (smoke and illuminating)			
Inspection Point	**Action**	**Effect Code**[56]	**Condition Code**[57]
6.4 Polythene Washer	6.4 Missing or loose - Replace	3	D
6.5 Celluloid Disc	6.5 Missing or perforated - Sentence	2	D
6.6 Misaligned	6.6.1 Gauge – Pass – Acceptable 6.6.2 Gauge – Fail - Sentence	2 1	NC D
6.7 Fins	6.7.1 Missing or loose – Replace Tail Unit 6.7.2 Superficial Damage – Gauge – Pass – Acceptable 6.7.2 Superficial Damage – Gauge – Fail - Sentence	2 4 2	NC NC D
6.8 Grub Screw	6.8. Missing or Loose – Replace	3	NC
6.9 Adaptor Spigot Tail	6.9.1 Missing – Replace 6.9.2 Loose or Bent - Sentence	2 2	NC D
7. Straightness Gauging			
7.1 Fail	3.1.1 Replace Tail Unit - Re-gauge - Pass 3.1.2 Replace Tail Unit - Re-gauge – Fail - Sentence	 2 2	 NC D
8. Tail Accessories			
8.1 Cap Retaining Primary Cartridge	8.1.1 Missing or cracked – Replace 8.1.2 Loose - Secure 8.1.3 Corroded, moderate or heavy - Replace	1 2 2	NC NC NC
8.2 Projector Assembly Cartridge	8.2.1 Missing or incomplete – Replace 8.2.2 Distorted, broken or cracked – Replace 8.2.3 Strap Carrying missing or damaged – Replace 8.2.4 Cup Assembly missing, broken or perished - Replace 8.2.5 Tape adhesive or rubber band missing - Replace	1 1 3 3 3	NC NC NC NC NC

Mortar Bomb (smoke and illuminating)			
Inspection Point	**Action**	**Effect Code[56]**	**Condition Code[57]**
5. Replacement Component Required			
5.1 Fuze, primary cartridge or augmenting cartridges	5.1 Sentence	2	C2

Annex V
(normative)
Specific to type inspection points – Mortar bomb (primary cartridges)

Mortar Bomb (Primary Cartridges)			
Inspection Point	**Action**	**Effect Code[58]**	**Condition Code[59]**
1. Percussion Cap			
1.1 Misfired or damaged	1.1 Handle with extreme care and remove for disposal	1	D
1.2 Proud of case	1.2 Sentence	1	D
1.3 Corroded	1.3.1 Light – Acceptable 1.3.2 Moderate or heavy - sentence	4 2	NC D
1.4 Annulus ring missing	1.4 Sentence	2	D
2. Striker Clip			
2.1 Missing	2.1 Sentence	2	D
2.2 Striker missing	2.2 Sentence	2	D
3. Body			
3.1 Corroded	3.1.1 Light – Acceptable 3.1.2 Moderate or heavy - sentence	4 2	NC D
4. Base			
4.1 Loose	4.1 Sentence	1	C2
4.2 Screw threads	4.2 Damaged - Sentence	2	D

[58] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[59] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Mortar Bomb (Primary Cartridges)			
Inspection Point	**Action**	**Effect Code[58]**	**Condition Code[59]**
4.3 Corroded	4.3.1 Light – Acceptable 4.3.2 Moderate or heavy - sentence	4 2	NC D
5. Brass Head or Cover			
5.1 Corroded	5.1.1 Light – Acceptable 5.1.2 Moderate or heavy - sentence	4 2	NC D
5.2 Dented, split, perforated or cracked	5.2 Sentence	2	D
6. Tube (Aluminium)			
6.1 Corroded	6.1.1 Light – Acceptable 6.1.2 Moderate or heavy – sentence	4 2	NC D
6.2 Bent	6.2 Sentence	2	D
7. Container Magazine (Aluminium)			
7.1 Bent	7.1 Sentence	2	D
7.2 Loose	7.2 Sentence	1	D
7.3 Split or Cracked	7.3 Sentence	1	D
7.4 Corroded	7.4.1 Light – Acceptable 7.4.2 Moderate or heavy – sentence	4 2	NC D
8. Paper Case			
8.1 Missing or loose	8.1 Sentence	2	D
8.2 Pierced, perforated or distorted	8.2 Sentence	3	D

Annex W
(normative)
Specific to type inspection points – Primers and tubes

Primers and Tubes			
Inspection Point	**Action**	**Effect Code[60]**	**Condition Code[61]**
1. Percussion Cap, Obturator Cup, Cap Holder or Firing Plug			
1.1 Misfired, damaged or proud	1.1 Sentence	1	D
2.1 Sunken or missing	1.2 Sentence	2	D
2.3 Corroded	2.3.1 Light or Moderate – Clean 2.3.2 Heavy - Sentence	4 2	NC D
2. Insulating Cup or Plug			
2.1 Missing, loose, cracked, split or proud	2.1 Sentence	2	D
2.2 Sunken	2.2 Acceptable	4	NC
3. Contact Piece or Plug			
3.1 Missing, loose, cracked, split, proud or sunken.	3.1 Sentence	2	D
3.2 Corroded	3.2.1 Light or Moderate – Clean 3.2.2 Heavy - Sentence	4 2	NC D
4. Body			
4.1 Threads	4.1 Damaged and primer will not seat correctly - Sentence	2	D
4.2 Corroded	4.2.1 Light or Moderate – Clean 4.2.2 Heavy - Sentence	4 2	NC D

[60] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[61] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Primers and Tubes			
Inspection Point	**Action**	**Effect Code[60]**	**Condition Code[61]**
5. Tube			
5.1 Split or cracked	5.1 Sentence	1	D
5.2 Dented	5.2 Sentence	2	D
5.3 Corroded	5.3.1 Light or Moderate – Clean 5.3.2 Heavy - Sentence	4 2	NC D
5.4 Mouth not belled	5.4 Acceptable	4	NC
6. Magazine or Sleeve			
6.1 Loose, split or cracked	6.1 Sentence	1	D
6.2 Dented or bent	6.2 Sentence	2	D
6.3 Corroded	6.3.1 Light or Moderate – Acceptable 6.3.2 Heavy - Sentence	 2	 D
6.4 Envelope or capsule liner	6.4 Damp, pierced or perforated - Sentence	2	D
6.5 Dome	6.5.1 Missing or loose – Liner not perforated – Acceptable 6.5.2 Missing or loose – Liner perforated - Sentence	 4	 NC
6.6 Distance or Locating Sleeve	6.6.1 Pierced or perforated – Acceptable 6.6.2 Missing - Sentence	 1	 D
6.7 Brass closing disc	6.7.1 Missing or loose - Sentence 6.7.2 Light or Moderate – Acceptable 6.7.3 Heavy - Sentence	1 1	D D
7. Cork or Paper Closing Disc or Plug			
7.1 Missing, broken or loose	7.1 Sentence	1	D
8. Celluloid Closing Cup			
8.1 Missing, broken or loose	8.1 Sentence	1	C2

Primers and Tubes			
Inspection Point	**Action**	**Effect Code[60]**	**Condition Code[61]**
9. Inner or Lower Celluloid Cup			
9.1 Missing, broken or loose	9.1 Sentence	2	D
10. Gauge			
10.1 High to gauge	10.1.1 Remove from cartridge case and try in alternative rounds 10.1.2 Any primer that can not be fitted to a cartridge case - Sentence	2	D
10.2 Low to gauge	10.2.1 Remove from cartridge case and try in alternative rounds 10.2.2 Any primer that can not be fitted to a cartridge case, try brass shim washers 10.2.3 Any primer that still can not be fitted to a cartridge case - Sentence	2	D
11. Primer or Tube Contaminated			
11.1 Oil contamination	11.1 Sentence	2	D
12. Rubber Sealing Rings			
12.1 Deterioration due to brass contact	12.1 Fit new sealing ring. Do NOT use luting or lubricants	3	NC

Annex X
(normative)
Specific to type inspection points – Pyrotechnics

Pyrotechnics			
Inspection Point	**Action**	**Effect Code[62]**	**Condition Code[63]**
1. Flares			
1.1 Gas generation has occurred causing bulging body or split seams	1.1.1 Bulged – Sentence 1.1.2 Split seams - Sentence	3 2	C1 D2
2. Smoke Generators			
2.1 Body corroded	2.1.1 Light or Moderate – Clean 2.1.2 Heavy - Sentence	3 2	NC D
2.2 Body damaged	2.2.1 Superficial – Acceptable 2.2.2 Other than superficial - sentence	4 2	NC D
2.3 Seams	2.3 Open - Sentence	2	D
2.4 Electrical Leads	2.4 Missing, loose or insulation perished - Sentence	2	D

[62] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[63] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Annex Y
(normative)
Specific to type inspection points – Rockets (anti-tank)

Rockets (Anti-Tank)			
Inspection Point	**Action**	**Effect Code**[64]	**Condition Code**[65]
1. In Launcher (e.g. 66mm HEAT)			
1.1 Tube Outer - Cracked	1.1 Sentence	1	D
1.2 Tube Outer - Incomplete	1.2 Sentence	1	D
1.3 Anti-Extension Rivets Missing or Broken	1.3 Sentence for Modification	1	C2
1.4 Rear Sight – Damaged, Missing or Incorrect	1.4 Sentence	2	D
1.5 Trigger Assembly Rubber Cover – Damaged, Missing or Loose	1.5 Sentence	3	D
1.6 Trigger Safety Mechanism – Damaged, Missing or Loose	1.6 Sentence	1	D
1.7 Detent Lever Assembly, Rubber Cover - Damaged	1.7 Sentence	3	D
1.8 Rear Cover – Damaged or Missing	1.8 Sentence	3	D
1.9 Tube Inner – Rear End Corroded	1.9 Sentence	2	D
1.10 Safety Pin - Missing	1.10 Fit new pin	1	NC
1.11 Rear Sight Cover - Missing	1.11 Sentence	3	D
1.12 Round Locking Tab - Missing	1.12 Sentence	2	D
1.13 Sling including Front Cover – Missing or Incomplete	1.13 Replace	2	NC
1.14 Safe to Arm Lever – Not Set to Safe	1.14 Set to SAFE	2	NC

[64] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[65] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Rockets (Anti-Tank)			
Inspection Point	**Action**	**Effect Code[64]**	**Condition Code[65]**
1.15 End Cap - Missing	1.15 Replace	4	NC
1.16 End Cap - Loose	1.16 Secure	4	NC
1.17 Shoulder Rest - Missing	1.17 Segregate and Sentence	3	C2
1.18 Shoulder Cap – Retained Correctly	1.18 Remove end cap and secure safely	4	NC
1.19 Eject Grommet with Safety Pin - Missing	1.19 Segregate and Sentence	3	C2
1.20 Eject Grommet with Safety Pin - Insecure	1.20 Secure Grommet	4	NC
1.21 Cocking Handle – Missing, Broken or Unserviceable	1.21 Segregate and Sentence	3	C2
1.22 Cocking Handle - Insecure	1.22 Secure	4	NC
1.23 Launch Tube – Dented or Damaged	1.23 Sentence	2	B1
1.24 Sights – Graticule not Visible	1.24 Segregate and Sentence	3	B1
1.25 Sights GTLS - Inoperable	1.25 Segregate and Sentence	3	B1
1.26 Shoulder Sling – Missing or Broken	1.26 Segregate and Sentence	3	C1
2. Rocket Head			
2.1 Corroded - Light	2.1 Clean and Repaint	4	NC
2.2 Corroded - Heavy	2.2 Sentence	3	D
2.3 Damaged - Superficial	2.3 Acceptable	4	NC
2.4 Damaged – Moderate or Severe	2.4 Sentence	2	D
2.5 Grub Screw – Missing or Protruding >3mm	2.5 Sentence	1	D2
3. Tail Assembly			
3.1 Fins - Damaged	3.1 Sentence	2	D
3.2 Expansion Cone - Damaged	3.2 Sentence	2	D
3.3 Nonel Tube – Damaged or Broken	3.3 Sentence	1	D
3.4 Flash Tube – Damaged or Broken	3.4 Sentence	1	D

Annex Z
(normative)
Specific to type inspection points – Shell HE (base fuzed)

Shell HE (Base Fuzed)			
Inspection Point	**Action**	**Effect Code[66]**	**Condition Code[67]**
1. Nose Plug			
1.1 Nose Plug	1.1.1 Missing – Replace	1/3	NC
	1.1.2 Loose - Secure	3	NC
2. Body			
2.1 Corrosion	2.1.1 Light or moderate – Clean or repaint	3	NC
	2.1.2 Extensive (Non Thin Wall) – Shot blast and repaint	3	NC
	2.1.3 Extensive (Thin Wall) – Sentence	3	D
	2.1.4 Heavy or pitted (Affects Wall Strength) – Sentence	1	D
	2.1.5 Heavy or pitted (Not Affecting Wall Strength) – Shot blast and repaint	3	NC
2.2 Overpaint Gauge	2.2.1 Chamber Gauge – Pass		
	2.2.2 Chamber Gauge – Fail – Rub Down High Spots – Re-Gauge – Pass	3	NC
	2.2.3 Chamber Re-Gauge – Fail – Clean and repaint – Gauge – Pass	3	NC
	2.2.3 Chamber Re-Gauge – Fail – Clean and repaint – Gauge - Fail	2	D

[66] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[67] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Shell HE (Base Fuzed)			
Inspection Point	**Action**	**Effect Code[66]**	**Condition Code[67]**
2.3 Damaged	2.3.1 Superficial, body not weakened and pass gauge	4	NC
	2.3.2 Dented – Gauge – Pass	4	NC
	2.3.3 Dented – Gauge – Fail - Sentence	2	D
	2.3.4 Dented – Moderate of Heavy – Sentence	2	D
	2.3.5 Ovalled or Swollen - Sentence	2	D
2.4 Loose in cartridge Case or Misaligned	2.4.1 Gauge – Pass	4	NC
	2.4.2 Gauge – Fail – Sentence	2	D
	2.4.3 Excessively loose and likely to separate from Case - Sentence	1	D
3. Driving or Obturating Band			
3.1 Missing, Loose, Spilt or Cracked	3.1 Sentence	2	D
3.2 Corroded	3.2.1 Light – Clean	4	NC
	3.2.2 Heavy or moderate - Replace	2	D
3.3 Dented, scored or cut but not likely to affect obturation.	3.3.1 Gauge - Unlikely to affect loading – Acceptable	4	NC
	3.3.2 Gauge Likely to affect loading - Sentence	2	D
3.4 Dented, scored or cut and likely to affect obturation	3.4.1 Sentence	2	D
3.5 Over-painted	3.6 Remove paint from driving band - Acceptable	3	NC
4. Tracer Retaining Plug			
4.1 Missing	4.1 Sentence	2	C2
4.2 Loose or Protruding	4.2.1 If intrusion is clear – Acceptable	3	NC
	4.2.2 Plug intrusion not clear – Sentence	2	C1
	4.2.3 Protruding and set fast - Sentence	2	C1
4.3 Brass disc corroded	4.3 Moderate or Heavy - Sentence	3	C!
5. Base Plug			

Shell HE (Base Fuzed)			
Inspection Point	**Action**	**Effect Code**[66]	**Condition Code**[67]
5.1 Protruding or Loose	5.1 Sentence	1	C2
6. Shell Base			
6.1 Loose	6.1 Sentence	2	B1

Annex AA
(normative)
Specific to type inspection points – Shell HE (nose fuzed or plugged)

Shell HE (Nose Fuzed or Plugged)			
Inspection Point	**Action**	**Effect Code[68]**	**Condition Code[69]**
1. External Body			
1.1 Contaminated in area of fuze, plug or shell	1.1.1 Test for explosive – Confirmed – Sentence	1	C2
	1.1.2 Test for explosive – Not Confirmed – Clean Area	4	NC
1.2 Concentric or Eccentric Overlip (Limit <15mm)	1.2.1 Within limit – Acceptable	4	NC
	1.2.2 Within limit after trying alternative fuze – Acceptable	4	NC
	1.2.3 Outside limit after trying alternative fuze - Sentence	2	B
1.3 Overpaint Gauge	1.3.1 Chamber Gauge – Pass	3	NC
	1.3.2 Chamber Gauge – Fail – Shot Blast – Gauge – Pass	3	NC
	1.3.3 Chamber Gauge – Fail – Shot Blast – Gauge - Fail	2	D
1.4 Corroded	1.4.1 Patches – Clean and repaint	3	NC
	1.4.2 Extensive – Shot blast and repaint	2	NC
	1.4.3 Heavy – Not likely to affect wall strength – Shot blast and repaint	2	NC
	1.4.3 Heavy – Likely to affect wall strength – Sentence	1	D
1.5 Damaged	1.5.1 Pass Gauge and not weakened – Acceptable	4	NC
	1.5.2 Fail Gauge OR Weakened - Sentence	2	D

[68] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[69] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Shell HE (Nose Fuzed or Plugged)			
Inspection Point	**Action**	**Effect Code[68]**	**Condition Code[69]**
1.6 Projectile loose or misaligned in cartridge case (QF)	1.6.1 Gauge – Pass – Acceptable	4	NC
	1.6.2 Gauge – Fail – Sentence	2	D
	1.6.3 Projectile excessively loose - Sentence	1	D
2. Grommet			
2.1 Missing or incomplete	2.1 Replace	3	NC
2.2 Rotted, badly worn or damp	2.2 Replace	3	NC
2.3 Loose or out of position	2.3 Refit	3	NC
2.4 Corroded	2.4.1 Light – Clean	3	NC
	2.4.2 Heavy or moderate - replace	3	NC
3. Driving or Obturating Band			
3.1 Missing, Loose, Spilt or Cracked	3.1 Sentence	2	D
3.2 Corroded	3.2.1 Light – Clean	4	NC
	3.2.2 Heavy or moderate - replace	2	D
3.3 Dented, scored or cut but not likely to affect obturation. (Loose Shell)	3.3.1 Unlikely to affect loading – Acceptable	4	NC
	3.3.2 Likely to affect loading - Sentence	2	D
3.4 Dented, scored or cut but not likely to affect obturation. (QF)	3.4.1 Gauge - Unlikely to affect loading – Acceptable	4	NC
	3.4.2 Gauge Likely to affect loading - Sentence	2	D
3.5 Dented, scored or cut and likely to affect obturation	3.5.1 For Shell <106mm – Damage >9.5mm Width or 6mm depth – Sentence	2	D
	3.5.2 For Shell >105mm – Damage >19mm Width or 6mm depth - Sentence	2	D
3.6 Over-painted	3.6 Remove paint from driving band - Acceptable	3	NC
4. Base Cover or Plate			

Shell HE (Nose Fuzed or Plugged)			
Inspection Point	**Action**	**Effect Code[68]**	**Condition Code[69]**
4.1 Corroded	4.1.1 Not perforated – Clean and repaint	3	NC
	4.1.2 Perforated - Sentence	2	D
4.2 Loose, split or perforated	4.2 Sentence	1	D
4.3 Lifted or distorted	4.3.1 If >5% of total circumference or >6mm in any one area – Sentence	1	D
	4.3.2 If <5% - Acceptable – Submit defect report	4	NC
5. Fuze or Plug/Shell Joint			
5.1 Fuze damaged	5.1.1 Superficial – Acceptable	4	NC
	5.1.2 Safe for handling, movement and storage – Sentence	2	C2
	5.1.3 Unsafe for handling, movement or storage - Sentence	1	D
5.2 Fuze or plug not fully tightened	5.2.1 Fuze threads damaged – Sentence	2	C2
	5.2.2 Plug threads damaged – Sentence	4	NC
	5.2.3 Fuze threads damaged – Reset using tap cleaning fluid	2	NC
	5.2.4 Fuze intrusion outside limits – Sentence	2	C2
	5.2.5 Plug intrusion outside limits - Replace	3	NC
5.3 Fuze or plug set fast	5.3.1 Fuze visually serviceable – Acceptable	4	NC
	5.3.2 Fuze not visually serviceable – Sentence	1	D
	5.3.3 Plug set fast - Sentence	2	D
5.4 Leather washer (if included in design)	5.4.1 Missing – Apply luting	4	NC
	5.4.2 Insufficient – Remove old luting and replace	4	NC
6. Fuze hole			
6.1 Concentricity	6.1.1 Within limit – Acceptable	4	NC
	6.1.2 Within limit after trying alternative fuze – Acceptable	4	NC
	6.1.3 Outside limit after trying alternative fuze - Sentence	2	B

Shell HE (Nose Fuzed or Plugged)			
Inspection Point	**Action**	**Effect Code[68]**	**Condition Code[69]**
6.2 Threads - Corroded	6.2.1 Heavy – Sentence	2	D
	6.2.1 Light or moderate - Clean	3	NC
6.3 Threads - Damaged	6.3 Reset tap cleaning fuze hole	2	NC
6.4 Threads - Contaminated	6.4.1 Test for explosive – Not-confirmed - Remove using brass pic and non-ferrous brush.	3	NC
	6.4.2 Test for explosive – Confirmed - Remove using brass pic and non-ferrous brush	1	NC
7. Cavity			
7.1 Brown liquid and ammonia smell present	7.1.1 Ammonium Nitrate confirmed – Sentence	1	D
	7.1.2 Ammonium Nitrate not confirmed - Clean	3	NC
7.2 Corroded	7.2.1 Light – Clean	3	NC
	7.2.2 Moderate or heavy - sentence	2	D
7.3 Liner or fuze cap well	7.2 Loose – Acceptable	4	NC
	7.2.1 Corroded Light – Clean	3	NC
	7.2.3 Corroded Moderate or Heavy – Replace	3	NC
	7.3 Cracked - Replace	3	NC
7.4 Set Fast Exploder	7.4.1 Undamaged	4	A2
	7.4.2 Damaged	1	C2
	7.4.3 Traces of HE filling – Remove	3	NC
	7.4.4 Other contamination – Test for TNT – Confirmed – Sentence	1	D
	7.4.4 Other contamination – Test for TNT – Unconfirmed – Remove contamination	3	NC
7.5 Paper Tube – Loose, damaged or Damp	7.5 Replace and Shellac Outer Surface	3	NC

Shell HE (Nose Fuzed or Plugged)			
Inspection Point	**Action**	**Effect Code[68]**	**Condition Code[69]**
7.6 Damaged	7.6.1 Light – Repair	3	NC
	7.6.2 Heavy or moderate – Sentence	1	D
7.7 Damp	7.7.1 Remove exploder, paper tube and other inert items – Dry	2	D
	7.7.2 Replace items if necessary		
7.8 Felt Discs	7.8 Missing, damaged or stained - Replace	1	NC
7.9 Cloth paper or discs	7.9 Missing, damaged or stained - Replace	1	NC
8. Topping			
8.1 HE Filling exposed through Topping of the Sealing Compound	8.1 Refill with appropriate Topping	3	NC
8.2 particles of HE Filling in Topping	8.2 Remove loose particles from the cavity	3	NC
9. Lifting Band			
9.1 Held in position on tope of exploder by lacquer shellac or equivalent	9.1 Repair using liquid shellac or equivalent	4	NC

Annex AB
(normative)
Specific to type inspection points – Shell (smoke and illuminating)

Shell (Smoke and Illuminating)			
Inspection Point	**Action**	**Effect Code[70]**	**Condition Code[71]**
1. External Body			
1.1 Concentric or Eccentric Overlip (Limit <15mm)	1.1.1 Within limit – Acceptable	4	NC
	1.1.2 Within limit after trying alternative fuze – Acceptable	4	NC
	1.1.3 Outside limit after trying alternative fuze - Sentence	2	B
1.2 Overpaint Gauge	1.2.1 Chamber Gauge – Pass	3	NC
	1.2.2 Chamber Gauge – Fail – Shot Blast – Gauge – Pass	3	NC
	1.3.3 Chamber Gauge – Fail – Shot Blast – Gauge - Fail	2	D
1.4 Corroded	1.3.1 Patches – Clean and repaint	3	NC
	1.3.2 Extensive – Shot blast and repaint	2	NC
	1.3.3 Heavy – Not likely to affect wall strength – Shot blast and re3aint	2	NC
	1.4.3 Heavy – Likely to affect wall strength – Sentence	1	D
1.4 Damaged	1.4.1 Pass Gauge and not weakened – Acceptable	4	NC
	1.4.2 Fail Gauge OR Weakened - Sentence	2	D
1.5 Projectile loose or misaligned in cartridge case (QF)	1.5.1 Gauge – Pass – Acceptable	4	NC
	1.5.2 Gauge – Fail – Sentence	2	D
	1.5.3 Projectile excessively loose - Sentence	1	D

[70] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[71] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Shell (Smoke and Illuminating)			
Inspection Point	**Action**	**Effect Code[70]**	**Condition Code[71]**
1.6 Filling – White Phosphorus (WP)	1.6.1 Leaking – Immerse in water and remove for demolition	1	D
1.7 Dented (Base Fuzed Only)	1.7.1 Light – Gauge – Pass	4	NC
	1.7.2 Light – Gauge – Fail – Sentence	2	C2
	1.7.3 Moderate or Heavy – Sentence	2	D
	1.7.4 Ovalled or Swollen - Sentence	2	D
2. Fuze or Plug/Shell Joint			
2.1 Fuze damaged	2.1.1 Superficial – Acceptable	4	NC
	2.1.2 Safe for handling, movement and storage – Sentence	2	C2
	2.1.3 Unsafe for handling, movement or storage - Sentence	1	D
2.2 Fuze or plug not fully tightened	2.2.1 Fuze threads damaged – Sentence	2	C2
	2.2.2 Plug threads damaged – Sentence	4	NC
	2.2.3 Fuze threads damaged – Reset using tap cleaning fluid	2	NC
	2.2.4 Fuze intrusion outside limits – Sentence	2	C2
	2.2.5 Plug intrusion outside limits - Replace	2	NC
2.3 Fuze or plug set fast	2.3.1 Fuze visually serviceable – Acceptable	4	NC
	2.3.2 Fuze not visually serviceable – Sentence	1/2	D
	2.3.3 Plug set fast - Sentence	2	D
2.4 Leather washer (if included in design)	2.4.1 Missing or unserviceable - Replace	3	NC
2.5 Nose Bush	2.5.1 Loose – Secure	1	NC
	2.5.2 Corroded - Light – Clean	3	NC
	2.5.3 Corroded - Heavy or moderate - Replace	2	C2
2.6 Luting	2.6.1 Missing – Apply Luting or equivalent	4	NC
	2.6.2 Insufficient – Clean and reapply	4	NC
3. Fuze hole			

Shell (Smoke and Illuminating)			
Inspection Point	**Action**	**Effect Code[70]**	**Condition Code[71]**
3.1 Concentricity	3.1.1 Within limit – Acceptable	4	NC
	3.1.2 Within limit after trying alternative fuze – Acceptable	4	NC
	3.1.3 Outside limit after trying alternative fuze - Sentence	2	B
3.2 Threads - Corroded	3.2.1 Heavy – Sentence	2	D
	3.2.1 Light or moderate - Clean	3	NC
3.3 Threads - Damaged	3.3 Reset tap cleaning fuze hole	2	NC
3.4 Discs Tracing Cloth	3.4 Missing or damaged – Fit new discs	3	NC
4. Nose Plug			
4.1 Loose (Base Fuzed Only)	4.1.1 Containing WP – Immerse in Water – Remove for Disposal	1	D
	4.2.2 Others - Sentence	1	D
5. Base			
5.1 Loose or protruding	5.1 Sentence	1	C2
5.2 Loose (Based Fuzed WP Only)	5.2 Immerse in Water – Remove for Disposal	1	D
6. Grub or Fixing Screw	6.1 Replace using luting or equivalent on threads	3	NC
	6.2 Loose - Secure	3	NC
7. Driving or Obturating Band			
7.1 Missing, Loose, Spilt or Cracked	7.1 Sentence	2	D
7.2 Corroded	7.2.1 Light – Clean	4	NC
	7.2.2 Heavy or moderate - Replace	2	D
7.3 Dented, scored or cut but not likely to affect obturation. (QF)	7.4.1 Gauge - Unlikely to affect loading – Acceptable	4	NC
	7.4.2 Gauge Likely to affect loading - Sentence	2	D
7.4 Dented, scored or cut and likely to affect obturation	7.4 Sentence	2	D
7.5 Over-painted	3.6 Remove paint from driving band - Acceptable	3	NC

Shell (Smoke and Illuminating)			
Inspection Point	**Action**	**Effect Code[70]**	**Condition Code[71]**
8. Grommet			
8.1 Missing or incomplete	8.1 Replace	3	NC
8.2 Rotted, badly worn or damp	8.2 Replace	3	NC
8.3 Loose or out of position	8.3 Refit	3	NC
8.4 Corroded	8.4.1 Light – Clean 8.4.2 Heavy or moderate - Replace	3 3	NC NC
9. Locking or Securing Ring			
9.1 Missing, Loose, Spilt or Cracked	9.1 Sentence	2	D
10. Fuze Well Cap			
10.1 Loose	10.1 Acceptable	4	NC
10.2 Corroded	10.2.1 Light – Clean 10.2.2 Heavy or moderate – Replace	2 2	NC NC
11. Burster Gunpowder			
11.1 Missing or Damp	11.1 Sentence	2	C2
11.2 Leaking, cracked or split	11.2 Remove gunpowder and sentence	1	C2
12. Metal Closing Disc			
12.1 Missing, pierced, lifting or ruptured	12.1 Sentence	3	C1
12.2 Corroded	12.2 Heavy or moderate - Sentence	3	C1
13. Paper Closing Disc			
13.1 Missing, pierced or perforated	13.1 Fit new disc using shellac or equivalent	3	NC
14. Twist or Shear Pins			
14.1 Missing or broken	14.1 Sentence	1	C2

Shell (Smoke and Illuminating)			
Inspection Point	**Action**	**Effect Code**[70]	**Condition Code**[71]
14.2 Corroded	14.2.1 Light – Acceptable	4	NC
	14.2.2 Heavy or moderate – Replace	1	C2

Annex AC
(normative)
Specific to type inspection points – Shot (APFSDS, APDS and practice DS)

Shot (APFSDS, APDS and Practice DS)			
Inspection Point	**Action**	**Effect Code[72]**	**Condition Code[73]**
1. Shot			
1.1 Corroded	1.1.1 Light or Moderate – Acceptable 1.1.2 Heavy - Sentence	3 2	NC D
1.2 Projectile loose or misaligned in cartridge case	1.2.1 Gauge – Pass – Acceptable 1.2.2 Gauge – Fail - Sentence	4 2	NC D
1.3 Projectile excessively loose	1.3 Sentence	1	D
2. **Sub Projectile**			
Refer to Manufacturer's Instructions			
3. Front Sheath, Nose or Sabot			
3.1 Damaged	3.1.1 Superficial without weakening or distortion 3.1.2 Weakened or distorted - Sentence	4 2	NC D
3.2 Dented, cracked or split	3.2 Sentence	2	D
4. Sabot			
4.1 Loose	4.1 Sentence	1	C2
4.2 Petals cracked	4.2 Sentence	1	D
5. Centring or Driving Band			

[72] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.

[73] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Shot (APFSDS, APDS and Practice DS)			
Inspection Point	**Action**	**Effect Code[72]**	**Condition Code[73]**
5.1 Loose	5.1 Sentence	2	C2
5.2 Cracked or split	5.2.1 Sentence	2	D
	5.2.2 Split type centring band - Sentence	2	C2
5. Oversize or undersize	5.3.1 Gauge – Pass	4	NC
	5.3.2 Gauge – Fail – refer to Manufacturers Instructions		

Annex AD
(normative)
Specific to type inspection points – Small arms ammunition

Small Arms Ammunition			
Inspection Point	**Action**	**Effect Code**[74]	**Condition Code**[75]
1. Percussion Cap			
1.1 Missing, corroded or waterproof missing	1.1 Sentence	2	D
1.2 Misfired, damaged or proud of base	1.2 Sentence	1	D
2. Bullet			
2.1 Dented, distorted, scored, split, loose or malformed	2.1 Sentence	2	D
2.2 Cannelure missing	2.2 Sentence	2	D
2.3 Cannelure wax	2.3.1 Missing - Acceptable - Defect Report 2.3.2 Excessive - Acceptable - Defect Report	4 4	NC NC
3. Cartridge Case			
3.1 Dented, split, pierced, distorted, corroded or crimp missing	3.1 Sentence	2	D
3.2 Discolouration	3.2 Acceptable	4	NC
3.3 Shotgun ammunition – torn, swollen or damp	3.3 Sentence	2	D
3.4 Propellant	3.4.1 Escaping – Sentence 3.4.2 Missing - Sentence	1 2	D D
3.5 Deposit	3.5.1 Light – Acceptable 3.5.2 Heavy - Sentence	4 2	NC D

[74] This is the Effect Code to be allocated if the recommended system at Clause 6 is used.
[75] This is the Condition Code to be allocated if the recommended system at Clause 6 is used.

Small Arms Ammunition			
Inspection Point	**Action**	**Effect Code[74]**	**Condition Code[75]**
4. Closing Wad or Disc			
4.1 Missing, loose or damp	4.1 Sentence	2	D

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 07.30

Third edition
March 2021

Ammunition processing operations - Safety, risk reduction and mitigation

UN SaferGuard
Securing ammunition, protecting lives

IATG 07.30:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Any task involving the repair, testing, modification, disassembly or breakdown of ammunition and explosives carries with it an increased risk of accidental initiation. It is therefore regarded as explosives processing and should be carried out in a facility suitable for the explosives process activity and normally in isolation from the storage of bulk stocks of explosives. This location is generally known as an ammunition process building (APB).

Explosives may function accidentally due to stimuli such as impact, friction, spark, heat, electrostatic discharge, radio frequency induced current, reaction with another substance or inherent chemical instability. The inadvertent initiation of even small quantities of explosives can lead to death or serious injury and may, through subsequent events, lead to a major catastrophe. Ammunition processing operations range from simple visual inspections, through component replacement to full breakdown.

It is much more hazardous to disassemble or breakdown explosives items than it is to fill them. During manufacture the components that contribute the greatest potential hazards are assembled to the main charge as late as possible, but in items for breakdown such components will be present when operations are begun. In many items where there is a requirement for breakdown, deterioration and corrosion will have occurred; this may have affected the explosives as well as the mechanical parts and will tend to make disassembly much more difficult and more hazardous than assembly.

This IATG module provides guidance on the general safety and management aspects of ammunition and explosive processing, whilst other IATG provide more specific safety advice for storage and processing operations[3].

These processes entail more risk than storage and therefore:

a) are conducted away from storage

b) are carried out in buildings designed to minimum standards (in order to protect both the ammunition and the personnel),

c) follow specific work plans (I&RIs/SOPs) identifying the process steps, safety hazards, equipment, and safety requirements,

d) are planned to expose the minimum number of personnel and amount of ammunition to risk.

[3] Specific safety precautions for the conduct of breakdown operations are contained in IATG 06.50 *Specific safety precautions.*

Ammunition processing operations - Safety and risk reduction and mitigation

1 Scope

This IATG module introduces and explains the specific requirements for safety and risk reduction and mitigation during the processing of ammunition and explosives within explosive facilities. It complements IATG 06.10:2015[E] *Control of explosive facilities,* IATG 06.30:2015[E] *Storage and handling* and IATG 06.50:2015[E] *Specific safety precautions* which all provide further safety advice for the storage of ammunition and explosives and the overall safety control of an explosives facility. The requirements of these IATG shall also be applied, where appropriate, to the processing of ammunition and explosives.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘ammunition process building’ (APB) refers to *a building or area that contains or is intended to contain one or more of the following activities: maintenance, preparation, inspection, breakdown, renovation, test or repair of ammunition and explosives*.

The term ‘processing’ refers to *the activities undertaken in a process facility that involves building, repair, refurbishment, breakdown, test and inspection of explosives articles and their components.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) 'shall' indicates a requirement: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) 'should' indicates a recommendation: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) 'may' indicates permission: It is used to indicate a course of action permissible within the limits of the document.

d) ‘can’ indicates possibility and capability: It is used for statements of possibility and capability, whether material, physical or casual.

4 Risk assessment (LEVEL 2)

A risk assessment shall be carried out prior to starting any ammunition processing activity. This should be in accordance with the guidelines contained within IATG 02.10:2015[E] *Introduction to risk management principles and processes* and the specific requirements of this IATG.

The minimum information of the hazardous properties of the explosive article for processing should be available for the individual carrying out the risk assessment, which are:

a) design drawings;

b) previous processing technical instructions for the type of explosive article;

c) sensitiveness data;[4]

d) chemical stability information;[5]

e) hazard classification codes;[6] and

f) health hazards.[7]

Any risk assessment should start from the perspective of remote processing or testing wherever possible, but if this is considered not to be necessary, or reasonably practicable, then established and tested processes should be used. The risk assessment should direct the selection of the most appropriate tools, equipment and processing to be used. Examples are shown in Table 1:

Findings	Details	Appropriate tools, equipment or process
Explosive vapour hazard	An explosive vapour hazard may be present during the process.	▪ Category A APB (or rooms) required.
Explosive dust risk	Bare, exposed explosive may be present during the process; hence explosive dust may be present.	▪ Category B APB (or rooms) required.[8]
Low sensitiveness[9]	The hazard data sheet suggests that the explosive is very vulnerable to initiation by static electricity.	▪ Anti static measures required. ▪ Non-sparking tools. ▪ Anti-static floor. ▪ Personal earthing equipment (Hazardous Area Personal Test Meter (HAPTM)).
Explosion risk	Disassembly requires high force to gain access to munition, hence there is a risk of explosion.	▪ Remote process needed. ▪ Operator protected behind armoured screen. ▪ One person risk.
Irritant fumes	The re-painting process requires the use of paint that produces irritant fumes.	▪ Protective face masks to be worn. ▪ Open windows, doors etc to provide air throughput or fit extractor fan.

Table 1: Example risk assessment findings

The findings of the risk assessment should be formally recorded and other documentation amended as necessary, for example:

a) the explosive limits licence[10] may require a temporary reduction in permitted net explosive quantity (NEQ) during the period of the processing task; or

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[4] This should be available from an Explosives Hazard Data Sheet, which is available from the manufacturer.

[5] This should be available from the records maintained in accordance with IATG 07.10:2021[E] *Surveillance and in-service proof.*

[6] This should be available from the records initiated under IATG 03.10:2015[E] *Inventory management*.

[7] See Footnote 6.

[8] See Clause 4 of IATG 05.40:2015[E] *Safety standards for electrical installations* for definition of building electrical categories.

[9] This is not the same as sensitivity. See definitions in IATG 01.40:2015[E].

[10] See IATG 02.30:2015[E] *Licensing of explosive facilities*.

b) standard inspection and repair instructions (I&RI) may require amendment.

5 Safe systems of work (LEVEL 2)

The safe processing of ammunition and explosives shall be achieved through establishing and implementing safe systems of work (SSOW). These SSOW will be guided by the risk assessment and the guidance contained within this IATG. In summary they should cover:

a) trained and competent staff (see Clause 6.6);

b) appropriate levels of direct supervision and overall management (see Clause 6.6);

c) suitable written work instructions (I&RIs) (see Clause 6.5);

d) appropriate equipment; and

e) adequate work facilities.

6 Controlling the risk (management)

There are a range of ammunition management systems and techniques available for controlling the risk during the processing of ammunition and explosives. These should all be implemented prior to the commencement of work.

6.1 Explosive limits (LEVEL 1)

A major element of risk reduction and mitigation shall be to limit the quantity of ammunition and explosives present in the APB (either being processed or in temporary storage). The guiding principle should be that if the task can be efficiently and effectively carried out by single explosive items it should be. Yet it is accepted that for minor tasks and lower calibre systems, operational efficiency will require the use of production line techniques. Technical judgement, combined with the results of the risk assessment, should be used to determine appropriate explosive limits for the APB during processing operations. These limits shall rarely be the maximum theoretical limit as determined in accordance with IATG 02.30:2015[E] *Licensing of explosive facilities.* The physical NEQ stored shall be the minimum necessary for the safe and efficient conduct of the processing task and shall never exceed the necessary quantity for one day's work.

The total licensed content of NEQ at or in an APB shall include ammunition in 'buffer stock' awaiting processing, the ammunition being processed and ammunition post processing. The level of post-processed, and pre-processed, ammunition should be kept as low as possible by regular collections and return to normal storage, and by good management principles by the I/C APB.

6.2 Personnel limits (LEVEL 1)

A limitation on the number of staff and visitors present within the APB shall be applied. This is known as the Personnel Limit. There should be two levels of personnel limits:

a) normal. This is the personnel limit for those persons normally permanently located within the APB during the processing task; and

b) maximum. This is the personnel limit that includes persons normally permanently present, transient staff involved in the delivery and collection of explosives, transitory supervisory staff and visitors.

c) personnel limits shall be kept to the minimum necessary for the safe and efficient completion of the processing task.

6.3 Lower risk operations (LEVEL 2)

Separate processing tasks on different types of ammunition and explosives in a single location should not normally be permitted. Separate tasks may be permitted to be carried out simultaneously if the explosive risk is assessed as low (e.g. for Hazard Division 1.2 or 1.4 ammunition where there is no mass explosion hazard) and there is a low probability of initiation. Such tasks could include the visual inspection or marking of ammunition.

A processing task shall never be considered as a low risk operation where exposed explosives substances are present or could be exposed as a result of the process.

6.4 Restricted tasks (LEVEL 2)

Due to higher levels of inherent risk the following operations shall only ever be undertaken by named individuals who are specifically licensed for that particular processing task by the national technical authority. Assumption of an appointment previously occupied by a named individual shall not mean that authority is automatically transferred to the new incumbent. These operations are:

a) experiments to alter the type or size of charges in propellant or bursting charges;

b) breakdown operations on strange, unknown, unfamiliar or foreign ammunition and explosives;

c) the manufacture of home made explosives (HME); and

d) the manufacture of training or simulated improvised explosive devices.

6.5 Work instructions (LEVEL 2)

Formal, written work instructions shall be developed for each type of processing task. The level of detail in the work instruction should be determined by the risk involved, the complexity of the task and the competency levels of the staff. The work instructions shall be available in the APB for consultation during the processing task.

Work instructions should consist of:

a) general work instructions on basic explosive safety that are applicable to all processing tasks; and

b) specific work instructions applicable to a particular processing task.

An example general work instruction is at Annex C for information.

An example specific work instruction, in the form of an Inspection and Repair Instruction (I&RI), is at Annex D for information.

6.6 Supervision and competency (LEVEL 2)

Individuals shall be considered to be competent[11] to supervise or undertake ammunition processing operations when:

a) they have been trained to an appropriate level on the specific task;

b) they have been educated to an appropriate level as to the risks inherent in the handling and processing of ammunition and explosives; and

c) they have gained sufficient experience of the task under direct supervision so as to be considered safe to work on the task.

[11] An individual's 'competence' to undertake any task is determined by a combination of his/her training, education and practical experience specific to that task. Just because someone has been doing the same ammunition related task for 20 years does not necessarily mean he/she is 'competent'; the person may just be extraordinarily lucky!

Records of training and qualifications shall be maintained throughout the career of the individual. These should be used as the basis for the written authorisation of individuals as to their competency to supervise or undertake specific ammunition processing tasks. No individual may process ammunition within an APB without written authorisation unless under the direct supervision of a qualified individual; this allows for 'on the job' training.

7 Controlling the risk (processes)

7.1 Processing facility (LEVEL 2)

Ammunition processing tasks should ideally take place in a building designed specifically for that purpose, although it may take place in a temporary location as long as all safety requirements can be met.

7.2 Exposed ammunition and explosives (LEVEL 1)

The quantity of exposed explosives (e.g. those unpacked) shall be kept to a minimum. Ideally only one container should ever be open at one time. All explosives that are not being worked on should be appropriately covered to minimise the risk of initiation by spark.

7.3 Remote operations (LEVEL 2)

Remote or semi-remote operations shall be the first choice wherever possible.

Remote operations shall always take place where:

a) the explosive composition is sensitive; or

b) the operation is considered more likely than normal to result in a fire or explosion.

The type of remote operation and the protection level required shall be determined by the type and quantity of explosive present. For example:

c) for small quantities of sensitive explosives or small devices adequate explosives guards,[12] protective gloves and tweezers may be all that is necessary; or

d) for larger quantities of explosives an armoured barrier with remotely operated tools may be required.

7.4 Personal protective equipment and clothing (LEVEL 1)

There may be a need for personal protective equipment or protective clothing (PPEC) during some ammunition processing tasks. The aim of PPEC should be to:

a) provide a degree of protection against the effects of accidental fire or explosion;

b) provide protection from health hazards; and

c) reduce hazards such as static electricity.

The risk assessment should determine the need for PPEC and the type required should be stated in the work instruction for the task (Clause 6.5).

[12] Explosives guards or armoured barriers should be engineered to be resistant to 125% of the normal explosive load of the ammunition being processed.

A suitable material for PPEC during processing tasks is probanised cotton[13] as this provides some protection from fire. Other types of PPEC may include face masks,[14] disposable gloves, eye protection or personal static electricity dischargers. PPEC shall be provided in appropriate sizes and designs for the existing personnel, which may include men and women with different body shapes and sizes.

7.5 Authorised tools and equipment (LEVEL 2)

A formal system should be put in place to ensure that only tools and equipment that are intrinsically safe to use in process facilities are used; a list should be maintained. It should be the responsibility of the national technical authority to advise on appropriate tools and equipment for use during processing tasks. The use of iron or steel tools should be discouraged and non-sparking equivalent materials used instead. Further guidance is at Annex E.

The tools and equipment authorised for each process task should be stated in the work instruction (Clause 6.5 and Annex D).

7.6 General procedures (LEVEL 1)

General procedures should be implemented that are common to every processing task as shown in Table 2.

Activity	Rationale	Requirement
Pre and Post Work Inspection	This ensures that the APB, tools and equipment are clean and in good working order. It also ensures that tools etc are not left inside machinery or a munition.	▪ This should be the responsibility of the task supervisor. ▪ 100% check of all tools. ▪ Cleanliness check. ▪ Unserviceable tools replaced.
Clear Exits	Unobstructed exits ensure that emergency evacuation and emergency service access is unimpeded.	▪ All doors and windows unfastened and unlocked. ▪ Security bolts and bars removed.
Minimise Flammable Material	Reduces fire risk.	▪ These include cotton rags, paints and solvents. ▪ Only the minimum required for each task should be in the APB. ▪ After use they should be stored in metal containers outside the APB and at least 1m from the wall. ▪ Rags with oil are susceptible to spontaneous combustion. These should be removed immediately from the APB.
Explosive Waste	Reduces fire and/or explosion hazard.	▪ This should be segregated from all other waste. ▪ Explosively contaminated cleaning materials should be treated as explosive waste. ▪ Explosive waste should be disposed of in accordance with IATG 10.10:2015[E] *Demilitarization and destruction of conventional ammunition.*

[13] Probanised cotton is cotton that is specially treated to improve fire resistance.

[14] A requirement for face masks should not be used as a substitute for forced air extraction if fume levels are hazardous to health.

Activity	Rationale	Requirement
Temperature in APB	Reduces fire and/or explosion hazard.	▪ The temperature within the APB should be maintained at a level consistent with the comfort of staff and the safety of the explosives. ▪ A temperature range of 13⁰C to 24⁰C should be optimum.
Humidity in APB	Reduces initiation risk due to static electricity.	▪ The humidity within the APB should be damp enough to reduce the risk of initiation due to static electricity.
Clean Area	Reduces the risk of dirt and grit being introduced into ammunition and explosives. Reduces the risk of contaminated PPEC leaving the APB.	▪ A separate room (normally a cloakroom) should be provided within the APB to allow staff to change into work clothes. ▪ This room should be accessible from the outside and offer appropriate privacy for male and female personnel. ▪ Within the room a 'clean line' should be established.
Electrostatic Discharge	Minimises the risk of ignition of primary explosives and electro-explosive devices (EED) from electrostatic discharge.	▪ See IATG 06.50:2015[E] *Special safety precautions.*
Spark Prevention	Reduces initiation risk due to sparking.	▪ Use soft soled footwear and clothing without metal fasteners. ▪ Use non-ferrous authorised tools and equipment. ▪ Floors, fittings and finishes susceptible to sparking should not be used (e.g. ceramic floor tiles).
Radio Frequency Hazards	Minimises the risk of ignition of electro-explosive devices (EED) from induced electrical current.	▪ Prohibit mobile telephones within the APB.[15] ▪ The location of radio transmitters should be controlled.

Table 2: General procedures for processing tasks

8 Contingency planning

8.1 Accident procedures (LEVEL 1)

Procedures shall be established that state the action to be taken in the event of an accident. These should be in accordance with IATG 11.10:2015[E] *Ammunition accidents: reporting and investigation*. As a guide, the following actions should be considered:

a) cease all processing tasks and make safe any ammunition or explosives that may present a further hazard;

b) give immediate first aid to any injured personnel. In the case of fatal accidents, bodies should not be touched except to confirm death. Out of respect, bodies should be covered until they can be removed from the scene;

c) summon medical assistance if required;

[15] They should be prohibited from the entire explosives area anyway.

d) immediately report the accident and await guidance from the nominated technical investigator (IATG 11.10:2015[E] *Ammunition accidents: reporting and investigation*);

e) cordon off the area to preserve evidence for the investigating authority. Nothing should be moved and everything should remain as it is in situ;[16] and

f) record the names of potential witnesses.

8.2 Thunderstorms (LEVEL 1)

Thunderstorms potentially contain a massive build up of static electricity within the atmosphere and thus present a serious hazard to ammunition and explosive processing. Work on electro-explosive devices (EED) and primary explosives is to cease immediately when there is a thunderstorm in the vicinity.[17] Where it is safe to do so, ammunition and explosives being worked on are to be made safe and all ammunition and explosives are to be repackaged and grounded.

The APB should then be evacuated and made secure until the thunderstorm has passed by.

8.3 Unsafe ammunition (LEVEL 1)

Procedures should be developed to deal with any spillage of explosives or any ammunition that is found to be in an unsafe condition (e.g. the exudation of explosives or if ammunition is inadvertently dropped).

Work should stop immediately until the situation has been resolved. If it is safe to do so all remaining ammunition and explosives should be repacked prior to evacuation of the APB.

These types of incidents may require the need for explosive ordnance disposal (EOD) support.

9 Heating explosives during processing (LEVEL 3)

Equipment for heating explosives will incorporate features designed to avoid overheating. There are special requirements for electrical appliances used for heating explosives during processing.[18] Whatever medium is used for heating or cooling explosives in processing it is essential to consider at the design stage how to control the temperature within safe limits. The provision of an independent overriding protection feature to cover failure of primary controls is essential.

10 Breakdown of explosive items (LEVEL 2)

It is much more hazardous to break down explosives items than to fill them. During initial filling and assembly, components that contribute the greatest potential hazards are assembled to the main charge as late as possible. Items undergoing breakdown will have these components present when breakdown operations begin. In many items where there is a requirement for breakdown, deterioration and corrosion will have occurred and this may have affected the explosives as well as the mechanical parts and will thus make disassembly much more difficult and potentially more hazardous than assembly.

10.1 The requirement for breakdown (LEVEL 2)

Ammunition shall only be broken down if there is a definite advantage to be gained by so doing, for instance for safer disposal or for inspection. If a safe system of working cannot be determined the explosives should be destroyed by enclosed incineration or by detonation of the complete item.

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[16] Photographs should be taken prior to moving the casualty for medical treatment if at all possible.

[17] It may be possible to get prior warning from the national meteorological office.

[18] See IATG 05.40 *Safety standards for electrical installations*.

10.2 Inspection of stocks awaiting disposal (LEVEL 2)

Explosives awaiting breakdown should be regularly inspected. Such an inspection, with special reference to the onset and progress of corrosion, will assist in ensuring that explosives items are broken down before they become dangerous.[19]

10.3 Risk assessing and planning breakdown of ammunition (LEVEL 2)

Explosive items shall not be broken down until the risks have been assessed, the operation has been planned and a layout and system of work, with appropriate safety measures, has been approved.

10.3.1. Plan of operation (LEVEL 2)

Preparation and approval of working instructions for operatives shall be completed before the breakdown commences. The training of operatives in the operations they will carry out should include an explanation of the safety rules applicable to that work. It may be necessary to institute a system of accounting for the arisings from explosives breakdown so that the likelihood of explosives or their components being overlooked, stolen or mistakenly disposed of is minimised. The possibility of hazards arising from incompatibilities not present in the original item as manufactured should be provided for.

In preparing the plan of operation the following data should be obtained:

a) drawings and specifications from the manufacturer;

b) safety information from the manufacturer;

c) explosives hazard data sheets; and

d) history of the stores including such aspects as rough handling, temperature cycling, sea water contamination etc.

10.3.2. Breakdown under precautions (LEVEL 3)

Where the risk assessment determines the need, breakdown operations considered to have an unacceptable hazard shall be carried out by remote control. The supply of filled items to the breakdown process and the removal of the components after breakdown should be so arranged that there is no accumulation of exposed explosive compositions and filled components beyond the approved limits.

10.4 Machinery and tools for breakdown operations (LEVEL 2)

Consideration should be given to the design of machinery and tools so that they cannot be wrongly used. For example, the leverage which is possible with tools should be related to the amount of work, generation of heat by friction, etc that the item can safely tolerate. Any tool which is hollow and which could conceivably be used to fit over the handle of another tool and so increase the leverage obtainable should either be excluded from the breakdown area or be modified to prevent its misuse. Adjustable tools should not be prescribed for breakdown operations.

The number and type of tools permitted for the operation should be listed in sufficient detail to preclude any likelihood of doubt. The unauthorised entry into the breakdown area of any tool not on the permitted list or modification of any machine or tool to alter its mode of operation shall not take place. The marking, colour coding of tools or use of a tool board are examples of good practice and will facilitate checking.

[19] See IATG 07.10 *Surveillance and proof*.

10.4.1. Use of water flushing equipment and autoclaves

Steaming out and water flushing shall only be carried out in a facility specially designed and provided for the purpose. Care shall be taken to avoid the mixing of incompatible explosives and also the contamination of explosives with any harmful materials. Therefore, the use of the same facility for steaming or flushing out explosives and items filled with inert ingredients should be avoided. Steaming out requires that special precautions be taken to prevent contamination of the surrounding area, and of aquifers in particular. Operatives are at particular risk from the toxic effects of TNT. Appropriate risk assessments shall be made and personal protective equipment and medical surveillance shall be provided.

10.5 Items not to be heated (LEVEL 1)

Items containing explosives shall not be heated to release the tightness of screw threads unless this operation has been authorised in the operating instructions. It is important to ascertain that such authorised heating will not cause migration of the filling into screw threads with subsequent increase in potential hazard during unscrewing operations. A trial designed to test this possibility should be carried out in advance and it should cover such ranges of temperature and time as may be used during normal working conditions. Unless a fail-safe system of automatic temperature control is used, there shall be a considerable margin of safety in the limits prescribed.

10.6 Sensitive components (LEVEL 2)

In breakdown operations, parts that are susceptible to initiation by light blows, friction etc, shall be protected during handling operations and this protection will only be removed at the latest practical stage. An example of this is the use of clips to cover primers in cartridge cases.

10.7 Difficult items (LEVEL 1)

Operatives engaged in the breakdown of explosive items shall be given precise and detailed instructions on the action to take if a situation arises which is not covered by the procedure laid down. Provision shall be made for the identification, collection and removal of all explosive items that cannot be broken down by the accepted procedure. Special consideration should be given to their storage and subsequent disposal.

10.8 Breakdown procedures (LEVEL 2)

The following examples of breakdown are not detailed procedures but should be used as an indicator of what should be included in working instructions.

10.8.1. Fixed ammunition

The order in which component parts of a complete round of gun ammunition undergoing breakdown should be removed will be decided after consideration of the nature and condition of the filling and, in particular, of the propellant in the cartridge. It is sound practice to sub-divide the quantity of explosives at risk as soon as practicable. Separation of the projectile from the cartridge case is an example. Components should usually be disassembled in order of decreasing sensitivity and for the projectile this will normally be as follows:

a) initiating devices such as fuzes;

b) gaines or exploders; and

c) the main filling.

Having segregated the projectile for later disassembly, the propellant charge should be removed and placed in a suitable receptacle. If the propellant is single base, provision shall be made to guard against the generation of static and its potential discharge by earthing and the use of anti-static or full conducting conditions as necessary. The cartridge primer should be removed using the appropriate tool and placed in a suitable container.

Fuzes removed should be suitably packed and segregated for later breakdown and disposal. Where there is any doubt as to the safety of manual removal of fuzes they should be removed by remote operation. If possible fuze magazines should be removed and packaged for later disposal. Further breakdown of fuzes should only be undertaken if essential for trials or test purposes and shall be carried out under strict control using approved tools and procedures. Exploders and any other internal components should be removed and separately packaged for later disposal.

Projectiles shall have the fuze well plugged with suitable paper and be taped closed, then suitably packaged for later disposal.

10.8.2. Aircraft bombs

Aircraft bombs shall not be broken down until it has been confirmed that they do not contain detonators or fuzes. Aircraft bombs should be broken down singly in isolation. The degree of isolation should be no more than is necessary to prevent the propagation of explosion to other explosives stores and to arrest fragments. The following technique described applies to all bombs completed to specifications that call for liners to the exploder cavity and sealing compositions to the filling. If the bombs being processed are not to this specification great care should be taken as exposed explosive will be present and may have migrated into screw threads etc.:

a) the plug representing pistol or fuze should be unscrewed and the exploder cavity examined to ensure that there is no detonator present;

b) exploders should be removed by means of lifting hooks or failing this by using kit sticks (a dowel rod with a rubber suction cap fitted to one end). Any exploders not removable by these methods shall be left and the bombs plugged for disposal; and

c) the exploder container and base plate should be removed by unscrewing the base plate. The component parts shall be separated at a later process.

10.8.3. Rocket tails and motors

The work instruction for the breakdown of rocket tails and motors shall be designed to prevent damage to the igniter and to ensure the protection of operatives against fire. It is particularly important to keep the igniters that have been removed from items away from the recovered propellant. This shall be achieved by a good working place layout and constant supervision.

10.8.4. White phosphorus (WP) and red phosphorus (RP) ammunition

WP or RP ammunition shall be broken down in two locations that are well separated from one another. The explosive components present shall be removed in the explosives area and the phosphorus on an area of the site reserved for work of this nature. If ammunition containing explosives does find its way to the WP or RP section of the breakdown operation it shall be removed immediately. All explosives are strong oxidants and violent reactions can occur if they come into physical contact with phosphorus. It is only by 100 per cent examination for the absence of explosive before the removal of white or red phosphorus is begun that freedom from accidents due to the presence of explosive can be ensured. During the removal of white or red phosphorus from ammunition special precautions shall be taken against fire hazards.

Annex A
(normative)
References

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

a) IATG 01.40 *Terms, glossary and definitions*. UNODA. 2015;

b) IATG 02.10 *Introduction to risk management principles and processes*. UNODA. 2015;

c) IATG 05.40 *Safety standards for electrical installations*. UNODA. 2015;

d) IATG 06.10 *Control of explosive facilities.* UNODA. 2015;

e) IATG 06.30 *Storage and handling*. UNODA. 2015;

f) IATG 06.50 *Specific safety precautions.* UNODA. 2015;

g) IATG 06.80 *Inspection of ammunition*. UNODA. 2015;

h) IATG 07.10 *Surveillance and proof*. UNODA. 2015; and

i) IATG 10.10 *Demilitarization and destruction of conventional ammunition.* UNODA. 2015.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UN ODA) holds copies of all references[20] used in this guide. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UN ODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[20] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guide:[21]

a) AASTP-1, Edition 1 (Change 3). *Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives.* NATO. 04 May 2010; and

b) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UN ODA) holds copies of all references[22] used in this guide. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UN ODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[21] Data from many of these publications has been used to develop this IATG.

[22] Where copyright permits.

Annex C
(informative)
Example General Work Instruction

GENERAL WORK PROCEDURES FOR AMMUNITION PROCESS BUILDINGS

C.1 General. This procedure is designed to provide general information on the daily operating of Ammunition Process Buildings (APBs). Specific information on technical functions may be found in the relevant Inspection and Repair Instruction (I&RI) appropriate to the task in hand. For the purpose of this procedure the term APB is to be taken to mean any location where an ammunition process, with the exception of disposals, is carried out.

C.2 APB Supervisor. The APB Supervisor is responsible to the Technical Officer in Charge (TOIC)[23] for the technical efficiency and supervision of all personnel in the APB.

C.3 Commencement of Work. Prior to commencement of work each day, or on taking over an APB, the APB Supervisor is to ensure that:

a) the APB is searched for any suspicious objects;

b) that all tools, equipment and expendable stores are inspected for serviceability;

c) the required number and grade of staff are present and that all members of the staff are conversant with the duties detailed in the relevant I&RI;

d) the staff are fully briefed as to the task in hand with particular emphasis on fire and accident procedures, and any special safety precautions to be implemented;

e) the staff are correctly dressed in the approved protective clothing and footwear;

f) the correct Fire Division Symbols are displayed with any Supplementary Symbols where necessary;

g) all doors are unlocked or unbolted and panic bolts fitted to exits are functioning correctly; and

h) the task board within the APB is completed to show:

- TOIC;
- APB Supervisor;
- Nature and type of ammunition being processed;
- Details of task;
- Hazard Division, Compatibility Group and Fire Division Symbol of the ammunition;
- Persons nominated for the fire party;
- Personnel- and Explosive-Limits (shown as total rounds in APB and rounds exposed);
- Location of First Aid Post;
- Overall explosive limits of the APB;
- Emergency telephone numbers for TOIC, Senior Fire Officer (SFO), Fire and Medical services; and
- Copy of the relevant I&RI, Fire Orders, Explosive Limit Licence for the APB and national health regulations for any substances used .

[23] The TOIC should normally be the senior ammunition qualified officer responsible for overall explosive safety at the facility.

C.4 Supervision. The APB Supervisor is to maintain constant supervision of the following points:

a) discipline, control and guidance of all APB staff;

b) Explosive and Personnel Limits within the APB and correct segregation of Compatibility Groups;

c) adherence to the instructions for the task detailed in the relevant I&RI; and

d) observance of working hours as detailed by the TOIC.

The APB Supervisor is not to leave the APB whilst work is in progress.

C.5 Cessation of Work.

a) the APB Supervisor is directly responsible for the security and safety of the APB;

b) the APB Supervisor is to ensure that on the cessation of work at break periods:

- all personnel are checked out of the APB;
- that no ammunition filling is left exposed. For example, all shells are to be plugged or fuzed;
- that electricity and machinery, with the exception of alarm circuits, is turned off; and
- all external doors and windows are secured.

c) Additionally, on cessation of daily work he/she is to ensure that:

- all paints, solvents, cleaning cloths and other inflammable materials are removed from the APB and returned to the Paint Store;
- that ammunition is repacked and grounded; and
- the security guards are to be informed if ammunition is to be left in an APB overnight. TOIC approval must be sought to leave ammunition in an APB overnight.

C.6 APB Maintenance.

a) a high standard of cleanliness is to be maintained at all times. Floors are to be kept clean by washing with water and soap or detergent. The use of floor polish on conducting floors is prohibited;

b) tools and equipment are only to be retained for the task in hand and for imminent tasks. All other tools and equipment are to be returned to storage;

c) rubbish and waste materials are to be kept to a minimum and placed in the receptacles provided. Appropriate Free From Explosive (FFE) Procedures are to be followed as laid down in *insert unit document reference*.[24]

d) outside areas and roadways are to be kept free of all nails, tape banding etc which could cause damage to vehicle tyres; and

e) the APB Supervisor is to ensure that a weekly check is carried out on the interior and exterior fabric of the APB. Particular attention is to be paid to front doors, transit doors, windows, pneumatic and electrical installations including security lights, lightning conductors, drains and concrete traverse supports. Any defects are to be reported to the Ammunition Storage Officer (ASO) for inclusion in the APB defects diary. Defects involving safety or operation of the APB are to be reported immediately.

[24] The relevant document reference should be inserted here by anyone choosing to use these general work instructions.

C.7 Fire Precautions.

a) smoking is strictly prohibited within the APB and NO SMOKING signs shall be displayed at all important places in the APB. Individuals shall be prohibited from possessing or carrying smoking materials;

b) the APB Supervisor is to acquaint him/herself and his/her staff with the regulations governing fire precautions and action to be taken in event of a fire;

c) fire orders, including the location of the APB Assembly Point, are to be prominently displayed. Personnel are to be instructed as to their specific duties in event of fire, and the fire party listed on the APB process board;

d) fire doors and escape routes are to be clearly marked, and kept clear of obstructions at all times. All personnel are to be provided with an unimpeded escape route at least 1m wide, and are not to be enclosed by Conveyor Gravity Rollers (CGR), benches or other equipment. Lift up sections of CGR do not constitute an escape route. All doors (including transit doors) are to be kept unbolted or unlocked whilst the APB is occupied;

e) approach roads are to be kept clear at all times to permit access to emergency services; and

f) fire practices are to be held monthly.

C.8 Accidents. The APB Supervisor is to ensure that all personnel are conversant with the action to be taken in the event of an accident involving ammunition. When in the opinion of the APB Supervisor there is any possibility of an explosion occurring as a result of an accident involving ammunition, the APB is to be immediately evacuated to the nearest Assembly Point. TOIC and the ASO are to be informed by the fastest possible means. No person is to re-enter the APB until authorised to do so by TOIC.

C.9 First Aid.

a) First Aid boxes are to be held in each APB and Transit Area. The location of the nearest first aid trained persons is to be displayed on the APB task board, these persons being responsible for the administration of first aid to the 'walking injured'. Serious cases are to be reported immediately to the TOIC and Medical Centre;

b) injuries are to be recorded in the APB Accident Register. In the event of serious injuries, written statements regarding the circumstances of the accident should be obtained from any witnesses as soon as practicable by the senior present person;

c) the APB accident register is an accountable document; and

d) when ammunition containing white phosphorus (WP) is held in an APB, a supply of clean water or copper sulphate solution ($CuSO_4$) and gauze is to be readily available. All personnel are to be aware of the immediate action to be taken for the treatment of phosphorus burns and a copy of the procedure to be followed is to be displayed in the APB. A large container of water capable of holding a full container of WP ammunition shall also be available.

C.10 Health and Safety.

a) The APB Supervisor is directly responsible for the health and safety of all staff whilst employed in the APB. The health regulations contained in *insert unit document reference* are to be followed at all times. Particular attention is to be paid to the correct use of protective clothing and gloves, respirators and barrier cream whenever these are required. Compressed air equipment is to be operated in accordance with *insert unit document reference*;

b) general safety precautions to be observed during movement and handling of ammunition and safety precautions specific to the nature involved are contained in *insert unit document reference* and the I&RI appropriate to the task in hand respectively. The APB Supervisor is to ensure that these precautions are rigorously observed by all APB staff;

c) the APB Supervisor is to take immediate action to halt any dangerous practice within the APB, whether or not it involves ammunition;

d) the APB Supervisor is to ensure that the relevant Safety Data Sheets for hazardous materials in use are displayed within the APB; and

e) the correct safety shoes are to be worn by all personnel employed within an APB.

C.11 Free From Explosive (FFE) Procedure.

a) the FFE procedures are contained in *insert unit document reference*;

b) all waste material and rubbish is to be bagged and have a FFE Certificate completed and taped to the outside of the bag. The APB Supervisor is to ensure that no bagged waste or rubbish is permitted to leave the APB without this certificate; and

c) staples and other sharps are not to be bagged. They are to be kept in a rigid container, marked and disposed of as at Sub Paragraph 11b.

C.12 Thunderstorms.

a) during thunderstorms all personnel are to be evacuated from buildings containing ammunition. When conditions indicate that thunderstorms are approaching the APB all work on ammunition requiring anti-static precautions is to cease and the ammunition is to be re-packed and grounded. The APB is to be evacuated until the threat has passed; and

b) when thunderstorms are sudden or imminent, the repacking and grounding of ammunition is to be carried out at the discretion of the APB Supervisor, subject to the evacuation of personnel being of prime importance. Ammunition not requiring anti-static precautions need not be re-packed.

C.13 Visitors.

a) any visitor entering the APB is to report immediately to the APB Supervisor. Work may proceed in the presence of authorised visitors provided that such visits are transitory and do not impede any person in the performance of his or her duties;

b) the personnel limit for the APB may exclude such visitors; and

c) the limit may also exclude not more than two supervisory personnel for periods of not more than 30 minutes at a time.

C.14 Anti-Static Precautions. The procedure to be followed when anti-static precautions are required is detailed in *insert unit document reference*.

C.15 Working Categories. The APB Supervisor is to ensure that the correct category is to be applied to the process in hand. The procedures specified in *insert unit document reference* are to be strictly adhered to. Particular attention is to be paid to APB cleanliness when special working categories are in force.

C.16 Prohibited Articles. The APB Supervisor is to ensure that all APB staff are aware of the regulations concerning prohibited articles. A list of these articles should be displayed at the entrance to each Explosives Area.

C.17 Accounting. The APB Supervisor is to ensure that all ammunition and components entering or leaving the APB are strictly controlled and accounted for. Checks are to be carried out frequently to ensure that ammunition cannot leave the APB incorrectly assembled. These checks should be carried out at least four times daily. On discovery of an apparent discrepancy all work is to cease until the matter is resolved and the appropriate TOIC is to be informed immediately.

C.18 APB Transit Areas.

a) whenever ammunition is being loaded or unloaded in an APB Transit Area the engines of all non-Cat C protected vehicles[25] are to be switched off; and

b) the maximum safe stacking heights for ammunition are not to be exceeded.

C.19 Foreman. The Foreman of the team employed within the APB may carry out the duties of the APB Supervisor if appropriately qualified. He/she is responsible to the APB Supervisor for the following, and must carry them out him/herself if acting as APB Supervisor:

a) control of all ammunition and components passing through the APB;

b) calling forward of ammunition to ensure a regular flow of work and collection of processed ammunition;

c) maintenance of all tools and equipment within the APB to ensure availability and serviceability;

d) maintenance of an adequate supply of expendable stores;

e) general cleanliness of the APB and surrounding areas and roadways;

f) adherence to all regulations;

g) checking of the interior and exterior fabric of the APB and surrounding area and reporting of all defects;

h) direct supervision of staff employed on non-technical tasks within the APB;

i) ensuring that all rubbish and waste materials have been inspected to ensure they are FFE before removal from the APB, and that a completed FFE Certificate is attached; and

j) instruction of all workers employed in the APB in the performance of their duties.

C.20 Documentation. The procedures contained within *insert unit document reference* are to be adhered to.

C.21 Ammunition Locations ex-APB. Ammunition leaving an APB after processing, that is, ammunition which has been subject to a change in Configuration, Condition or Hazard Division, may require a new storage location to be allocated. The ammunition accountant is to be contacted prior to the ammunition leaving the APB to obtain a receipt location for the adjusted ammunition.

[25] See IATG 05.50 *Vehicles and mechanical handling equipment (MHE) in explosives facilities*.

Annex D
(informative)
Example Specific Inspection and Repair Instruction (I&RI)

Technical Officer in Charge (TOIC) Inspection & Repair Instruction

Part 1 – General

Designation of Ammunition:	Correct Technical Name ADAC / NSN / Other specific identifier Lot # / BKI Provide sufficient information to identify the ammunition type that is the subject of the I&RI. If the inspection is relevant to a specific lot or batch, this should also be included.
Process/Task:	INSPECTION & REPAIR Specify the operation that is to take place, e.g. PERIODIC ROUTINE EXAMINATION or IN-SERVICE SURVEILLANCE or BREAKDOWN FOR DISPOSAL or REPLACEMENT OF FUZES etc.

1.1 TOIC Authorisation

I&RI Serial No:	*Insert serial number identifying processing unit*
Copy No:	*x* of *total copies*
Signature:	
Name and Appointment	M Y SIGNATURE TOIC
Date:	29 February 2020

1.2 Contents

1.3 Warnings & Cautions

WARNINGS:	WARNING In this section tabulate all warnings that are identified in the process Operative Instructions at Part 8. Warnings provide critical safety information and should be highlighted in RED BOLD block capitals.
Cautions:	Caution In this section tabulate all Cautions that are identified in the process Operative Instructions at Part 8. Cautions provide important safety information and should be highlighted in Red Bold using sentence case, to differentiate from the warnings.

1.4 Preliminaries

Location:	e.g. Ammunition Process Building A3, Western Processing Area Provide the specific location at which the task is to be undertaken. If required this section should include any specific safety requirements for the location, such as: • Process Building to be traversed on all sides • Electrical Category B • Conducting or Anti-Static regime required in the Process Building • etc.
Personnel:	**a.** Supervisor: Ammunition Supervisor (IATG L3) [AS] **b.** Operators: (1) 3 x Ammunition Processor (IATG L2A) [AP1, AP2, AP3] (2) 1 x Ammunition Handler (IATG L1) [AH1] (3) 1 x Ammunition Handler (IATG L1) & MHE Operator [AH2] *NB – references shown in square brackets are to identify individual operatives in order to allocate specific tasks in the Sequence of Operations (Part 5) and develop individual Operative Instructions (Part 8).* The composition of the team and the qualification levels will vary depending on the task. The team shall be large enough to complete the task safely and efficiently. Additional supervisors and/or operators under training may be authorised, but the total number of personnel present shall remain ALARP.
Personnel Limits:	Normal: This is the personnel limit for workers normally permanently located in the APB during the processing task. (e.g. 6 using the above example for personnel) Maximum: This is the personnel limit that includes all workers normally permanently present, transient staff involved in the delivery and collection of explosives, transitory supervisory staff and visitors. (e.g. 8 based on the above example for personnel) Definitions from IATG 07.10 s6.2. NB – The Normal and Maximum personnel limits must be in compliance with the ELL for the Process Building.
Explosive Limits:	Maximum: In accordance with ELL (specified by HD) Task: Specify in kg the maximum NEQ that shall be present in the APB at any given time to enable safe and efficient operations. The Task NEQ should take account of how much ammunition is expected to be processed in a normal day (or session) of work. The Task Explosive limit shall be the lower of the NEQ authorised on the ELL and the NEQ of the amount of ammunition expected to be processed in a day (or session).

HCC	List the HCC of: • Ammunition and components at start of task • Ammunition and components at end of task Some tasks may entail break down of ammunition and replacement of components, e.g. fuzes. The HCC of the ammunition may change as a result of the changed component and/or the removed component may have a different HCC to the new component.
Publications and Documentation:	List all relevant publications and documents that are to be readily available during the processing task, e.g. APB General Work Instruction; Ammunition specific Technical Documentation; etc.

Part 2 – Munitions, Components & Packaging

2.1 Munitions (Complete Rounds)

Quantity	Designation	Description	Remarks
Total number of rounds to be processed	ADAC / NSN / Other specific identifier (as per "Designation of Ammunition" box in Part 1)	Correct Technical Name (as per "Designation of Ammunition" box in Part 1)	Provide sufficient information to identify the ammunition type that is the subject of the I&RI. If the inspection is relevant to a specific lot or batch, this should also be included.

2.2 Energetic Components

In this table list all energetic components that will be required to complete the processing task and any energetic components that may be generated as part of the breakdown of the ammunition undergoing processing. E.g. Fuzed artillery ammunition that is having the fuzes removed to be replaced with lifting eyes will generate Fuzes as energetic components at the end of the task.

Serial	Quantity	Designation	Description	Remarks
1.		ADAC / NSN / Other specific identifier	Correct Technical Name (of component)	Specify if the component is consumed or generated during the processing task.
2.				
3.				
4.				
5.				

2.3 Non-Energetic Components

In this table list all non-energetic components that will be required to complete the processing task and any energetic components that may be generated as part of the breakdown of the ammunition undergoing processing. E.g. It may be necessary to change rubber "O-ring" seals due to deterioration. The table should identify the new "O-ring" seal to be inserted in the ammunition. The removed components should also be listed and the remarks column specify their disposal, e.g. "Waste – for contaminated disposal" or "For inspection, refurbishment and return to store" etc.

Serial	Quantity	Designation	Description	Remarks
1.		ADAC / NSN / Other specific identifier	Correct Technical Name (of component)	Specify if the component is consumed or

				generated during the processing task.
2.				Suggested "disposal" of components removed from ammunition.
3.				
4.				
5.				

2.4 Packaging

In this table list all packaging that is required for the complete munition or any components. This should include both external (e.g. ammunition boxes) and internal (e.g. spacers) packaging. Packaging that is to be re-used need not be specified, unless it requires re-marking as part of the process.

Serial	Quantity	Designation	Description	Remarks
1.		UN Packaging Code or other specific identifier	Packaging description	e.g. Describe metal or wooden box; quantity of rounds/components per item of packaging
2.				
3.				
4.				
5.				

Part 3 – Tools & Equipment

3.1 Specialist Tools

List any tools that are provided by, or on behalf of, the ammunition manufacturer that are developed especially for operations on this particular ammunition type. This will often be the case for guided weapons, but may also include, for example, function safety testers for electronic artillery fuzes.

Any tools that have to be specially manufactured for the processing task should also be listed.

Serial	Catalogue No	Description	Quantity	Remarks
1.	If the tool has been catalogued, its reference should be included. This may be NSN or other catalogue system.	Provide as specific a description as possible, e.g. “Function Safety Tester, Fuze Electronic [specific designation]”		Include any comments, such as if a tool has to be locally manufactured.
2.				
3.				
4.				
5.				

3.2 General Equipment & Tools

List any common tools that may be used for multiple processing tasks on different ammunition natures.

Serial	Catalogue No	Description	Quantity	Remarks
1.	If the tool has been catalogued, its reference should be included. This may be NSN or other catalogue system.	Provide as specific a description as possible, e.g. “Mobile Dispenser for Oscillation Mill Wound Steel Strapping 19mm”		Include any additional information, e.g. “Non-Ferrous tool.”
2.				
3.				
4.				
5.				

3.3 Expendable Items

List any expendable items and consumables. This includes items used as part of the task and any consumable items of Personal Protective Equipment, e.g. nitrile gloves.

Serial	Catalogue No	Description	Quantity	Remarks
1.	If available	Provide as specific a description as is necessary, e.g. "Protective Coveralls, without metallic fastenings."		Where appropriate, an explanation of what the item(s) will be used for may be included.
2.				
3.				
4.				
5.				

Part 4 – Sequence of Operations

Designation of Ammunition:	Correct Technical Name ADAC / NSN / Other specific identifier Lot # / BKI Provide sufficient information to identify the ammunition type that is the subject of the I&RI. If the inspection is relevant to a specific lot or batch, this should also be included.
Process/Task:	INSPECTION & REPAIR Specify the operation that is to take place, e.g. PERIODIC ROUTINE EXAMINATION or IN-SERVICE SURVEILLANCE or BREAKDOWN FOR DISPOSAL or REPLACEMENT OF FUZES etc.

The Sequence of Operations is a step by step description of the processing task. The Sequence may be divided into individual or team-sized stages to aid understanding.

- Specific operations may be repeated at different points of the process, e.g. “visual inspection of propellant augmenting cartridges” may occur after removal of a mortar round from its packaging and again before it is returned to its packaging. These operations would have the same Operation Number.
- Tasks must be allocated to an operative by grade and, where necessary, by individual operative number.
- The task statement shall be succinct. Complex tasks should be broken down into simple sub-steps. The task statement says only what is to be done, not how it is done.
- Any tools & equipment required for the task shall be listed and cross-referenced with the tools & equipment lists at Part 4.

Serial	Operation	Operative	Task	Tools & Equipment Required
1.		Identified in Personnel box in section 1.4 above, e.g. AS, AP2, AH2 etc.	e.g. “Remove mortar bomb from packaging and place on processing bench.”	
2.				
3.				
4.				
5.				

Part 5 – Outline Process Chart

Designation of Ammunition:	Correct Technical Name ADAC / NSN / Other specific identifier Lot # / BKI Provide sufficient information to identify the ammunition type that is the subject of the I&RI. If the inspection is relevant to a specific lot or batch, this should also be included.
Process/Task:	INSPECTION & REPAIR Specify the operation that is to take place, e.g. PERIODIC ROUTINE EXAMINATION or IN-SERVICE SURVEILLANCE or BREAKDOWN FOR DISPOSAL or REPLACEMENT OF FUZES etc.

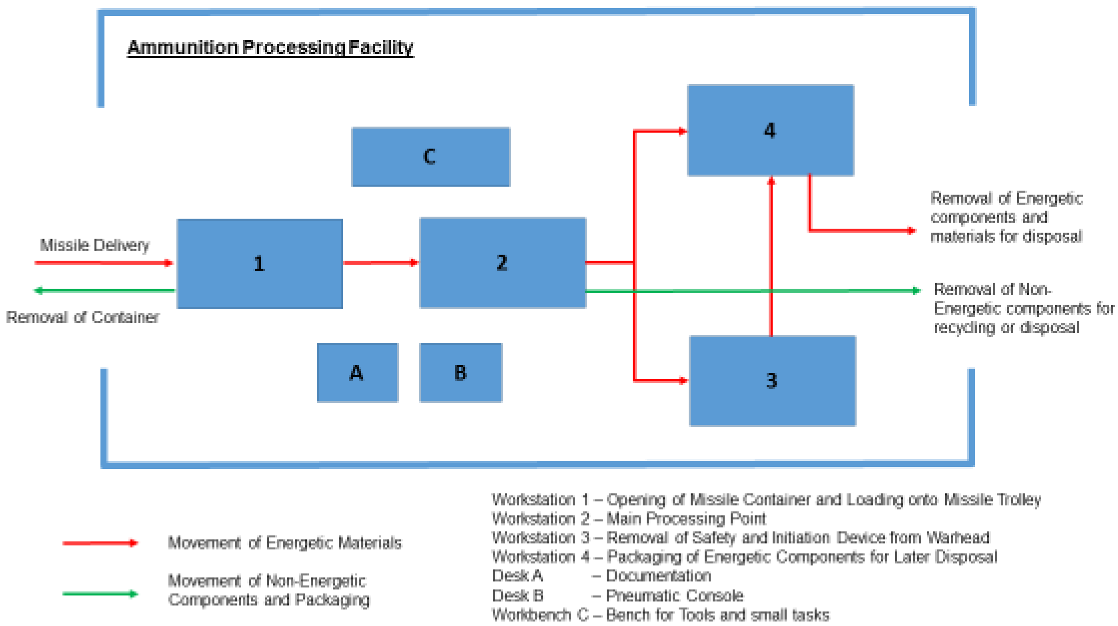
The format for the Outline Process Chart may be a simple list or a flow diagram. The important aspects are that:

- Operations and Inspections shall be listed in a logical order.
- The Chart shall show changes of state, e.g. from fuzed round to plugged etc.
- All materials and components being introduced to the main process line shall be shown.
- All materials and components being removed from the main process line shall be shown.

Part 6 – Process Area Flow Diagram

Designation of Ammunition:	Correct Technical Name ADAC / NSN / Other specific identifier Lot # / BKI Provide sufficient information to identify the ammunition type that is the subject of the I&RI. If the inspection is relevant to a specific lot or batch, this should also be included.
Process/Task:	INSPECTION & REPAIR Specify the operation that is to take place, e.g. PERIODIC ROUTINE EXAMINATION or IN-SERVICE SURVEILLANCE or BREAKDOWN FOR DISPOSAL or REPLACEMENT OF FUZES etc.

This may be in one of two formats, or a combination. One format is to show a diagrammatic layout of the processing area with the flow of the munition through the various workstations. The example shown here was used for a processing instruction for the breakdown of 9M33M OSA Surface-to-Air missile (SA-8 "Gecko"):



If more detail of exactly what task is carried out at each workstation, this can be shown in a flow process chart, as per the attached example. This could either be as a table, or as a conventional flow chart with the operation numbers (as shown in the example) shown at each stage of the flow.

Part 7 – Operative Instructions

Designation of Ammunition:	Correct Technical Name ADAC / NSN / Other specific identifier Lot # / BKI Provide sufficient information to identify the ammunition type that is the subject of the I&RI. If the inspection is relevant to a specific lot or batch, this should also be included.
Process/Task:	INSPECTION & REPAIR Specify the operation that is to take place, e.g. PERIODIC ROUTINE EXAMINATION or IN-SERVICE SURVEILLANCE or BREAKDOWN FOR DISPOSAL or REPLACEMENT OF FUZES etc.

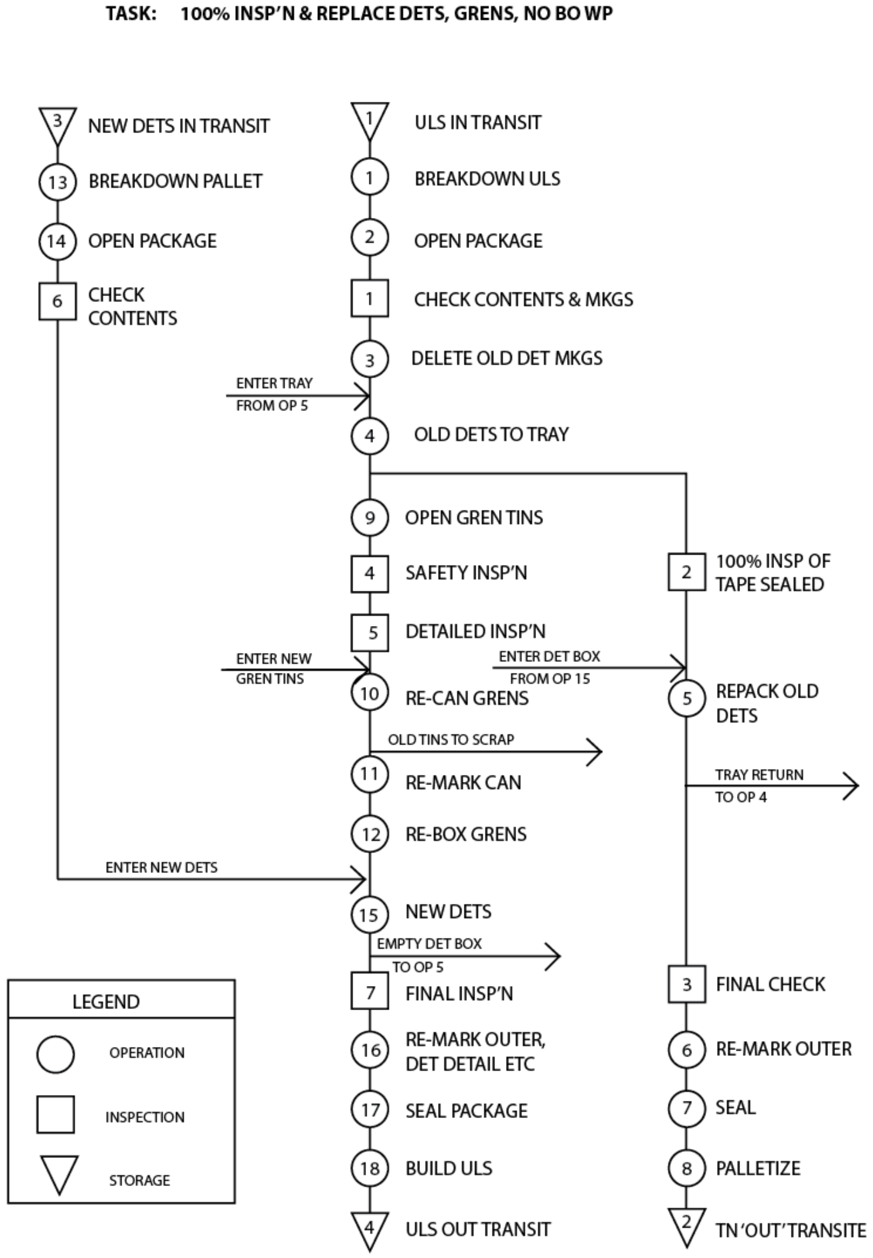
Each operative involved in the processing task, as identified in the Personnel Box at Part 1, section 1.4 shall be provided with a personalized Operative Instruction Sheet. For each individual the task instructions shall:

- State exactly what is to be done.
    - All inspection points shall be listed in a logical order.
- State how it is to be done.
    - The TOIC must satisfy himself/herself that the method stated is the safest effective way for the task to be completed.
    - Diagrams, drawings and photographs should be used where possible to illustrate how the task step is to be completed.
- State the order in which it is to be done.
- State all tools & equipment required for the task.
- All Safety points and information shall be **HIGHLIGHTED**.

Operative Name:	A MOWTECK
Operative Grade:	Ammunition Processor [AP2]
Task:	e.g. Receive, Unpack and Visually Inspect the Ammunition

Serial	Operation	Task Instructions	Tools & Equipment Required
1.	Cross-refer to Sequence of Operations at Part 5	Detailed, step-by-step instructions.	
2.		Include Safety information: WARNING: ALL WARNINGS ARE TO BE INCLUDED IN RED BOLD BLOCK CAPITALS AND LISTED IN THE TABLE AT PART 1, SECTION 1.3. Caution: All Cautions are to be included in Red Bold (Sentence Case) and listed in the table at Part 1, Section 1.3.	
3.			

4.			
5.			


TASK: 100% INSP'N & REPLACE DETS, GRENS, NO BO WP
3 NEW DETS IN TRANSIT
13 BREAKDOWN PALLET
14 OPEN PACKAGE
6 CHECK CONTENTS
1 ULS IN TRANSIT
1 BREAKDOWN ULS
2 OPEN PACKAGE
1 CHECK CONTENTS & MKGS
3 DELETE OLD DET MKGS
ENTER TRAY FROM OP 5
4 OLD DETS TO TRAY
9 OPEN GREN TINS
4 SAFETY INSP'N
5 DETAILED INSP'N
ENTER NEW GREN TINS
10 RE-CAN GRENS
OLD TINS TO SCRAP
11 RE-MARK CAN
12 RE-BOX GRENS
ENTER NEW DETS
15 NEW DETS
EMPTY DET BOX TO OP 5
7 FINAL INSP'N
16 RE-MARK OUTER, DET DETAIL ETC
17 SEAL PACKAGE
18 BUILD ULS
4 ULS OUT TRANSIT
2 100% INSP OF TAPE SEALED
ENTER DET BOX FROM OP 15
5 REPACK OLD DETS
TRAY RETURN TO OP 4
3 FINAL CHECK
6 RE-MARK OUTER
7 SEAL
8 PALLETIZE
2 TN 'OUT' TRANSITE
LEGEND
OPERATION
INSPECTION
STORAGE

Annex E
(informative)
Guidance on processing tools and equipment (LEVEL 3)

E.1 All tools and equipment used for processing explosives and munitions should comply with the requirements of the relevant national technical authority. A formal system of approval should be operated which confirms that the tools and equipment are suitable for use in the relevant processing environment, comply with national legislation and, where appropriate, are acceptable to the national technical authority for the munition concerned.

E.2 All materials used in the construction of a machine, its tools and associated equipment that are likely to come into contact with explosives, should be approved as compatible with the explosives concerned. Compatibility in this context means that the material shall not produce any chemical or physical interaction to cause the explosives to deteriorate and cause fire, explosion or render them unserviceable. Due regard must be given to the requirement that the material chosen must not be liable to produce sparks.

E.3 All equipment and machinery and their related components will be bonded together and earthed to prevent electrical discharges. See IATG 05.40:2015[E] *Safety standards for electrical installations* and IATG 05.50:2015[E] *Vehicles and mechanical handling equipment in explosives facilities.*

E.4 Hoppers etc. feeding explosives to machines should be sited and protected to minimise the transmission of fire and explosion and their effects on the operatives. The quantity of explosives shall be kept as low as possible bearing in mind the need for efficient operation. Particular care is required with small arms propellants as these may burn to detonation if the depth of bed is sufficient (see the Explosives Hazard Data Sheet for the particular propellant).

E.5 Machinery for use with explosives shall be designed to keep frictional effects of moving parts to a minimum. Consideration shall be given to the robustness of the machines and any possibility of distortion under load that could compromise the clearances between moving parts during operation.

E.6 Where there is a possibility that they could work loose and fall into mixing machinery, nuts should be secured in position by drilling through them and their bolts and securing them with twisted wire. Blind holes in a machine where explosives can accumulate, especially if threaded, should to be avoided. Where such cavities are unavoidable they shall be closed off or filled.

E.7 When machines are designed or selected, due regard should be paid to their suitability for inspection, dismantling and cleaning. A suitable receptacle shall be provided where leakage or spillage of explosives or oil from a machine occurs. Receptacles should be readily removable so that they may be emptied frequently.

E.8 Electrical circuits should be designed to the requirements of IATG 05.40:2015[E] *Safety standards for electrical installations*.

E.9 All control gear should be designed to 'fail' to a known safe condition, (using 'fail to safe' principle).

E.10 A maintenance regime should be devised, in conjunction with the manufacturer of the equipment, for all machinery used for processing of explosives. This shall be recorded and held by the user of the machine. It should include the measurement of any critical clearances and the location of all lubrication points on a machine. Only lubricants compatible with the materials being processed should be used. Machinery should be designed to prevent the lubricant and explosives from contaminating each other. The maintenance regime should include a visual examination to ensure that explosives dust does not accumulate. Details of the routine maintenance carried out, including lubrication, should be recorded in the maintenance logbook for each machine.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL
AMMUNITION TECHNICAL
GUIDELINES

IATG
08.10

Third edition
March 2021

Transport of ammunition

UN SaferGuard
Securing ammunition, protecting lives

IATG 08.10:2021

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The transport of dangerous goods (which includes ammunition and explosives) should be regulated in order to prevent, as far as possible, accidents to persons or property and damage to the environment, the means of transport employed or to other goods.

With different regulations in every country and applying to different modes of transport, the international movement of ammunition and explosives would be seriously impeded, if not made impossible and unsafe, without international agreements. As ammunition and explosives can also be subject to other kinds of constraints (i.e. safe storage requirements and environment protection factors), consistent agreements for their safe transport within and between States are essential.

In order to ensure consistency between various regulatory systems, the United Nations has developed mechanisms for the harmonization of hazard classification criteria[3] during transport and safe transport conditions. These are accepted by other international agreements that relate to the transport of ammunition and explosives by road, rail, air or sea.

Changes to the original packaging invalidates the hazard classification and requires reassessment.

[3] Refer to IATG 01.50 *UN Explosive Hazard Classification System and Codes.*

Transport of ammunition

1 Scope

This IATG module introduces the extant international agreements and instruments for the safe transportation of conventional ammunition.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 General

Responsibility for the transport of dangerous goods issue within the UN system lies with the UN Economic Commission for Europe (UNECE)[4] whose mandate includes the establishment of norms, standards and conventions to facilitate international cooperation on transportation within and outside the European region.

UNECE is responsible for the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).[5] This is a single, globally harmonized system to address the classification of chemicals, labels, and safety data sheets during transportation; this includes military and civil explosives, which is explained more fully in IATG 01.50 *UN Explosive Hazard Classification System and Codes*.

[4] http://www.unece.org/trans/danger/what.html .

[5] *United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. ST/SG/AC.10/30/Rev.6. Geneva. United Nations. 2016.

4.1 UN Model Regulations[6]

The *United Nations Recommendations on the Transport of Dangerous Goods* (referred to as *UN Recommendations* and sometimes as the '*Orange Book')* have been developed by the United Nations Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods in the light of technical progress, the advent of new substances and materials, the exigencies of modern transport systems and, above all, the requirement to ensure the safety of people, property and the environment. They are addressed to governments and international organisations concerned with the regulation of the transport of dangerous goods, including ammunition and explosives.

The *UN Recommendations* are presented in the form of the *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*[7] (referred to as the *UN Model Regulations*). They aim at presenting a basic scheme of provisions that will allow uniform development of national and international regulations governing the various modes of transport; yet they remain flexible enough to accommodate any special requirements that might have to be met. It is expected that governments, intergovernmental organisations and other international organisations, when revising or developing regulations for which they are responsible, will conform to the principles laid down in the *UN Model Regulations*, thus contributing to worldwide harmonization in this field.

The structure, format and content of the *UN Model Regulations* should be followed to the greatest extent possible in order to create a more user-friendly approach, to facilitate the work of enforcement bodies and to reduce the administrative burden. Although only a recommendation, the *UN Model Regulations* were drafted in the mandatory sense (i.e., the word 'shall' is employed throughout the text rather than 'should') in order to facilitate direct use of the *UN Model Regulations* as a basis for national and international transport regulations.

The *UN Model Regulations* that relate to ammunition and explosives are structured as shown in Annex C.

The *UN Model Regulations* are a complementary document to the GHS and contain details of the symbols and hazard classifications required for the safe transport of ammunition and explosives. This hazard classification system is explained within IATG 01.50 *UN Explosive Hazard Classification System and Codes*, which is a normative reference to this IATG.

Ammunition and explosives should, therefore, be classified, labelled and marked during transportation in accordance with the requirements of IATG 01.50 *UN Explosive Hazard Classification System and Codes*.

Ammunition and explosives should be transported in accordance with the requirements of the *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations.*[8]

In order to meet the UN hazard classification criteria, thus ensuring, as far as possible, that ammunition and explosives are safe to transport, Class 1 items must be packaged in their full-service pack (FSP). Once outside their FSP their UN Hazard Classification Code (HCC) is no longer extant. HCC are allocated after a series of stringent tests; the HCC is only applicable to that specific item packed in the packing configuration in which it was tested.

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[6] Extracted from http://www.unece.org/trans/danger/publi/unrec/rev13/13nature_e.html.

[7] *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Nineteenth revised edition), ST/SG/AC.10/1/Rev.19, , New York and Geneva, United Nations, 2015. *(Referred to as the UN Model Regulations). https://shop.un.org/*

[8] The *UN Model Regulations* have been used as the basis for transport mode specific requirements, which are covered in this IATG under Clauses 5 to 8.

5 Transport of ammunition by road

Although the *UN Model Regulations* provide the basic framework for the safe transport of explosive by road, they are designed to be generic of transport mode and not specific to road transport. The *European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)*[9] was therefore developed by the UNECE, which is specifically designed to cover the transport of dangerous goods (including ammunition and explosives) by road. ADR closely follows the layout, structure, language and requirements of the *UN Model Regulations.*[10]

The Agreement itself is short and simple. The key article is the second, which states that, apart from some excessively dangerous goods, other dangerous goods (including ammunition and explosives) may be carried internationally in road vehicles subject to compliance with:

a) the conditions laid down in ADR Annex A for the carriage of ammunition and explosives, in particular as regards their packaging and labelling; and

b) the conditions laid down in ADR Annex B, in particular as regards the construction, equipment and operation of the road vehicle carrying the ammunition and explosives.

Ammunition and explosives should therefore be transported by road in accordance with the requirements of the *European Agreement Concerning the International Carriage of Dangerous Goods by Road.*

6 Transport of ammunition by rail

The international agreement that regulates the safe transport of dangerous goods (including ammunition and explosives) by rail is the *Convention for International Carriage by Rail (COTIF)*.[11]

COTIF is managed through the Intergovernmental Organization for International Carriage by Rail (OTIF)[12] [13] whose principal objective is to develop the uniform systems of law that apply to the carriage of passengers and freight in international through traffic by rail. These systems of law have been in existence for decades and are known as the CIV[14] and CIM[15] Uniform Rules which are effectively contracts of carriage across state boundaries.

OTIF has further developed an *International Ordinance on the Transport of Dangerous Goods by Rail (RID)*, (*Appendix I to Annex B to the Convention for International Carriage by Rail*).

Ammunition and explosives should therefore be transported by rail in accordance with the requirements of the *International Ordinance on the Transport of Dangerous Goods by Rail (RID)*.

7 Transport of ammunition by air

Dangerous goods, which include ammunition and explosives (Class 1), are carried regularly and routinely by air. To ensure they do not put an aircraft and its occupants at risk there are extant

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[9] *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)*, ECE/TRANS/257 (Vol 1 and II), New York and Geneva. 01 January 2017.

[10] ADR is also consistent with the structure of RID (see Clause 6) and of the IMDG Code (see Clause 8).

[11] *Convention for International Carriage by Rail (COTIF)*. Edition 1. December 2010

[12] www.otif.org

[13] 50 states are members of OTIF (as at 1 May 2017).

[14] *Uniform Rules concerning the Contract for Carriage of Passengers and Luggage by Rail.*

[15] *Uniform Rules concerning the Contract for Carriage of Goods by Rail.*

international standards, which each State, under the provisions of the *Chicago Convention*,[16] [17] should introduce into national legislation. This system ensures governmental control over the carriage of dangerous goods by air and gives world-wide harmonization of safety standards.

Annex 18 of the *Chicago Convention* deals with the safe transport of dangerous goods by air. In general, it sets down broad principles, but one of the Standards requires that dangerous goods be carried in accordance with the *Technical Instructions for the Safe Transport of Dangerous Goods by Air*[18] (referred to as the *'Technical Instructions')*. States are required by Annex 18 to have inspection and enforcement procedures to ensure that dangerous goods are being carried in compliance with the requirements.

The *'Technical Instructions'* are managed by the International Civil Aviation Organization (ICAO) and contain a very comprehensive set of requirements; among other things they provide for the classification of dangerous goods and have a list of them. The list identifies those goods that are:

a) forbidden under any circumstances;

b) forbidden on both passenger and cargo aircraft in normal circumstances but could be carried in exceptional circumstances subject to exemption by the States concerned;

c) forbidden on passenger aircraft but permitted on cargo aircraft in normal circumstances; and

d) permitted on both passenger and cargo aircraft in normal circumstances.

The *'Technical Instructions'* require that all dangerous goods be packaged and, in general, restrict the quantity per package according to the degree of hazard and the type of aircraft (i.e. passenger or cargo) to be used. There is generally no restriction on the number of packages per aircraft.

The *'Technical Instructions'* stipulate the packing type and methods to be used, including the detailed specifications for the packaging and the stringent testing regime they must successfully complete before they can be used. There are requirements for the markings and labels for packages and the documentation for consignments.

In the *'Technical Instructions'* there is a requirement that every package of dangerous goods is inspected externally by the operator before carriage to ensure it is in a fit state and appears to comply with all the relevant requirements. Packages are subject to:

a) loading restrictions;

b) segregation of those containing incompatible dangerous goods; and

c) restraining methods to prevent movement in flight.

Aircraft operators should be aware of what dangerous goods have been loaded on their aircraft; in the event of an aircraft accident the *'Technical Instructions'* require that they shall, as soon as possible, inform the State in which the accident occurred of what was on board and where it was located. However, it is possible that, depending on the circumstances and place of an accident, this information may not be available instantly.

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[16] *Convention on International Civil Aviation, Annex 18. The Safe Transport of Dangerous Goods by Air*. (Fourth Edition). ICAO. July 2011.

[17] There are currently 191 signatories to the Chicago Convention.

[18] *ICAO Technical Instructions for the Safe Movement of Dangerous Goods by Air*. (Doc 9284).

The *'Technical Instructions'* also require that operators shall report to the relevant authority accidents and incidents involving dangerous goods. States in turn should have procedures in place to investigate such occurrences.

The *'Technical Instructions'* contain training requirements, which should apply to everyone involved in consigning, handling and carrying dangerous goods, cargo and passenger baggage. These include the need for refresher training at two-year intervals and the keeping of training records. There are specific responsibilities for shippers and operators. Consignment shippers shall ensure staff preparing consignments of dangerous goods receive training or that another organisation with trained staff is used. Aircraft operators shall ensure their own staff and those of their handling agents are trained. Training programmes for operators should be subject to approval by the State of the operator.

Therefore, ammunition and explosives should be transported by air in accordance with the latest versions / amendments to:

a) Annex 18 to the *Convention on International Civil Aviation, The Safe Transport of Dangerous Goods by Air*. (Fourth Edition). IACO. July 2011; and

b) *IACO Technical Instructions for the Safe Movement of Dangerous Goods by Air.* (Doc 9284).

The International Air Transport Association (IATA) has produced a 'field manual' version of the ICAO *'Technical Instructions'.* The IATA *Dangerous Goods Regulations*[19] (DGR) present the requirements for shipping dangerous goods by air in a user friendly, easy to interpret format. It also includes additional information that can assist shippers in making sure their consignments are in compliance and will be accepted quickly and easily by the airlines. Finally, since IATA member airlines are somewhat stricter in their requirements than the *ICAO Technical Instructions*, the DGR specifies more precisely how to prepare a shipment. The DGR should, therefore, also be consulted prior to transporting ammunition on an IATA member airline.

8 Transport of ammunition by sea

The carriage of dangerous goods (including ammunition and explosives) at sea falls under the remit of the *International Convention for the Safety of Life at Sea (SOLAS).*[20] [21] Chapter VII, Part A of SOLAS concerns the carriage of dangerous goods.

Chapter VII, Part A covers the carriage of dangerous goods in packaged form. It includes provisions for the classification, packing, marking, labelling, documentation and stowage of dangerous goods. States parties to the convention are required to issue instructions at the national level. Chapter VII makes mandatory use of the *International Maritime Dangerous Goods Code* (IMDG),[22] [23] developed by the International Maritime Organization,[24] which is constantly updated to accommodate new dangerous goods and to supplement or revise existing provisions.

Ammunition and explosives should be transported by sea in accordance with:

a) Part A to Chapter VII of the International Convention for the Safety of Life at Sea (SOLAS); and

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[19] *IATA Dangerous Goods Regulations (DGR)* (58th Edition). 2017. .

[20] *International Convention for the Safety of Life at Sea, (SOLAS)*, IMO, 1974. (Entered into force of 25 May 1980).

[21] There are currently 172 Member States and three Associate Members to SOLAS.

[22] *International Maritime Dangerous Goods (IMDG) Code*. (Amendment 38-16). IMO. 2016.

[23] IMDG is based on the contents of the *United Nations Recommendations on the Transport of Dangerous Goods* (see Clause 4.1).

[24] www.imo.org

b) the *International Maritime Dangerous Goods (IMDG) Code*. (Amendment 38-16). IMO. 2016.

9 Ammunition logistics hubs, inter-modal changes, and secure holding and safe haven locations (LEVEL 1)

With the exception of ammunition cargo ships, which always have associated quantity distances (see IATG 02.20 *Quantity and separation distances*), ammunition in transportation does not generally require the application of explosives safety quantity-distances (QD), while in movement. However, when ammunition in transit stops for more than a temporary halt, or is being loaded to or unloaded from or between transportation conveyances (handling), it shall have appropriate QD applied to all surrounding exposures or risk management principles shall be applied. Examples include transportation hubs such as ports, airfields, railyards, inter-modal change areas (e.g. rail-to-truck, ship-to-truck, truck-to rail or ship), secure holding areas for ammunition conveyances, and safe havens that are stopping places for safe and secure temporary holding of an ammunition conveyance en-route to its final destination.

Such locations shall each be considered as an explosives facility or location and must meet the siting requirements of IATG 05.10 for the ammunition hazard divisions and quantities present. When QD requirements of IATG 02.20 cannot be met, then risk management principles and processes detailed in IATG 02.10 Introduction to risk management principles shall be applied and appropriate risk assessments, risk analyses and explosives safety cases shall be conducted and risk decisions obtained from appropriate decision-makers. Any residual risk must be communicated to all affected parties.

Ideally, planning of ammunition movements will have been conducted well ahead of time, with all required documentation (e.g. explosives safety site plan or risk decision) in place, prior to the arrival of the ammunition shipment.

It is possible to construct a harbour area (transit area) near to, or within, an existing ASA using barricades to reduce the QDs (IATG 05.30 Barricades). Natural ground features may be used for this purpose, but the most common forms are artificial earth mounds, reinforced concrete and masonry walls, or a combination of these types. A barricade may be completely destroyed in an explosion, but its design should be such that it will stop or sufficiently slow down low angle, high velocity fragments before it collapses or is dispersed. If personnel protection is being afforded by a barricade, then its design will need to ensure that it does not present an additional hazard.

Security of this harbour area must be to the same standard as for an ASA. Access must be strictly controlled, contraband measures put in place and all fire precautions, fire-fighting equipment and emergency procedures must be in position.

To be effective, a barricade shall be constructed of properly specified materials to a minimum effective thickness.

10 Security during transport (LEVEL 1)

10.1 General security requirements (logistic movement)

Ammunition should only be transported in locked and sealed containers. The locks of such containers should be in accordance with the requirements of the European Standard EN12320:2001, *Building hardware – Padlocks and padlock fittings – Requirements and test methods*.[25]

[25] Although this standard is aimed at building security, the section on lock types is equally valid for container security.

Shipments shall be checked upon receipt and, where possible during transit, to ensure that seals are intact. If there are indications of theft, tampering or damage an immediate stock check shall take place to determine whether a loss has occurred.

Ammunition boxes or crates should be secured and sealed prior to loading into the containers.

10.1.1. Road transport

Road transport may be conducted by marked or unmarked military vehicles, (sometimes even armoured vehicles), or civilian transport.

If civilian contractors are used to move ammunition by road, then procedures for authorization, security, monitoring and inspection of both the movements and the contractors themselves should be in place beforehand. They should be equipped with specific protection measures, (e.g. alarm systems on vehicles or electronic tracers in boxes), monitored by the police, or guarded by military or security forces, depending on the type and quantity of ammunition transported and the respective risk assessment.

Transport routes should generally be planned in advance and information concerning these routes should be treated as classified. Procedures for regular traffic between the same two locations should be varied and reviewed regularly.[26]

A general security principle is that ammunition and weapons should be transported separately during vehicle moves.

10.1.2. Rail transport

End-opening containers[27] shall be placed door to door during rail shipments. Barriers on rail cars should be used to protect side-opening containers and deter their opening.

10.1.3. Air transport

Air transport can be conducted by transport agents. These are individuals or organisations, such as cargo companies or air freight agencies, who assume primary responsibility for facilitating, managing or organising the transport of ammunition from the point of dispatch to their final destination. They may use leased or chartered freighter aircraft with hired aircrews. Such agents should obtain the necessary over-flight authorisation for the countries over which the goods will be transported. Detailed flight and routing plans should be charted and overseen to ensure adherence and security.

End-opening containers shall be placed door to door during air shipments. Where possible, containers of non-sensitive items should be placed on either side of side-opening ammunition containers to protect them and deter their opening during transit.

Ammunition should not be shipped on aircraft that do not offer a direct flight to the destination airport in order to reduce the possibility of the ammunition container(s) being offloaded en-route in error or by criminal design. Refuelling stops only may be permitted.

Ammunition should not be shipped using airlines that have been named in previous UN Sanctions Committee monitoring group reports.

[26] Strategies for clandestine movement of ammunition may be developed, but guidance on such strategies falls outside the scope of this IATG.

[27] As opposed to side opening containers which have doors or protective sheeting along their length.

10.1.4. Sea transport

End-opening containers shall be placed door to door during sea shipments. Containers of non-sensitive items should be placed on either side of side-opening ammunition containers to protect them and deter their opening during transit.

Prior to the voyage the consignor of the ammunition should liaise with the master of the vessel to agree the most appropriate location(s) for ammunition containers on the vessel stow plan.

Ammunition should not be shipped on vessels that do not offer a direct voyage to the destination port in order to reduce the possibility of the ammunition container(s) being offloaded en-route in error or by criminal design.

Ammunition should not be shipped using vessels that have been named in previous UN Sanctions Committee monitoring group reports.

10.2 Documentation

Each transport movement of ammunition should be accompanied by cargo documentation/freight papers. Hand-over/take-over protocols requiring signatures upon receipt should also be in place.

10.3 Emergency procedures

Ammunition and related weapons should always be transported in separate vehicles. Only in exceptional circumstances may they be transported together. In the case of an accident, standardised contingency plans should be at hand that include:

a) advice for traffic control and safety regulation;

b) instructions for immediate first aid; and

c) notification procedures for contacting the appropriate authorities, (including how to gain access to ammunition specialists, Explosive Ordnance Disposal (EOD) support, medical and fire prevention personnel).

Annex A
(normative)
References

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

d) *Convention on International Civil Aviation, Annex 18. The Safe Transport of Dangerous Goods by Air. (Fourth Edition). ICAO. July 2011. http://www.imo.org/en/Publications/Pages/Home.aspx;*

e) *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)*, ECE/TRANS/257 (Vol 1 and II), New York and Geneva. 01 January 2017. http://www.unece.org/trans/danger/publi/adr/adr2017/17contentse0.html;

f) European Standard EN12320:2001, *Building hardware – Padlocks and padlock fittings – Requirements and test methods*;

g) IATG 01.50 *UN Explosive Hazard Classification System and Codes*. UN ODA. 2015;

h) *ICAO Technical Instructions for the Safe Movement of Dangerous Goods by Air.* (Doc 9284). ICAO. https://www.icao.int/safety/DangerousGoods/Pages/technical-instructions.aspx;

i) *International Convention for the Safety of Life at Sea(SOLAS)*, Chapter VII – Carriage of Dangerous Goods. IMO. 1974 (Entered into force of 25 May 1980);

j) *International Maritime Dangerous Goods (IMDG) Code*. (Amendment 38-16). IMO. 2016. http://www.imo.org/en/Publications/Pages/Home.aspx;

k) International Ordinance on the Transport of Dangerous Goods by Rail (RID), (Appendix C to the International Agreement on Rail Freight Transport). COTIF. 1 January 2017. http://otif.org/fileadmin/new/2-Activities/2D-Dangerous-Goods/RID_2017_E.pdf; and

l) *United Nations Recommendations on the Transport of Dangerous Goods Model Regulations*, (Nineteenth revised edition), ST/SG/AC.10/1/Rev.19, New York and Geneva, United Nations, 2015. *(Referred to as the UN Model Regulations)*. https://shop.un.org/.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[28] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition/ . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[28] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) *Handbook of Best Practices on Conventional Ammunition*, Chapter 3. Decision 6/08. OSCE. 2008. http://www.osce.org/fsc/33371; and

b) *IATA Dangerous Goods Regulations (DGR)* (58th Edition). 2017. http://www.iata.org/publications/store/Pages/dgr-print-manuals.aspx

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[29] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references/. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: . National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[29] Where copyright permits.

Annex C
(informative)
Structure of UN Model Regulations [30]

Part	Title	Chapter	Title
1	General Provisions, Definitions, Training and Security	1.1	General provisions
		1.2	Definitions and units of measurement
		1.3	Training
		1.4	Security provisions
2	Classification	2.0	Introduction
		2.1	Class 1 – Explosives
3	Dangerous Goods List, Special Provisions and Exceptions	3.1	General
		3.2	Dangerous Goods List (DGL)
		3.3	Special provisions applicable to certain articles or substances
		3.4	Dangerous goods packed in limited quantities
		3.5	Dangerous goods packed in excepted quantities
4	Packing and Tank Provisions	4.1	Use of packagings, including intermediate bulk containers (IBC)
		4.1.5	Special packing provisions for goods of Class 1
5	Consignment Procedures	5.1	General provisions
		5.2	Marking and labelling
		5.3	Placarding and marking of transport units
		5.4	Documentation
6	Requirements for the construction and testing of packagings	6.1	Requirements for the construction and testing of packagings
7	Provisions concerning Transport Operations	7.1	Provisions concerning transport operations by all modes of transport
		7.2	Model provisions
A	Appendix A - List of generic and NOS proper shipping names[31]		
B	Appendix B - Glossary of Terms		

Table C.1: Structure of UN Model Regulations

[30] Only those regulations relating to ammunition and explosives are contained within this structural summary.

[31] A list of ammunition and explosives has been extracted from this document and is included at Annex C to IATG 01.50 *UN Explosive Hazard Classification System and Codes.*

Annex D Transport of ammunition by road

1. Introduction

Safety and security of ammunition do not end at the Ammunition Storage Area (ASA) gate. An ammunition specialist needs to be aware of all requirements for transportation of ammunition to ensure that the load gets to the intended place and intended user in a manner that is as safe and secure as possible. There will be situations which cannot be avoided - traffic accidents, delays, attacks/fires - but as long as SOPs for transport cover the actions to be taken and the escorting personnel and drivers are trained in these actions, the chances of catastrophe are reduced.

An ammunition specialist should be able to advise on all transport safety and security matters and tell transport operatives how to ensure a successful journey during ammunition movements.

2. Regulations

This module, Transport of ammunition, briefly covers transport of ammunition by road. It mainly tells us where to find more detailed transport instructions.

The United Nations Recommendations on the Transport of Dangerous Goods Model Regulations (colloquially known as the Orange Book or the UN Model Regulations) provide the basic framework for the safe transport of explosives by road, but are designed to be generic to all transport modes and are not specific to road transport. They cover the hazards associated with all dangerous goods, including ammunition and explosives (AE). However, they do not go into practicalities.

The European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) is specifically designed to cover the transport of dangerous goods (including AE) by road. The ADR closely follows the layout, structure, language and requirements of the UN Model Regulations. Although it is a publication for European use, it is often used worldwide as a 'best practice' guide to the road movement of ammunition.

This annex is a series of useful extracts from the Orange Book and ADRs. Nations may have their own transport regulations, but in the same way that IATG offers them a guide to the best way of carrying out ammunition management, this note gives guidance on ammunition safety and security during road transport. As with any IATG, if a nation’s own regulations make the ammunition and populace safer and more secure than the guidance here, then they should follow their regulations. If not, they can adapt and adopt the advice here.

3. Explosives safety

AE can be assumed to be SAFE when all the following have been satisfied:

The chemical composition of each explosive item in the munition, submunition or component has been tested and accepted as safe and suitable for service in accordance with current procedures.

They have been classified for storage and transport by the relevant authority.

The time elapsed since manufacture has not exceeded the service life. Some items will come under the category of Safe to Move (for subsequent disposal), but not necessarily Safe to Use in their design.

All removable safety devices are correctly fitted.

Non-removable safety devices are set to safe or other non-live positions, as appropriate to their state of preparation.

They can be seen not to be damaged, corroded, distorted or incorrectly assembled, and are known not to have been involved in an accident/incident or otherwise subjected to excessive heat, friction, or abnormal shock.

They are not subject to 'Restrictions in Use'.

AE are to be regarded as UNSAFE when they do not meet the SAFE conditions, or when their condition is unknown. They are to continue to be regarded as unsafe until such time as a competent person has confirmed their safety.

Normally, only those explosive substances and articles which are listed in the Dangerous Goods List in the Orange Book chapter 3.2 may be accepted for transport. However, competent authorities retain the right to approve transport of explosive substances and articles for special purposes under special conditions. Entries have been included in the list for 'Substances, explosive, not otherwise specified' and 'Articles, explosive, not otherwise specified'. These are for use when no other method of operation is possible. (Orange Book Vol1: ch 2.1).

4. Purpose of Classification of Explosives

Classification is a legal requirement for the transport of explosives. This classification is also used for storage. The classification becomes inapplicable when the explosives item is removed from its authorised packaging. Safety in storage and transportation is based on the assignment of explosives into various Hazard Divisions (HD), further Storage sub-Divisions (SsD) and Compatibility Groups (CG), resulting in a Hazard Classification Code (HCC) (e.g., 1.1 D). The Classification Regulations deal with such matters as:

The standards and marking of packages.

Segregation based on sensitivity and compatibility.

The type of explosive hazard anticipated if the items are involved in a fire or explosion (e.g. probability of mass explosion).

Maximum quantity limits based on the effects of an accidental fire or explosion.

The possibilities of fighting a fire in which the items are involved.

5. Documentation (Orange Book Vol 2: Ch 5.4)

The consignor who offers dangerous goods (i.e. AE) for transport shall provide the carrier with a dangerous goods transport document, either in paper form by electronic data process (EDP) or electronic data information (EDI) technique. The consignor should still produce a paper copy for the carrier. The copy provided to the carrier, whichever method is used, should be signed and completed by the consignor. (Orange Book vol 2: para 5.4.1.1, 5.4.1.2)

The dangerous goods transport document shall contain the following information: (Orange Book Vol 2: para 5.4.1.2)

Name and address of the consignor; (Orange Book Vol 2: para 5.4.1.3)

Name and address of the consignee; (Orange Book Vol 2: para 5.4.1.3)

The date of preparation of the document plus the date it was given to the carrier; (Orange Book Vol 2: para 5.4.1.3)

The following information for each dangerous substance or article for transport: (Orange Book Vol 2: para 5.4.1.4)

The UN Serial Number (UNS), e.g. UNS 0014;

The proper shipping name, including the technical name in parenthesis where applicable; (Orange Book Vol 1: para 3.1.2, 3.1.2.8)

The HCC of each type of ammunition;

Any subsidiary hazard class for subsidiary risks (e.g. radioactive material in some weapon sights).

The NEQ of each separate item by UNS. (Orange Book Vol 2: para 5.4.1.5.1)

In addition, a document will be provided by the consignor to the carrier, in the appropriate language, regarding actions to be taken by the carrier. This shall include (as a minimum): (Orange Book Vol 2: 5.4.1.5.7.2)

Any supplementary requirements for loading, stowage, transport, handling and unloading;

Restrictions on the transport and routeing instructions;

Emergency arrangements appropriate to the consignment.

A certificate or declaration is to be provided by the consignor stating that the consignment is acceptable for transport and the ammunition is packaged, labelled, marked and classified, and is in a proper condition for transport in accordance with the applicable regulations. The text of this certificate shall be:

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled, and are in all respects in proper condition for transport according to applicable international and national government regulations.

This certificate shall be signed and dated by the consignor. (Orange Book Vol 2: 5.4.1.6.1)

All documents should be held by the carrier away from the dangerous load so it is available in case of accident or emergency. (Orange Book Vol 2: para 5.4.3)

The consignor shall retain a copy of all documents for at least 3 months. (Orange Book Vol2: 5.4.4.1)

6. Control of AE movements

To ensure the safety of AE stocks and personnel, all AE movements are to be conducted according to the rules. (ADR 7.5.11)

AE are to be transported in accordance with the manufacturers' instructions and specifications.

When orientation arrows are required, packages and overpacks shall be orientated in accordance with such marks. (ADR 7.5.1.5)

Measures must be taken to ensure the security of AE (e.g. tarpaulin, secured to the vehicle using fibre straps, clearing of inflammable materials from vehicle, etc.). (ADR 7.5.7.1)

The security of the AE must be assured. Someone must always remain with the vehicle carrying the AE when in an unsecured area. (ADR Vol 2 8.4.1)

Safety is paramount. Ensure that vehicles are loaded according to all rules and properly accounted for and secured to the vehicle. (ADR 7.5.11)

Where substances and articles of different divisions of class 1 are loaded on one transport unit, the load as a whole shall be treated as if it belonged to the most dangerous division (in the order 1.1, 1.5, 1.2, 1.3, 1.6, 1.4). The net mass of explosives of CG ‘S’ shall not count towards the limitation of quantities carried. (ADR 7.5.5.2.2)

Where substances classified as 1.5D are carried on one transport unit with those in HD 1.2, the entire load shall be treated for carriage as HD 1.1. (ADR 7.5.5.2.2)

CG mixing rules for transport by road must be adhered to. They are different than those for storage (see table below, Orange Book vol2: 7.1.3.1.2 and ADR 2019 vol 2 para 7.5.2.2).

Articles of CGs D and E may be fitted or packed together with their own means of initiation provided that such means have at least two effective protective features designed to prevent an explosion in the event of accidental functioning of the means of initiation. Such articles and packages shall be assigned to CGs D or E. (Orange Book Vol 1: para 2.1.2.1.1 note 1)

Articles of CGs D and E may be packed together with their own means of initiation, which do not have two effective protective features when, in the opinion of the competent authority of the country of origin, the accidental functioning of the means of initiation does not cause the explosion of an article under normal conditions of transport. Such packages shall be assigned to CGs D or E. (Orange Book Vol1: para 2.1.2.1.1 note 2)

When AE is moved by road it should be in convoy, whether with other vehicles carrying ammunition or with escort vehicles. A minimum distance of 50m should be observed between each transport unit. (ADR 2019 vol 2 para 8.5 S1 (5))

Generally, AE should not be transported at night. If vehicles must stop for the night and the AE stay on the vehicle, the vehicle shall be placed under continuous guard. (ADR 2019 vol 2 para 8.5 S1 (6))

7. CG mixing rules for explosives transported by road

CG	A	B	C	D	E	F	G	H	J	L	N	S
A	X											
B		X		a								X
C			X	X	X		X				bc	X
D		a	X	X	X		X				bc	X
E			X	X	X		X				bc	X
F						X						X
G			X	X	X		X					X
H								X				X
J									X			X
L										d		
N			bc	bc	bc						b	X
S		X	X	X	X	X	X	X	X		X	X

Above table: Compatibility Group mixing rules for transport of AE (taken from ADR 2019 vol 2 para 7.5.2.2) by road.

Key to CG mixing in transport (above) (taken from ADR 2019 vol 2 para 7.5.2.2)

X Mixed loading permitted

a Packages containing articles of CG 'B' and those containing articles or substances of CG 'D' may be loaded together provided they are effectively segregated such that there is no danger of transmission of detonation from the articles of CG 'B' to the articles or substances of CG 'D'.

b Different types of articles of HCC '1.6N' may be carried together as '1.6N' only when it is proven by testing or analogy that there is no additional hazard of sympathetic detonation between the articles. Otherwise, they should be treated as HD '1.1'.

c When articles of CG 'N' are carried with articles or substances of CG 'C', 'D' or 'E', the articles of CG 'N' should be considered as having the characteristics of CG 'D'.

d Packages containing substances or articles of CG 'L' may be loaded together on one vehicle or in one container with packages containing the same types of substances or articles of CG 'L'.

Note: Definitions and explanations of compatibility groups are in the Orange Book Vol 1: para 2.1.2.1.1, ADR Vol 1 2.2.1.1.6) and in IATG 01.50 para 6.2).

8. Training (see Orange Book Vol1: Chapters 1.3 and 1.4.2) and (ADR 2019 vol2 8.2.1&2)

All personnel involved at any stage during the movement of AE must be fully trained in their responsibilities. They shall only carry out those tasks they have been trained in, under supervision at first, then alone, once the supervisor is satisfied they are efficient.

All shall be familiar with the general requirements of the regulations for the carriage of dangerous goods (AE). They will be trained in the hazards related to AE. They will be trained in safe handling techniques and in the emergency actions to be carried out in the case of an accident or incident.

Initial training must be followed up with annual refresher training. This may be general or, if a particular incident has occurred due to incorrect procedures, the correct way to carry out those procedures must be reinforced.

The unit or organisation which oversees the AE management and transportation must keep records of when and where all training has been carried out, together with a list of names and whether the person passed or failed the training where applicable.

9. Movements

When AE is moved by road in convoy, a minimum of 50m distance must be left between vehicles. In built up areas and where speed is restricted, this can be adjusted to fit the circumstances. On all occasions, someone must always remain with the vehicle carrying the AE. (ADR Vol2 8.5.S1(5))

Vehicles carrying AE will have a means of communication with their HQ. Vehicles carrying electric detonators are not to use radios except in an emergency.

10. Vehicle requirements

It is accepted that, in some parts of the world, getting ideal vehicles will prove impossible. That said, the best, safest vehicles available should always be used for transporting AE. (Orange Book Vol2:7.1.3.3.1 and ADR 7.5.1.2)

Vehicles carrying AE shall be serviceable, have a spare wheel and a wheel changing kit. (ADR 9.1.2)
All vehicles carrying AE shall comply with the requirements of ADR 9.2.

Vehicles used for the transportation of AE shall be suitable for the load to be carried and the road conditions on which the vehicle is to travel. (ADR 9.1.2)

Vehicles with trailers can be used if the trailer has a braking system which is operated automatically should the trailer become loose from the vehicle. (ADR 9.1.2)

11. Equipment

Vehicles carrying AE, including to and from the ASA, shall carry the following equipment: (ADR Vol 2 8.1.5.2)

Personal protective and prevention equipment in order to carry out general actions and protect against hazards in specific emergency situations. This must include protective gloves and goggles.

A high visibility vest for each person.

A contraband container for storing smoking materials, matches, lighters, cigarettes etc. This is to be under control of the convoy commander.

Eye rinsing liquid.

A wheel chock of a size suited to the maximum mass of the vehicle and to the diameter of the wheel.

Two sealed beam hand torches with a constant light which can be seen at 150m distance.

Two self-standing red warning triangles for marking stationary vehicles on the road.

Two red warning flags.

A shovel and pickaxe.

When the security situation allows, the internationally recognised 'explosives' symbol and explosive hazard division will be displayed on both sides and the rear of the vehicle for the highest risk HCC. This does not apply to consignments of 1.4S only. (Orange Book Vol 2: 5.3.1.1.2 ADR 5.3.1.1.2, 5.3.1.5.1)

12. Driver requirements

Some parts of the world may have different driving regulations, for instance, the age that people can drive heavy goods vehicles with dangerous cargoes may be less than 22. This may be the case, but it is not an excuse to lower other standards, such as training.

Vehicles transporting AE shall have a co-driver.

Drivers and co-drivers of vehicles carrying AE shall be trained in the handling and transport of AE, in particular those methods relating to the particular AE being carried. Both shall hold a certificate issued by a competent authority stating they have been on a training course and passed an examination on the particular requirements that have to be met during the carriage of dangerous goods. (ADR Vol 2 8.2.1.1)

Drivers and co-drivers shall be in good health before starting out on a journey with AE.

Both the driver and co-driver shall be the national minimum legal age and have the appropriate driving license for the class of vehicle they will be driving.

Both shall be briefed about the type of AE carried and the hazards associated with them. (ADR Vol 2 8.2.2.3.4)

They shall be briefed on the security situation (where appropriate) in the area of travel and actions to be taken in event of problems. (ADR Vol 2 8.3.2)

NO passengers are allowed to be carried (other than the co-driver). (ADR Vol 2 8.3.1)

13. AE packaging

AE is given an HCC in its authorised packaged state. It may react differently when not in this packaging. Always bear this in mind when deciding what to transport on each vehicle.

AE will ALWAYS be carried in packages, except for large bulk items, e.g. large artillery shell.

Use the original boxes where possible. If this is impossible, use a similar box and ensure all AE is tightly packed inside it. This method of packaging ammunition shall only be used when the alternative is to leave the AE in a place where it may be taken illegally.

14. Markings

The package/box should be marked with a MINIMUM of:

The word 'EXPLOSIVES'.

The contents of the box (type of ammunition).

The hazard classification code (HCC).

UN Serial number and proper shipping name. (Orange Book Vol1; para 2.0.2.2, ADR 5.2.1.5, 5.2.2.1)

The weight or quantity of items in the box.

The box shall be accompanied by a printed instruction sheet giving details of storage, handling and disposal requirements for the contents.

15. Fire safety

Prevention is better than cure.

A serviceable CO2 fire extinguisher will be carried in the cab. To balance effectiveness (capacity) against ease of extraction and use, a 10kg extinguisher is recommended. (ADR Vol 2.8)

Smoking is not permitted in the vehicle or within 30m of the vehicle. (ADR 7.5.9)

Fuel shall not be carried anywhere other than in the fuel tank.

No fire-making materials, matches, lighters or similar shall be carried in AE carrying vehicles.

Vehicles transporting AE shall be fitted with a grounding strap to permit the release of any build-up of static electricity.

16. Loading and unloading AE

As well as ensuring the safety of the AE during transportation, they must be secured. Check the contents of a vehicle before it begins its journey and at the end of its journey. If the vehicle must stop for any reason, check the contents at the stop and before beginning the journey again. Report any discrepancies to HQ immediately.

AE should, where possible, be transported on a separate vehicle from any other goods.

Where this is NOT possible, AE and general cargo (NOT dangerous cargo) will be secured to ensure no movement from either load. Exceptions to this rule are if the AE is 1.4S and if safety devices, pyrotechnic in 1.4G are mixed with safety devices, electrically initiated in class 9. (ADR 7.5.2.1, 7.5.7.1)

AE are to be evenly spread across the vehicle load area and are not to be stacked above the side and tail boards.

AE should be prevented from moving by use of chocks and battens.

If on an open lorry, the AE should be covered by a secured tarpaulin or similar waterproof cover. (ADR 7.5.7.1)

When detonators are being carried, they must be in an approved metal or wooden box.

Ideally detonators should be carried on their own vehicle. If not, they should be carried in the cab, well away from the other AE.

Except in an emergency, only load or unload AE at a recognised ammunition site.

Where possible, only load/unload during daylight.

The engine of the carrying vehicle shall be shut off during loading/unloading, unless the engine has to be used to drive any equipment connected with loading/unloading. (ADR Vol 2 8.3.6)

Use the CG mixing rules for transport (see table Compatibility Group mixing rules for transport of AE (taken from ADR 2019 vol 2 para 7.5.2.2)).

For maximum loads by NEQ for different types of vehicle and different HDs, see table below (total NEQ in kg, all HDs added and considered as worst case except for CG S). (ADR 7.5.5.2.1)

Transport Unit	HD	1.1		1.2	1.3	1.4		1.5 & 1.6	FFE packages
	CG	1.1A	Other 1.1			Other 1.4	1.4S		
EX/II [a]		6.25	1 000	3 000	5 000	15 000	Capacity	5 000	Capacity
EX/III [b]		18.75	16 000	16 000	16 000	16 000	Capacity	16 000	Capacity

Note: [a] EX/II unit is a vehicle designed to carry AE with a flat bed.

[b] EX/III unit is a vehicle designed to carry AE in a tank.

17. Safe driving

The speed of vehicles carrying AE shall not exceed 90 km/h. A speed limiting device should be fitted to vehicles over 3.5 tonnes. Maximum speeds should be adjusted dependent on the state of the roads being travelled on. (ADR Vol 2 9.2.5)

Drivers of vehicles carrying AE shall avoid rapid acceleration or, where possible, sudden braking.

18. Actions on breakdown/accident (Orange Book Vol 2: 7.1.9 & 7.2.4)

Extinguish any fires and disconnect the vehicle battery.

Use the wheel chock to immobilise the vehicle (in case the brake cables burn through).

Secure the scene using red triangles and warning flags.

Ensure safety and security of the AE by whatever means are necessary.

Contact nearest police or military, tell them you are carrying AE and request assistance.

Report the accident to your HQ, your departure point and your destination. Stop people approaching the vehicles. Await assistance.

If a broken-down vehicle needs repairing, unload all AE first.

Move broken down vehicle onto the side of the road.

If an uncontrollable fire breaks out, evacuate and secure an area 500m around the vehicle. Use local help to secure the area and warn others away.

A broken-down vehicle may be towed, but only to a nearby repair facility. Speed is not to exceed 40kph.

19. Summary

Remember – an ammunition specialist's responsibility for the safety and security of the AE does not stop at the ASA gate. As the expert, it is your job to ensure that when others transport AE away from the ASA, they do it correctly. Although accidents are impossible to avoid, by following the basic rules in this note, many accidents are preventable and, if an accident does occur, further damage can be minimised.

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 08.20

Third edition
March 2021

Storage and handling of ammunition and explosives at airfields

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

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United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

E-mail: conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The storage and handling of ammunition and explosives at airfields are operations that present inherent risks to persons and property. A national authority shall therefore have a legal responsibility to ensure that during any operation involving storage and/or handling of ammunition and explosives that the risks associated with those operations are both tolerable and as low as reasonably practicable (ALARP).

One of the most efficient means of protecting the public from the effects of an explosive event is by the use of separation distances, which ensure that they are always at a tolerably safe distance from the explosives during storage and handling. A point to remember is the greater the separation distance, the greater the protection afforded.

An assessment of the effects of an undesirable explosives event (e.g., blast, thermal fireball, and fragment (munitions and/or structural debris) radii), and predictions of specified levels of risk (in terms of injury or damage), has allowed the development of 'best practice' separation distances. Tables of Net Explosive Quantity (NEQ) and associated minimum recommended distances have been developed by international organisations. These tables, (which contain appropriate separation distances), are known as Quantity Distance (QD) Tables and, together with other criteria for their use, should form the foundation for the safe storage and licensing[3] of Potential Explosion Sites (PES) as well as for the placement of any Exposed Sites (ES) in a location where it is at risk from explosion effects that could emanate from an explosion at any PES. These QD Tables are based on trials and other data, but are susceptible to uncertainty owing to the variability of the nature of explosions and the incompleteness of trials data.[4] QD should therefore be subject to continuing refinement as further data becomes available. Such information should be shared internationally.

<u>NOTES</u>

- These QD principles are applied in IATG 2.20 for above ground ammunition storage generally. Here these principles are applied to the specific conditions on airfields. Consult IATG 2.20 for more background on QD principles.
- The use of QD is by necessity a compromise between 'an acceptable level of risk' and 'absolute protection', as it is generally impractical to procure/restrict all the land around explosives locations and airfields such that all risk and explosion effects are eliminated. Glass breakage, some structural damage, and fragment impacts, in some cases capable of injury and possibly death, may be expected to occur outside these 'safe' separation distances. Greater separation than those called for by the minimum QD should be applied whenever possible/practicable.

There is an online IATG Implementation Support Toolkit available on the UN SaferGuard website and among the tools is an Explosives Limits Licence creation tool[5].

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[3] See IATG 02.30:2020[E] *Licensing of explosive facilities.*

[4] Even though extensive trials have taken place in support of their development.

[5] www.un.org/disarmament/un-saferguard/explosives-limit-license

1 Scope

This IATG module provides Quantity-Distance (QD) guidelines for two types of airfields used by military aircraft where Ammunition and Explosives (AE) are handled and stored:

a. Military airfields (i.e., utilized only by military aircraft); are an area prepared for the accommodation (including any buildings, installations and equipment) of landing and takeoff of military aircrafts.

b. Joint-use airfields (i.e., utilized by commercial and military aircraft); Civilian airfields where written agreements exist between the military and the host nation or national authority that allow military use of airfields, or portions of airfields, for which both parties have executed a joint-use agreement granting equal privileges. This area is generally limited to runways and taxiways. All other facilities (parking ramps, hangars, terminals, etc.) are the sole property of the host nation or national authority.

Air Forces have a requirement for weapons to be on or near the airfield in order to maintain required operations. This can be for both domestic and deployed operations during peacetime or wartime. The exposure of personnel or facilities to unacceptable risk from an accidental explosion or the detonation of ammunition and explosives (AE) must be mitigated. The key areas of a typical military airfield are shown below (Figure 1).

Figure 1 Military Airfield

1. Runways: Aircraft land and take-off from runways, the threshold at each end is marked with a series of white stripes and the compass orientation of the runway, and a centre-line is painted along the middle to assist pilots in steering their aircraft.

2. Aircraft: The primary function of an airfield is to operate aircraft.

3. Security: To control access to the airfield, a guardhouse is provided at the main entrance, where vehicles and visitors are vetted. A continuous security fence encloses the airfield perimeter and is patrolled by armed guards.

4. Technical Areas: Aircraft repair and maintenance is carried out in hangars. The movement of fuel, weapons and personnel around the extensive perimeter of an airfield requires a number of specialist vehicles.

5. Dispersals: An aircraft parking area situated away from the main technical site, often with some form of protection for individual aircraft. To offer more protection against enemy air attack, many military airfields now house their combat aircraft in Hardened Aircraft Shelters or Hardened Aircraft Bunkers, which can withstand a nearby bomb blast or chemical attack.

6. Air Traffic Control: Sited with an uninterrupted view of the airfield, the air traffic control tower controls all aircraft movements. To assist aircraft to maneuver safely in crowded skies and bad weather, a variety of electronic navigation aids, instrument landing and precision approach radar systems are available on modern airfields.

7. Munitions Storage: Bombs, ammunition, missiles, explosives and pyrotechnics are stored in a secure compound located well away from technical and domestic areas of the airfield. The storage buildings are protected by blast walls or earth revetments and are arranged in a symmetrical pattern, well-served by road. In this image, the site can be seen to be enclosed by a double security fence.

8. Fuel Storage: Fuel Storage Airfields normally have several bulk fuel storage installations, since intensive aircraft operations consume vast quantities of fuel. These installations are located around the airfield and can be sited unprotected above-ground, semi-buried or completely buried.

9. Domestic Areas: Domestic Areas Airfields are manned by highly-trained personnel who live in barrack accommodation adjacent to the technical area of the base. Barrack blocks normally have a regular plan and are situated adjacent to dining, recreation and car-parking facilities.

The following guidance is intended to provide the **minimum acceptable levels** of explosives safety.

Wherever possible, the greatest protection possible should be provided even though specific QDs may not be defined.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘barricade’ refers to *a natural ground feature, artificial mound, barricade or wall which, for storage purposes, is capable of preventing direct communication of explosion from one quantity of* ***explosives*** *to another although it may be destroyed in the process*.

A barricade *is capable of intercepting high velocity low angle projections from a potential explosion site and preventing initiation of explosives stocks stored nearby.*

NOTE 1 A barricade might be located at a PES or at an ES.

NOTE 2 If located at the PES, a barricade may be destroyed by an explosion.

NOTE 3 The term 'traverse' has been replaced with barricade.

The term 'ammunition storage area' refers to *an area used for the handling, processing and storing of ammunition and explosives. Where there is no fence, it is taken as being the area within a radius of 50 m from any building or stack containing explosives*.

The term 'debris and fragment distance' (DFD) refers *to the distance from the point of explosion to the point which the density of the debris and fragments generated by the explosion has decreased to where people in the open are not expected to be seriously injured. This is equivalent to the hazardous fragment distance (HFD).*

NOTE 1 Blast distance (BD) is the protection from the shock front, high pressure wave produced by the deflagration or detonation of an explosive.

NOTE 2 If an Exposed Site (ES) provides sufficient protection (barricade and protected roof) against debris and fragments the BD may be used. Otherwise use the greater of the BD or the DFD (HFD).

The term 'exposed site' (ES) refers to *a magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the potential explosion site (PES) under consideration*.

The term 'heavy walled building' refers to *a building of non-combustible construction used for explosive storage with walls of at least 450 mm reinforced concrete (RC), or 700 mm brick, or equivalent penetration resistance of other materials, with or without a protective roof. The door is normally strengthened if it faces another potential explosion site (PES)*.

The term '*earth-covered magazine (ECM)'* refers to *a magazine, normally built at ground level, with earth-covered roof, sides and rear, and constructed in corrugated steel or reinforced concrete.*

NOTE 1 The front wall may/may not be protected by a barricade. When present, a front barricade can provide significant protection to an ECM's contents from an explosion at an adjacent explosive location and potentially mitigate the effects of an explosion inside the ECM.

The term 'hazards of electromagnetic radiation to ordnance' (HERO) is), or the interference of electronics that may cause weapons, ordnance, munitions or explosives to initiate the potential for electromagnetic radiation (EMR) to cause either direct initiation of electro-explosive device (EED).

The term 'foreign object debris' (FOD) refers to any object, live or not, located in an inappropriate location in the airport environment that has the capacity to injure the airport or air carrier personnel and damage aircraft.

The term 'hammerhead' is the area near the end of the runway where aircraft turn.

The term hazardous fragment distance (HFD) refers *to the distance from the point of explosion to the point at which the density of hazardous fragments generated by the explosion has decreased to where people in the open are not expected to be seriously injured. This is equivalent to DFD.*

NOTE 1 HFD is an impact density of less than one hazardous fragment per $55.7m^2$.

The term 'inhabited building' refers to *a building or structure occupied in whole or in part by people (usually civilian).* The term is used synonymously with *occupied building*.

The term inhabited building distance (IBD) refers to '*the minimum permissible distance between a potential explosion site (PES) and a non-associated exposed site (ES) that requires a high degree of protection from an explosion*.

NOTE 1 The IBD is a form of Outside Quantity Distance (OQD).

The term 'inside quantity distance' (IQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) inside the explosives area*.

The term 'inter-magazine distance' (IMD) refers to *the minimum permissible distance between a building or stack containing explosives to other such buildings or stacks which will prevent the immediate propagation of explosions or fire from one to the other by missile, flame or blast*.

NOTE 1 The IMD is a form of Inside Quantity Distance (IQD).

NOTE 2 Subsequent reactions (fire or detonation) may still occur at adjacent explosive locations that meet IMD, as a result of burning debris, high angle fragment impacts, building collapse, etc.

The term 'magazine' refers to *any building, structure, or container approved for the storage of explosive materials. (c.f. explosive storehouse (ESH))*'.

The term 'outside quantity distance' (OQD) refers to *the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) outside the explosives area*.

The term 'potential explosion site' (PES) refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an explosion of its content*.

The term 'process building distance' (PBD) refers to *the minimum permissible distance from a building or stack containing explosives to an ammunition process building, or from an ammunition process building to another ammunition process building, which will provide a reasonable degree of immunity for the operatives within the ammunition process building(s), and a high degree of protection against immediate or subsequent propagation of explosions*.

NOTE 1 The PBD is a form of Inside Quantity Distance (IQD).

The term 'public traffic route' (PTR) refers to *a road used for general public traffic; a railway outside the explosives area that is used for public passenger traffic; a waterway, such as a river having tidal water or a canal, used by passenger vessels*.

NOTE 1 A PTR is an ES.

The term 'public traffic route distance' (PTRD) refers to *the minimum permissible distance between a potential explosion site (PES) and public traffic routes, which is such that the ignition or explosion of explosives at the PES will not cause intolerable danger to the occupants of vehicles at an exposed site (ES*).

NOTE 1 The PTRD is a form of Outside Quantity Distance (OQD).

The term 'quantity distance' (QD) refers to *the minimum permissible distance required between a potential explosion site (PES) and an exposed site (ES)*.

The term 'separation distance' refers to *a generic term for the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES).*

NOTE 1 Separation distances may or may not involve the use of the quantity distance system. They can be developed through the use of explosion consequence analysis.

The term 'transit area' refers to *areas where consignments of explosives undergoing movements are assembled/dismantled for transhipment between modes of transport that operate within an explosives facility and those that operate outside the area.*

The term 'vulnerable building' refers to *an exposed site (ES) deemed to be vulnerable by nature of its construction or function and therefore sited at greater than IBD.*

NOTE 1 Examples are multi-story buildings with lots of exposed glass facing the PES, hospitals, places of high concentrations of people such as schools and churches, and warehouse type structures that use curtain-wall construction techniques.

The term 'vulnerable building distance' (VBD) refers to *the minimum permissible distance between a potential explosion site (PES) and a vulnerable building.*

NOTE 1 The VBD is a form of Outside Quantity Distance (OQD).

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Separation distances

A separation distance is the minimum permissible distance between a potential explosion site (PES) and an exposed site (ES) where the risks due to an explosive event have been determined as tolerable by the appropriate national authority. Separation distances may not necessarily involve the use of the quantity distance system (Clause 5). They can be developed using an explosion consequence analysis (see IATG 02.10 *Introduction to risk management principles and processes*). Notwithstanding, the use of the quantity distance system is considered to be 'best practice' by many States and will therefore form the basis of the guidance within this IATG module.

Quantity distances do not, however, exclude the risk to the public from projections, broken glass, displaced tiles etc., or the risk of some minor injury to occupants. Glazing is an important factor in building occupant protection and protective features are relatively easy to provide.[6]

5 Background to quantity distances

Many States use rules based upon the explosives, their quantity, and the distance from the explosive to where people and in some cases, critical facilities/equipment are at risk. These rules are known as Quantity-Distance (Q-D) criteria and are based on the approach derived from the *Hopkinson-Cranz Scaling Law*,[7] [8] which is further amended by a range of coefficients. It is the basis of much of the work on the estimation of appropriate quantity and separation distances.

The *Hopkinson-Cranz Scaling Law* is also referred to as the *Cube Root Scaling Law*:

$(R_1/R_2) = (W_1/W_2)^{1/3}$ $R = ZW^{1/3}$	R = Range (m) Z = Constant of Proportionality (dependent on acceptable blast overpressure). **The coefficient 'Q' is used for QD work.** W = Explosive Weight (kg) **The coefficient NEQ is used for QD work.**

Table 1: Hopkinson-Cranz Scaling Law

See IATG 02.20 *Quantity and separation distances* for more detailed information on Q-D criteria. This IATG module will focus on the Q-D criteria for airfields. The Q-D criteria detailed in this module do not apply to:

a. The transportation of explosives around the airfield,
b. Aircraft containing only installed explosives[9],
c. Explosives contained on the person of crew and passengers (e.g., AE for mission use).

6 Measurements of Quantity and other Separation Distances

6.1 Potential Explosion Sites (PES) to Exposed Sites (ES). All separation distances from a PES are to be measured as indicated in Table 2 below.

	From (PES)	
To (ES)	Aircraft / Open stacks AE	Structures
Aircraft / Open stacks WITH AE	Nearest points between AE load (or from where that AE would normally be loaded) and aircraft AE load*	Nearest points between walls and aircraft AE load / open stack
Aircraft WITHOUT AE	Nearest points between AE load and aircraft	Nearest points between walls and aircraft

[6] Analysis of glazing hazards is a specialist component of an explosion consequence analysis. See IATG 02.10 *Introduction to risk management principles and processes* and the *UK Glazing Hazard Guide 1997.*

[7] Hopkinson B, UK Ordnance Board Minutes 13565, 1915.

[8] Cranz C, *Lehrbuch der Ballistik*, Springer-Verlag, Berlin, 1916.

[9] Safety of Life At Sea (SOLAS), egress systems components, engine starter cartridges, fire extinguisher cartridges and other such items necessary to flight operations.

Structure containing AE	Nearest points between AE load and ES walls	Nearest points between walls and ES walls
Runway	Nearest points between AE load and centerline of the runway	Nearest point between walls and centerline of the runway
Taxiway	Nearest points between AE load and nearest point of the taxiway	Nearest point between walls and nearest point of the taxiway

*If cargo aircraft, the distance must be determined from the outside of the fuselage

Table 2: Measurement of separation distances between relevant PES and ES

Areas requiring QD separation (Designated Areas)

6.2.1 Designated Areas – General comments

1) A Designated Area is an authorized area specifically designated for the loading, unloading or parking of combat and/or cargo aircraft loaded with AE. This represents an area with a recurring hazard as it is continuously or frequently used for that purpose.

2) Aircraft carrying AE must be loaded, unloaded or parked in a Designated Area. This area should be separated from an ES, by the Q-D given in paragraph 7.

3) Combat Aircraft Parking Area (CAPA)/Combat Aircraft Loading Area (CALA) are examples of designated areas.

6.2.2 Principles for Selecting Designated Areas

The following principles should be followed in selecting Designated Areas:

a. The safest possible area compatible with Q-D prescribed in this module and operational requirements must be used.

b. CAPA/CALA - Any area that meets both the applicable explosives safety criteria (prescribed in this module) and airfield (safety and operational) criteria (e.g., runway clear zones). There may be other restrictions and/or regulations that affect the selection of designated areas as CAPA. For example, operational/tactical requirements, additional hazard from forward firing AE (directional and potential long range), specific weapon systems, etc. AE delivery trailers must not remain longer than needed at the CAPA to conduct the loading or unloading operation.

c. Convoy routes, End-of-Runway, Hammerheads for lining up fighter aircraft prior to take off and Arm/De-Arm pad activities are exempted from (in these cases the aircraft is in transportation mode) licensing (i.e., siting). As such, during arming/disarming, the firing direction should be blocked by a vertically faced traverse[10](i.e., barricade). When a vertically faced traverse is not available, directional AE should be armed/de-armed in an area specifically designated with a safe weapon heading established. If Pads and Hammerheads are to be used for loading and unloading, or designated for hung weapon other than hung gun, they must be sited for the NEQ permitted.

[10] See Barricade Design (UK) Nationally Approved Structures, Section 10.9 b.

d. Aircraft weapon systems such as guns, rockets, missiles, and flare dispensers pose an additional hazard (beyond their explosives hazard) because of their directional response and potential long range, if inadvertently activated on the ground. As a result, aircraft AE posing a directional hazard should face the direction involving least exposure of personnel, equipment and facilities to the line of fire. Due to the agility, velocity and random nature of a missile's (guided or unguided) trajectory, the traditional safe direction may not mitigate the risk to personnel, aircraft, equipment and facilities.

7 Application of Q-D

The following Q-D requirements assume HD 1.1 loads. However, they may also be used for other HDs. Where IATG 02.20 permits, lesser distances may be used for HDs other than HD 1.1. The Q-D tables provide distances for Propagation Prevention, Table 4 and External QD, Table 5 and Table 6. Required Q-D associated with "Aircraft Quantity Distance (AD)" callouts below can be found in Table 3.

In addition, a limited number of HD 1.2 and HD 1.3 QD relationships (e.g., CAPA, Ready Service, Inhabited Buildings, Roads, Runways, Holding areas (i.e., open stack of AE) and workshops) are provided in Table 7 and 8 respectively. As noted earlier, where possible, the greatest protection possible should be provided even though specific Q-Ds may not be defined.

7.1 Q-D for Aircraft Loaded with HD 1.1 AE

a. Exterior Q-D from Designated Areas

The appropriate Exterior Q-D given in Table 5 and Table 6 apply between Designated Areas or AE aircraft and ES not related to the servicing and support of the aircraft within the designated area.

b. Q-D between Aircraft Loaded with Explosives

1) Un-barricaded - Individual aircraft, or groups of aircraft at Designated Areas, loaded with AE must be separated as follows:

a) AD9-distances (4.8 $Q^{1/3}$) To protect against prompt propagation of aircraft loaded with AE of comparable resistance to propagation as robust shells [11]

b) AD10-distances (7.2 $Q^{1/3}$) To protect against prompt propagation of detonation.

c) AD13-greater of the BD (12.0 $Q^{1/3}$) or the Debris and Fragment Distance (DFD) = Hazardous Fragment Distance (HFD) where nearly complete protection against fragments is deemed necessary.

Lesser or different distances may be used for specific weapons where trials have shown that such distances are adequate to minimize the probability of propagation.

2) Barricaded - AD9-distances (4.8 $Q^{1/3}$) between adjacent aircraft may be reduced to AD6-distances (2.4 $Q^{1/3}$), if the line of sight between AE can be interrupted by a barricade extending a minimum of 0.3m above the highest piece of AE being separated. The barricade will prevent simultaneous propagation due to high velocity, low angle fragments. It should be noted, however, that a barricade does not necessarily prevent

[11] This provides a limited degree of protection.

subsequent propagation or damage caused by blast, lobbed items, debris or secondary fires.

7.2 Q-D to Runways and Taxiways

It is recommended that the separation of the PES from runways and taxiways should be large enough to prevent them being rendered non-operational by ground shock as a result of an explosion in a PES.

AD13-distances BD (12.0 $Q^{1/3}$) should be used to provide protection to the aircraft on both runways and taxiways.

7.3 Direct and Indirect Support Facilities and Activities

a.Direct Support. Facilities and activities directly related to maintaining, servicing, controlling, and flying AE loaded aircraft are considered directly related to AE on the flight line supporting those AE loaded aircraft and may be sited per Tables 2 and 5 as follows:

1) Unhardened Facilities. AD10-distances (7.2 $Q^{1/3}$) should be used for direct support facilities.

2)Hardened Facilities. If hardened to NATO criteria, reduced distances of AD8 (3.6 $Q^{1/3}$) should be used for direct support.

3)Examples of non-explosives facilities and functions considered to be related to AE loaded aircraft include:

a) Activities and their operating facilities for handling AE on the flight line;

b) Facilities to prepare and service armed aircraft, and those that house personnel who fly combat aircraft (e.g., alert crew shelters);

c) Flight line combat aircraft associated facilities, which may contain field offices, break rooms, unit training rooms, and equipment/supply rooms;

d) Aircraft maintenance and operations functions;

e) Hot pit refueling areas, and civil engineer (CE) fire protection stations;

f) Petroleum, Oils and Lubricants (POL) Facilities;

g) Forward supply points;

h) Intelligence, debriefing, and flight line security functions; and

i) CE functions solely dedicated to maintaining the runway and taxiways.

b.Indirect Support. Indirect support facilities and activities are facilities and functions that are not directly related to AE loaded aircraft flight line operating requirements and should be sited per Tables 3, 5 and 6 as follows:

1) Unhardened Facilities. AD14-distances (16 $Q^{1/3}$) should be used for unhardened indirect support facilities.

2) Hardened Facilities. If facilities are hardened to NATO criteria, reduced distances of AD12 (9.6 $Q^{1/3}$) should be used for indirect support facilities.

3) Examples of non-explosives facilities and functions not considered directly related to AE loaded aircraft include:

a) Maintenance Support Activities;

b) Engine shops;

c) Tire and wheel shops;

d) Aviation supply warehouses; and

e) Support Equipment maintenance facilities.

c. Unrelated Facilities. Facilities and activities unrelated to AE loaded aircraft flight line operating requirements fall within the criteria of paragraph 7.6.

7.4 QD for Emergency Power Supply Shelter and POL Shelter for the support of Hardened Aircraft Shelters

7.5 QD to Military Aircraft not Loaded with Explosives

To protect military aircraft such as tankers, transports and reserve aircraft not loaded with explosives from potential destruction from a PES, use AD13 distances-(12.0 $Q^{1/3}$). At this distance, in most cases, aircraft may sustain damage due to fragments but should remain operable.

The minimum distances are:

- AD12 (9.6 $Q^{1/3}$) for embarking/disembarking military personnel from transport aircraft,
- AD10 (7.2 $Q^{1/3}$) for tanker aircraft and,
- IBD specified in the appropriate tables if a structure is included where passengers assemble, such as a passenger terminal building should be maintained. It should be noted some passenger terminals can be considered a Vulnerable Building. Consult the National Authority to determine if increased distance should be implemented for a passenger terminal.

7.6 QD to facilities and activities unrelated to AE loaded aircraft flight line operations (i.e. IBD)

a.Use AD16-distances from the rear, and AD17a-distances from the sides, and AD17b-distances from the front of ready service ECM[12] containing up to 10000 kg NEQ at loading density of up to

[12] Reduced distance=only NATO standard ECM

20 kg/m^3. If the ES provides sufficient protection (barricade and protected roof) against debris and fragments, the BD may be used. Otherwise use the greater of the BD or DFD (HFD).

b.Use AD15-distances for other PES where AE are present on a long-term basis. If the ES provides sufficient protection (barricade and protected roof) against debris and fragments, the BD may be used. Otherwise use the greater of the BD or the DFD (HFD).

c.Where ES have been hardened, lesser distances may be used depending on the degree of hardening provided.

7.7 QD for Aircraft Loaded with HD 1.2, 1.3

Table 7 and Table 8 contain a limited number of HD 1.2 and HD 1.3 QD relationships.

7.8 QD for Aircraft Loaded with AE of more than one HD

Refer to IATG 01.50 for guidance on Aircraft loaded with AE of more than one HD. The appropriate mixing and aggregation rules for Hazard Divisions and Storage Sub-Divisions should be used.

7.9 Aircraft Effective Net Explosive Quantity (ENEQ)/Maximum Credible Event (MCE)

a.ENEQ - There are occasions where using scientific modeling will show that the ENEQ of a given weapon can be determined and can provide evidence that the resultant detonation of the weapon may be considerably less than the Net Explosives Quantity of the combined HD in the weapon. For example, a missile with 30 kg HD 1.1 warhead and a 100 kg HD 1.3 propellant charge may not produce a combined 130 kg HD 1.1 event effect.

b.MCE - In addition to using the ENEQ of a particular weapon, there are certain circumstances where it is possible to determine that the aggregated NEQ of an Aircraft does not need to be used for the computation of QDs. Aircraft fuselage and other parts of the airframe can act as effective barriers to propagation caused by high velocity low angle fragmentation. Hence, a reduced MCE value is possible. Appropriate reduced MCE values for Aircraft types and weapon loads would have to be determined based on evidence on a case-by-case basis.

7.10 AE Loaded Aircraft exempt from normal separation distance requirement

a.Aircraft configured only with the items listed below (i.e. basic load) are exempt from QD siting requirements when evaluated as a PES but are still required to be sited as an ES. The aircraft should be parked in a designated aircraft parking area meeting airfield criteria and the aircraft treated as explosives-loaded in all other respects.

The following AE can be uploaded and downloaded at the designated aircraft parking area provided that the quantity of AE being loaded or unloaded is limited to a single aircraft load.

1)HD 1.2. gun AE (30 mm or less).

2)HD 1.3 captive carry training missiles, aircraft defensive flares or chaff, practice and simulated bombs with spotting charges.

3)HD 1.4 AE.

b.Search and Rescue (SAR) aircraft loaded with any combination of illumination, spotting, marking, or other pyrotechnic articles up to 100 kg of HD 1.3.

Munitions delivery trailers (i.e., ALS, Universal Ammunition Loading System, inert bombs, trailers modified to carry chaff & flare magazines) are considered in the transportation mode (i.e., QD-exempt) provided the trailers do not remain at the designated aircraft parking area longer than the loading or unloading operation being conducted.

7.11 QD for Joint Use Airfields (commercial and military aircraft)

a.Joint use airfields where facilities are shared, are airfield layouts that provides scope for joint operations providing the maximum separation distances between military and civilian air operations. Operations at joint use airfields are to be conducted to provide the highest level of safety to the public. For example, taxi routes for AE loaded aircraft should be separated as far as possible from civilian terminal buildings and aircraft loaded with AE should be separated as far as possible from civilian aircraft.

b.Aircraft are generally more vulnerable to the effects of blast overpressure during take-off and landing than when taxiing or overflying a runway. Large aircraft have larger control surfaces than light aircraft and take-off and land at greater speeds, therefore, may receive higher stress loads from blast overpressure. As it is not feasible to accurately predict how every type of aircraft will behave, the application of separation distances for civilian aircraft operations should be based on personnel exposure rather than aircraft preservation.

c.The following are the minimum PTRD to be used considering taxiways, runways, passenger terminals and combat alert crew facilities as ES to AE storage facilities (ESH and APBs) and aircraft parking in designated areas:

1). From AE storage facilities at military airfields with cohabitated civilian air passenger traffic, a separation of high density PTRD is required to runways and taxiways with IBD required for passenger terminals. However, many large passenger terminals can be classified as a Vulnerable Buildings due to large glass facades, glass roof panels and light metallic large span roof components, all of which are vulnerable to blast pressures. In such cases, National Authorities must be consulted to decide whether increased distances should be implemented.

2). From AE storage facilities at military airfields with infrequent civilian air freight traffic but no civilian air passenger traffic, a separation of medium density PTRD is required to runways and taxiways.

3). Parking areas for civilian aircraft with no passengers require a minimum separation of high density PTRD from AE storage facilities (magazines and workshops) and designated areas.

8 Operational Considerations

a. Hazards of Electromagnetic Radiation to Ordnance[13] must be considered.

The procedures required to avoid inadvertent initiation of electro-explosive devices during handling and loading of AE onto aircraft are to be implemented during all airfield AE operations.

[13] See IATG 5.60 Version 2 for additional information

There are procedures to ensure that minimal acceptable risk exists between explosives and other airfield resources. To prevent inadvertent ignition of electro-explosive devices (EEDs), separation between sources of electromagnetic radiation is required. Accidental firing of EEDs carried on an aircraft is initiated by stray electromagnetic energy as a possible hazard on an airfield. A large number of these devices are initiated by low levels of electrical energy and are susceptible to unintentional ignition by many forms of direct or induced stray electrical energy such as radio frequency energy from ground and airborne emitters. Additional sources of stray electrical energy are lightning discharges; static electricity and triboelectric effects (friction-generated). Therefore, where explosives are handled at or near an aircraft, safety and separation clearances are required.

Hazards of Electromagnetic Radiation to Ordnance (HERO)—The danger of accidental actuation of electro-explosive devices or otherwise electrically activating ordnance because of radio frequency electromagnetic fields.

WARNING: Ensure the aircraft being loaded or unloaded is not within the hazard zone of any operating transmitters.

b. Marking of Airfield AE Facilities

1. Directional Safe Heading Markings

Directional safe headings should be permanently marked on the ground and can be marked in the manner described at Figure 1, indicating the direction of the safe heading and showing the bearing.

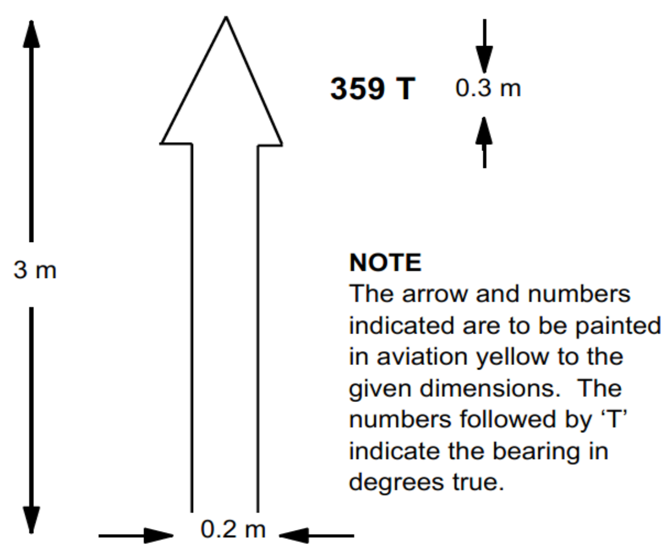


Figure 2 Directional Weapon Safe Heading Marking

2. Display of Hazard Division and Safety Signs

Where practical and when it will not create an airfield obstruction or FOD hazard, warning signs are to be posted when armed aircraft or transport aircraft loaded with explosive freight are present on flight lines and dispersal or within HAS or hangars displaying the appropriate hazard division and supplementary hazards. (Examples at Figure 3). The positioning of signs is to be agreed with the Unit Fire Officer and Senior Air Traffic Control Officer and as a minimum they should be on all the normal approach routes to the PES. There is no requirement to display safety signs for aircraft fitted only with installed explosives.

Figure 3 Example Armed Aircraft Warning Sign

c. Rotary Wing Aircraft

Helicopter landing areas for loading and unloading AE within storage sites and quick reaction alert sites will be considered aboveground magazines and may be sited at IMD based only upon the NEWQD on board the helicopters. The following requirements apply to these helicopter landing areas:

1. Flight clearance criteria are met.
2. Landing and takeoff approaches will not be over magazines.
3. Helicopter operations will be limited to ammunition support of the magazines concerned.
4. Carrying passengers is not permitted.
5. Safety precautions normal to other modes of transportation are to be observed.
6. Explosives operations will not be conducted in magazines or maintenance buildings located within IBD from the helicopter landing area during takeoff, landing or loading/off-loading of the helicopters. These magazines and buildings will be closed during landing or takeoff.
7. AE upload exercises involving ground vehicles will not take place during helicopter upload exercises unless the two exercises are separated by at least Direct Support Facilities distance.
8. Safe weapon headings should be established.

d. Un-manned Aerial Vehicles (UAV)

UAV are considered and treated as aircraft per the guidelines in this module.

e. AE Prohibited Areas (Airfield Explosive Prohibited Area)

AE facilities shall be prohibited in areas within approach and departure zones at all fixed and rotary wing aircraft landing facilities. The approach and departure zones for aircraft are those areas designated and described in accordance with National Approved airfield criteria for specific country.

Annex A
(normative)
References

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

a) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) AASTP-1, Edition B, Version 1. *NATO Guidelines for the Storage of Military Ammunition and Explosives. (Part IV, Chapter 5)*. NATO Standardization Office (NSO). December 2015;

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[14] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition management programmes.

14

Annex C
(informative)
Quantity distance requirements for airfields

TABLE 3 HD 1.1 QD for Airfields (Page 1)

NEQ (kg)	AD1	AD2	AD3	AD4	AD5	AD6	AD7	AD8	AD9	AD10
	0.5 $m/kg^{1/3}$	0.8 $m/kg^{1/3}$	1.1 $m/kg^{1/3}$	1.8 $m/kg^{1/3}$	2 $m/kg^{1/3}$	2.4 $m/kg^{1/3}$	3.2 $m/kg^{1/3}$	3.6 $m/kg^{1/3}$	4.8 $m/kg^{1/3}$	7.2 $m/kg^{1/3}$
1	1	1	2	2	2	3	4	4	5	8
2	1	2	2	3	3	4	5	5	7	10
3	1	2	2	3	3	4	5	6	7	11
4	1	2	2	3	4	4	6	6	8	12
5	1	2	2	4	4	5	6	7	9	13
6	1	2	2	4	4	5	6	7	9	14
7	1	2	3	4	4	5	7	7	10	14
8	1	2	3	4	4	5	7	8	10	15
9	2	2	3	4	5	5	7	8	10	15
10	2	2	3	4	5	6	7	8	11	16
20	2	3	3	5	6	7	9	10	14	20
30	2	3	4	6	7	8	10	12	15	23
40	2	3	4	7	7	9	11	13	17	25
50	2	3	5	7	8	9	12	14	18	27
60	2	4	5	8	8	10	13	15	19	29
70	3	4	5	8	9	10	14	15	20	30
80	3	4	5	8	9	11	14	16	21	32
90	3	4	5	9	9	11	15	17	22	33
100	3	4	6	9	10	12	15	17	23	34

125	3	4	6	9	10	12	16	18	24	36
150	3	5	6	10	11	13	18	20	26	39
175	3	5	7	11	12	14	18	21	27	41
200	3	5	7	11	12	15	19	22	29	43
225	4	5	7	11	13	15	20	22	30	44
250	4	6	7	12	13	16	21	23	31	46
275	4	6	8	12	14	16	21	24	32	47
300	4	6	8	13	14	17	22	25	33	49
325	4	6	8	13	14	17	23	25	34	50
350	4	6	8	13	15	17	23	26	34	51
375	4	6	8	13	15	18	24	26	35	52
400	4	6	9	14	15	18	24	27	36	54
425	4	7	9	14	16	19	25	28	37	55
450	4	7	9	14	16	19	25	28	37	56
475	4	7	9	15	16	19	25	29	38	57
500	4	7	9	15	16	20	26	29	39	58
600	5	7	10	16	17	21	27	31	41	61
700	5	8	10	16	18	22	29	32	43	64
800	5	8	11	17	19	23	30	34	45	67
900	5	8	11	18	20	24	31	35	47	70
1000	5	8	11	18	20	24	32	36	48	72
1200	6	9	12	20	22	26	35	39	52	77
1400	6	9	13	21	23	27	36	41	54	81
1600	6	10	13	22	24	29	38	43	57	85
1800	7	10	14	22	25	30	39	44	59	88

2000	7	11	14	23	26	31	41	46	61	91
2200	7	11	15	24	27	32	42	47	63	94
2500	7	11	15	25	28	33	44	49	66	98
3000	8	12	16	26	29	35	47	52	70	104
3500	8	13	17	28	31	37	49	55	73	110
4000	8	13	18	29	32	39	51	58	77	115
4500	9	14	19	30	34	40	53	60	80	119
5000	9	14	19	31	35	42	55	62	83	124
6000	10	15	20	33	37	44	59	66	88	131
7000	10	16	22	35	39	46	62	69	92	138
8000	10	16	22	36	40	48	64	72	96	144
9000	11	17	23	38	42	50	67	75	100	150
10000	11	18	24	39	44	52	69	78	104	156

*BD = Blast Distance, DFD = Debris and Fragment Distance. If an Exposed Site (ES) provides sufficient protection (barricade and protected roof) against debris and fragments the BD may be used. Otherwise use the greater of the BD or the DFD (HFD).

NEQ (kg)	**AD11***		**AD12***		**AD13***		**AD14***	
	BD	**DFD**	**BD**	**DFD**	**BD**	**DFD**	**BD**	**DFD**
	8 $m/kg^{1/3}$	RC/masonry	9.6 $m/kg^{1/3}$	RC/masonry	12 $m/kg^{1/3}$	Open/light	16 $m/kg^{1/3}$	RC/masonry
1	8	61	10	61	12	121	16	61
2	11	61	13	61	16	136	21	61
3	12	61	14	61	18	145	24	61
4	13	61	16	61	20	152	26	61
5	14	61	17	61	21	158	28	61
6	15	61	18	61	22	162	30	61

7	16	61	19	61	23	166	31	61
8	16	61	20	61	24	170	32	61
9	17	61	20	61	25	173	34	61
10	18	61	21	61	26	177	35	61
20	22	95	27	95	33	198	44	95
30	25	130	30	130	38	211	50	130
40	28	155	33	155	42	222	55	155
50	30	175	36	175	45	230	59	175
60	32	191	38	191	47	237	63	191
70	33	204	40	204	50	243	66	204
80	35	216	42	216	52	248	69	216
90	36	226	44	226	54	253	72	226
100	38	235	45	235	56	258	75	235
125	40	255	48	255	60	267	80	255
150	43	271	52	271	64	275	86	271
175	45	284	54	284	68	282	90	284
200	47	296	57	296	71	289	94	296
225	49	306	59	306	73	294	98	306
250	51	315	61	315	76	299	101	315
275	53	324	63	324	79	304	105	324
300	54	331	65	331	81	308	108	331
325	56	338	67	338	83	312	111	338
350	57	345	68	345	85	316	113	345
375	58	351	70	351	87	320	116	351
400	59	356	71	356	89	323	118	356

425	61	362	73	362	91	326	121	362
450	62	367	74	367	92	330	123	367
475	63	371	75	371	94	332	125	371
500	64	376	77	376	96	335	127	376
600	68	392	81	392	102	345	135	392
700	72	405	86	405	107	354	143	405
800	75	417	90	417	112	362	149	417
900	78	427	93	427	116	369	155	427
1000	80	436	96	436	120	376	160	436
1200	86	452	103	452	128	387	171	452
1400	90	466	108	466	135	397	179	466
1600	94	477	113	477	141	406	188	477
1800	98	488	117	488	146	414	195	488
2000	101	497	121	497	152	421	202	497
2200	105	505	125	505	157	428	209	505
2500	109	516	131	516	163	437	218	516
3000	116	532	139	532	174	450	231	532
3500	122	546	146	546	183	461	243	546
4000	127	557	153	557	191	472	254	557
4500	133	567	159	567	199	481	265	567
5000	137	577	165	577	206	489	274	577
6000	146	593	175	593	219	504	291	593
7000	154	606	184	606	230	517	307	606
8000	160	618	192	618	240	528	320	618
9000	167	628	200	628	250	539	333	628

10000	173	637	207	637	259	548	345	637

TABLE 3 HD 1.1 QD for Airfields (Page 2)

NEQ (kg)	AD15*		AD16*		AD17a*		AD17b*	
	BD	DFD	BD	DFD	BD	DFD	BD	DFD
	22.2 $m/kg^{1/3}$	RC/masonry	14 $m/kg^{1/3}$	ECM side/rear	18 $m/kg^{1/3}$	ECM side/rear	18 $m/kg^{1/3}$	ECM front
1	23	61	14	41	18	41	18	94
2	28	61	18	47	23	47	23	96
3	33	61	21	52	26	52	26	99
4	36	61	23	55	29	55	29	102
5	38	61	24	57	31	57	31	104
6	41	61	26	60	33	60	33	107
7	43	61	27	62	35	62	35	110
8	45	61	28	63	36	63	36	112
9	47	61	30	65	38	65	38	115
10	48	61	31	66	39	66	39	118
20	61	95	39	77	49	77	49	145
30	69	130	44	84	56	84	56	167
40	76	155	48	89	62	89	62	183
50	82	175	52	93	67	93	67	196
60	87	191	55	97	71	97	71	207
70	92	204	58	100	75	100	75	217
80	96	216	61	103	78	103	78	225
90	100	226	63	105	81	105	81	233
100	104	235	65	108	84	108	84	240
125	111	255	70	113	90	113	90	256
150	118	271	75	117	96	117	96	269

175	125	284	79	121	101	121	101	281
200	130	296	82	125	106	125	106	291
225	136	306	86	128	110	128	110	301
250	140	315	89	131	114	131	114	309
275	145	324	92	133	118	133	118	317
300	149	331	94	136	121	136	121	324
325	153	338	97	138	124	138	124	331
350	157	345	99	140	127	140	127	337
375	161	351	101	142	130	142	130	337
400	164	356	104	144	133	144	133	338
425	167	362	106	146	136	146	136	338
450	171	367	108	148	138	148	138	338
475	174	371	110	150	141	150	141	338
500	177	376	112	151	143	151	143	338
600	188	392	119	157	152	157	152	339
700	198	405	125	162	160	162	160	340
800	207	417	130	167	168	167	168	341
900	215	427	136	171	174	171	174	342
1000	222	436	140	175	180	175	180	342
1200	236	452	149	182	192	182	192	344
1400	249	466	157	188	202	188	202	346
1600	260	477	164	193	211	193	211	347
1800	271	488	171	198	219	198	219	349
2000	280	497	177	202	227	202	227	351
2200	289	505	183	206	235	206	235	352

2500	302	516	191	212	245	212	245	355
3000	321	532	202	220	260	220	260	359
3500	338	546	213	228	274	228	274	363
4000	353	557	223	234	286	234	286	367
4500	367	567	232	240	298	240	298	371
5000	380	577	240	245	308	245	308	375
6000	404	593	255	255	328	255	328	383
7000	425	606	268	263	345	263	345	391
8000	444	618	280	271	360	271	360	399
9000	462	628	292	277	375	277	375	407
10000	479	637	302	284	388	284	388	415

*BD = Blast Distance, DFD = Debris and Fragment Distance. If an Exposed Site (ES) provides sufficient protection (barricade and protected roof) against debris and fragments the BD may be used. Otherwise use the greater of the BD or the DFD (HFD).

TABLE 3 HD 1.1 QD for Airfields (Page 3)

NEQ (kg)	AD18	AD19	AD20
	20 m/kg$^{1/3}$ and AFMAN	25 m/kg$^{1/3}$ and AFMAN	16 m/kg$^{1/3}$ and AFMAN
1	16	16	16
2	16	16	16
3	16	16	16
4	71	16	16
5	71	16	16
6	71	16	16
7	71	16	16
8	71	16	16
9	71	16	16
10	71	16	16
20	71	16	16
30	71	16	16
40	71	16	16
50	71	16	16
60	71	16	16
70	71	16	16
80	71	16	16
90	71	16	16
100	71	16	16
125	71	16	16
150	71	16	16
175	71	16	16

200	71	16	16
225	71	16	16
250	71	121	50
275	71	121	50
300	71	121	50
325	71	121	50
350	71	121	50
375	71	121	50
400	71	121	50
425	71	121	50
450	71	121	50
475	71	121	50
500	159	199	127
600	169	211	135
700	178	222	143
800	186	233	149
900	194	242	155
1000	200	250	160
1200	213	266	171
1400	224	280	179
1600	234	293	188
1800	244	305	195
2000	252	315	202
2200	261	326	209
2500	272	340	218

3000	289	361	231
3500	304	380	243
4000	318	397	254
4500	331	413	265
5000	342	428	274
6000	364	455	291
7000	383	479	307
8000	400	500	320
9000	417	521	333
10000	431	539	345

TABLE 3 HD 1.1 QD for Airfields (Page 4)

AD Table 4			Airfield Distances HD 1.1 - PROPAGATION PREVENTION							
			CAPA ≤ 10 000 kg NEQ		HAS 1st Gen ≤ 2500 kg NEQ			HAS 2nd & 3rd Gen ≤ 5000 kg NEQ		
			UNBAR (a)	BAR (b)	R (c)	S (d)	F (e)	R (f)	S (g)	F (h)
CAPA	BAR	(1)	AD6 [k] AD9		AD6			AD6		
	UNBAR	(2)	AD10 AD9 [j]		AD9			AD9		
HAS 1st GENERATION	REAR	(3)	AD3		AD2		AD3	AD2		AD3
	SIDE	(4)								
	FRONT	(5)	AD8	AD6	AD4	AD6	AD7	AD4	AD6	AD8
HAS 2nd & 3rd GENERATION	REAR	(6)	AD3		AD2		AD3	AD2		AD3
	SIDE	(7)								
	FRONT	(8)			AD3	AD4	AD5	AD3	AD4	AD6
RS	READY SERVICE	(9)	No QD [m]		AD2		AD3	AD2		AD3
RS		(10)	AD4 [c]							
RS		(11)	AD9	AD6	AD4	AD6	AD7	AD4	AD6	AD8
RS		(12)	AD6		AD3		AD5	AD3		AD6
RS		(13)	AD6 [c]		AD3 [l] AD6		AD6	AD3 [l] AD6		AD6
RS		(14)	AD6 [bc] AD9 ~~AD15~~	AD6 [c]	AD9			AD9		
	STORAGE AREA	(15)	AD3		AD4			AD4		
		(16)			AD6			AD6		
		(17)	AD4							
		(18)	AD3		AD4			AD4		
		(19)			AD6			AD6		
		(20)	AD4							
		(21)	AD6 [c]	AD4 [bc] AD6 [c]	AD4		AD4 [h] AD6	AD4		AD4 [h] AD6
		(22)	AD8 [c]	AD6 [c]	AD6		AD6 [h] AD8	AD6		AD6 [h] AD8
		(23)	AD9 [c]	AD6 [c]			AD9			AD9
		(24)	AD6 [c]		AD6			AD6		
		(25)	AD2 [b] AD6		AD6			AD6		
		(26)	AD6 [bc] AD9 ~~AD15~~	AD2 [b] AD6	AD6		AD9	AD6		AD9
	WORKSHOP	(27)	AD11 BD		AD11 BD			AD11 BD		
		(28)	AD11 Max BD/DFD		AD11 Max BD/DFD			AD11 Max BD/DFD		
		(29)								

TABLE 4 HD 1.1 QD for Propagation Prevention

AD Table 4			Airfield Distances HD 1.1 - PROPAGATION PREVENTION											
			READY SERVICE ≤ 10 000 kg NEQ ; load density ≤20 kg/m³						A&E STORAGE AREA					
			ECM				MAGAZINE		ECM				MAGAZINE	
			R (i)	S (j)	FU (k)	FB (l)	UNBAR (m)	BAR (n)	R (o)	S (p)	FU (q)	FB (r)	UNBAR (s)	BAR (t)
CAPA	BAR	(1)	AD10				AD10		AD10				AD10	
	UNBAR	(2)												
HAS 1st GENERATION	REAR	(3)	AD1 AD2 [o]		AD3 [n]		AD7		AD2 [b] AD6		AD3		AD7	
	SIDE	(4)												
	FRONT	(5)	AD3 [n]		AD8 [n]	AD6 [n]	AD10				AD6	AD8	AD10	
HAS 2nd & 3rd GENERATION	REAR	(6)	AD1 AD2 [o]		AD3 [n]		AD7		AD2 [b] AD6		AD3 [a] AD6		AD7	
	SIDE	(7)												
	FRONT	(8)												
RS	READY SERVICE	(9)	AD2 [b] AD3 [a]		AD2 [b] AD4 [c]		AD4 [c]		AD2 [b] AD3 [a]		AD2 [b] AD4 [c]		AD4 [c]	
RS		(10)	AD2 [b] AD4		AD4 [c]				AD2 [b] AD4		AD4 [c]			
RS		(11)	AD2 [b] AD6		AD9 [c]		AD9 [c]	AD2 [bc]	AD2 [b] AD6		AD9 [c]		AD9 [c]	AD2 [bc]
RS		(12)			AD9 [c]		AD9				AD9 [c]		AD9	
RS		(13)	AD2 [b] AD6		AD2 [b] AD6		AD2 [bc] AD6 [c]		AD2 [b] AD6		AD2 [b] AD6		AD2 [bc] AD6 [c]	
RS		(14)			AD9 [h]		AD9	AD2 [bc]			AD9 [h] ~~AD15~~		AD9 [c] ~~AD15~~	AD2 [bc]
	STORAGE AREA	(15)	AD1 [a]		AD2 [a]		AD3		AD1 [a]		AD2 [a]		AD3	
		(16)												
		(17)	AD2 [b] AD3 [a]		AD3 [b] AD4 [c]		AD4		AD2 [b] AD3 [a]		AD2 [bc] AD4 [c]		AD4	
		(18)	AD1 [a]		AD3 [a]		AD3		AD1 [a]		AD3 [a]		AD3	
		(19)												
		(20)	AD2 [b] AD4		AD4 [c]		AD4		AD2 [b] AD4		AD4 [c]		AD4	
		(21)	AD2 [a]	AD2 [a] AD3	AD6 [cp]	AD4 [ah]	AD6	AD4 [b] AD6	AD2 [a]	AD2 [a] AD3	AD6 [c?p]	AD4 [ah]	AD6	AD4 [b] AD6
		(22)	AD4		AD8 [cp]	AD6	AD8	AD6	AD4		AD8 [c?p]	AD6	AD8	AD6
		(23)	AD2 [b] AD6		AD9B [c]	AD6	AD9B		AD2 [b] AD6		AD9B [c]	AD6	AD9B	
		(24)			AD6		AD6				AD6		AD6	
		(25)	AD2 [b] AD6				AD2 [bc] AD6c		AD2 [b] AD6				AD2 [bc] AD6 [c]	
		(26)	AD2 [b] AD6		AD9	AD2 [b] AD6	AD9 [c]	AD2 [bc]	AD2 [b] AD6		AD9 ~~AD15~~	AD2 [b] AD6	AD9 [c] ~~AD15~~	AD2 [bc]
	WORKSHOP	(27)	AD11 BD				AD11BD		AD11 BD				AD11 BD	
		(28)	AD11 Max BD/DFD				AD11 Max BD/DFD		AD11 Max BD/DFD				AD11 Max BD/DFD	
		(29)												

TABLE 4 HD 1.1 QD for Propagation Prevention

FOOTNOTES FOR AD HD 1.1 TABLE 4	
a	Storage of primary explosives is not allowed in the ES
b	Storage of primary explosives or items vulnerable to spall are not allowed in the ES
c	Effect of lobbed ammunition
d	DFD should be considered whenever possible to protect against fragment hazards (choose larger of BD/DFD). Whenever full protection is required IBD criteria should be used.
e	Barricades (only) protect against low-angle, high-speed fragments; side-rear of an ECM or arch of a HAS suffice as barricade for this purpose
f	Whenever full protection is required AD15 should be used
g	Effect of high velocity projections (or primary fragments/debris)
h	ES has a door barricade
i	Limited degree of protection
j	Robust shells
k	Not for groups
l	For robust stores or in wartime or emergency (moderate degree of protection instead of high)
m	No QD for NEQ ≤ 50 kg
n	The loading density limitation of 20 kg/m³ does not apply
o	Use AD2 when load density > 20 kg NEQ / m³
p	Effect of high velocity projections

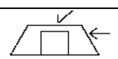
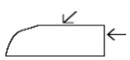
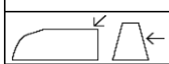
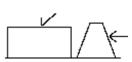
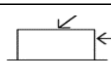
AD Table 5			Airfield Distances HD 1.1 - EXTERNAL QUANTITY DISTANCES							
			CAPA ≤ 10 000 kg NEQ		HAS					
					1st Gen ≤ 2500 kg NEQ			2nd & 3rd Gen ≤ 5000 kg NEQ		
			UNBAR (a)	BAR (b)	R (c)	S (d)	F (e)	R (f)	S (g)	F (h)
MIL AIRCRAFT UNLOADED	BAR	(1)	AD10 [cd] AD12 BD [cd] AD13 BD [ad]		AD10 [cd] AD12 BD [cd] AD13 BD [ad]			AD10 [cd] AD12 BD [cd] AD13 BD [ad]		
	UNBAR	(2)								
CIVIL AIRCRAFT UNLOADED	BAR	(3)	AD15 Max of BD/DFD		AD20	AD19	AD15 [l] Max of BD/DFD OR AD18	AD20	AD19	AD15 [l] Max of BD/DFD OR
	UNBAR	(4)								
HARDENED Direct Support [f]	Mil	(5)	AD8		AD8			AD8		
UNHARDENED Direct Support [f]	Mil	(6)	AD10 [b] AD12 BD [b] AD12 [e] Max BD/DFD	AD10 [b] AD12 BD [b]	AD10 [b] AD12 BD [b] AD12 [e] Max BD/DFD			AD10 [b] AD12B [b] AD12 [e] Max BD/DFD		
HARDENED Indirect Support [g]	Mil	(7)	AD12 BD		AD12 BD			AD12 BD		
UNHARDENED Indirect Support [g]	Mil	(8)	AD14 BD [e]		AD14 BD [e]			AD14 BD [e]		
Base Administrative Support Facilities	Mil	(9)	AD15 Max BD/DFD		AD20	AD19	AD15 [l] Max BD/DFD OR AD18	AD20	AD19	AD15 [l] Max BD/DFD OR AD18
Runways & Taxiways	Mil	(10)	AD4 [hj] AD13 BD [di]		AD4 [hj] AD13 BD [di]			AD4 [hj] AD13 BD [di]		
	Civil	(11)	AD15 Max BD/DFD		AD20	AD19	AD15 [l] Max BD/DFD OR AD18	AD20	AD19	AD15 [l] Max BD/DFD OR AD18
LOW DENSITY	PTRD	(12)	½AD15 Max BD/DFD		½AD20	½AD19	½AD15 [l] Max BD/DFD OR ½AD18	½AD20	½AD19	½AD15 [l] Max BD/DFD OR ½AD18
MEDIUM DENSITY	PTRD	(13)	2/3 AD15 Max BD/DFD		2/3 AD20	2/3 AD19	2/3 AD15 [l] Max BD/DFD OR 2/3 AD18	2/3 AD20	2/3 AD19	2/3 AD15 [l] Max BD/DFD OR 2/3 AD18
HIGH DENSITY	PTRD	(14)	AD15 Max BD/DFD		AD20	AD19	AD15 [l] Max BD/DFD OR AD18	AD20	AD19	AD15 [l] Max BD/DFD OR AD18
	IBD	(15)								
VULNERABLE CONSTRUCTIONS		(16)	2*AD15		2*AD15			2*AD15		
OPS SMALL QTY [m]	POL	(17)	10m		10m			10m		
UNDERGROUND [n]	POL	(18)	½AD6 ≥ 25m		½AD6 ≥ 25m			½AD6 ≥ 25m		
PROTECTED [o] ABOVEGROUND	POL	(19)								
UNPROTECTED ABOVEGROUND [p]	POL	(20)	AD10 [q] AD15 Max BD/DFD		AD10 [q] AD15 Max BD/DFD			AD10 [q] AD15 Max BD/DFD		
Communication Lines [s]	Electrical Supply & Communication Lines [w]	(21)	2/3 AD15 ≥ 60m Max BD/DFD		2/3 AD15 ≥ 60m Max BD/DFD			2/3 AD15 ≥ 60m Max BD/DFD		
Overhead power lines >15 kV [t]	Electrical Supply & Communication Lines [w]	(22)								
Underground cables	Electrical Supply & Communication Lines [w]	(23)	AD3 ≥ 15m		AD3 ≥ 15m			AD3 ≥ 15m		
Major installations [u]	Electrical Supply & Communication Lines [w]	(24)	AD15 Max BD/DFD		AD15 Max BD/DFD			AD15 Max BD/DFD		
Minor installations [v]	Electrical Supply & Communication Lines [w]	(25)	AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]		AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]			AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]		

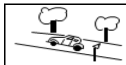
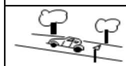
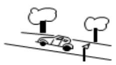
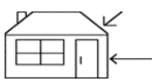
TABLE 5 HD 1.1 QD for External Quantity Distances

AD Table 6			Airfield Distances HD 1.1 - EXTERNAL QUANTITY DISTANCES											
			READY SERVICE *≤ 10 000 kg NEQ ; load density ≤ 20 kg/m^3*						A&E STORAGE AREA					
			ECM				MAGAZINE		ECM				MAGAZINE	
			R (i)	S (j)	FU (k)	FB (l)	UNBAR (m)	BAR (n)	R (o)	S (p)	FU (q)	FB (r)	UNBAR (s)	BAR (t)
MIL AIRCRAFT UNLOADED	BAR	(1)	AD10 BD [cd] AD12 BD [cd] AD13 BD [ad]				AD10 BD [cd] AD12 BD [cd] AD13 BD [ad]		AD10 BD [cd] AD12 BD [cd] AD13 BD [ad]				AD10 BD [cd] AD12 BD [cd] AD13 BD [ad]	
	UNBAR	(2)												
CIVIL AIRCRAFT UNLOADED	BAR	(3)	AD16 Max of BD/DFD	AD17A Max of BD/DFD	AD17B Max of BD/DFD		AD15 Max of BD/DFD		AD16 [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17A [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17B [k] Max of BD/DFD **OR** AD15 Max of BD/DFD		AD15 Max of BD/DFD	
	UNBAR	(4)												
HARDENED Direct Support [f]	Mil	(5)	AD8				AD8		AD10 Max of BD/DFD				AD10 Max of BD/DFD	
UNHARDENED Direct Support [f]	Mil	(6)	AD10 BD [be] AD12 BD [be]				AD10 BD [be] AD12 BD [be]		AD10 Max of BD/DFD [b] AD12 Max of BD/DFD [b]				AD10 BD [b] AD12 BD [b]	
HARDENED Indirect Support [g]	Mil	(7)	AD12 BD				AD12 BD		AD12 Max of BD/DFD				AD12 Max of BD/DFD	
UNHARDENED Indirect Support [g]	Mil	(8)	AD14 BD [e]				AD14 BD [e]		AD14 Max of BD/DFD				AD14 Max of BD/DFD	
Base Administrative Support Facilities	Mil	(9)	AD16 Max of BD/DFD	AD17A Max of BD/DFD	AD17B Max of BD/DFD		AD15 Max of BD/DFD		AD16 [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17A [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17B [k] Max of BD/DFD **OR** AD15 Max of BD/DFD		AD15 Max of BD/DFD	
Runways & Taxiways	Mil	(10)	AD4 [hj] AD13 BD [di]				AD4 [hj] AD13 BD [di]		AD4 [hj] AD13 BD [di]				AD4 [hj] AD13 BD [di]	
	Civil	(11)	AD16 Max of BD/DFD	AD17A Max of BD/DFD	AD17B Max of BD/DFD		AD15 Max of BD/DFD		AD16 [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17A [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17B [k] Max of BD/DFD **OR** AD15 Max of BD/DFD		AD15 Max of BD/DFD	
LOW DENSITY	PTRD	(12)	½AD16 Max of BD/DFD	½AD17A Max of BD/DFD	½AD17B Max of BD/DFD		½AD15 Max of BD/DFD		½AD16 [k] Max of BD/DFD **OR** ½AD15 Max of BD/DFD	½AD17A [k] Max of BD/DFD **OR** ½AD15 Max of BD/DFD	½AD17B [k] Max of BD/DFD **OR** ½AD15 Max of BD/DFD		½AD15 Max of BD/DFD	
MEDIUM DENSITY	PTRD	(13)	*2/3* AD16 Max of BD/DFD	*2/3* AD17A Max of BD/DFD	*2/3* AD17B Max of BD/DFD		*2/3* AD15 Max of BD/DFD		*2/3* AD16 [k] Max of BD/DFD **OR** *2/3* AD15 Max of BD/DFD	*2/3* AD17A [k] Max of BD/DFD **OR** 2/3 AD15 Max of BD/DFD	*2/3* AD17B [k] Max of BD/DFD **OR** *2/3* AD15 Max of BD/DFD		*2/3* AD15 Max of BD/DFD	
HIGH DENSITY	PTRD	(14)	AD16 Max of BD/DFD	AD17A Max of BD/DFD	AD17B Max of BD/DFD		AD15 Max of BD/DFD		AD16 [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17A [k] Max of BD/DFD **OR** AD15 Max of BD/DFD	AD17B [k] Max of BD/DFD **OR** AD15 Max of BD/DFD		AD15 Max of BD/DFD	
	IBD	(15)												
VULNERABLE CONSTRUCTIONS		(16)	*2** AD15 Max of BD/DFD				*2** AD15 Max of BD/DFD		*2** AD15 Max of BD/DFD				*2** AD15 Max of BD/DFD	
OPS SMALL QTY [m]	POL	(17)	10m				10m		10m				10m	
UNDERGROUND [n]	POL	(18)	½AD6 ≥ 25m				½AD6 ≥ 25m		½AD6 ≥ 25m				½AD6 ≥ 25m	
PROTECTED [o] ABOVEGROUND	POL	(19)												
UNPROTECTED ABOVEGROUND [p]	POL	(20)	AD10 [q] AD16 Max of BD/DFD	AD10 [q] AD17A Max of BD/DFD	AD10 [q] AD15 Max of BD/DFD		AD10 [q] AD15 Max of BD/DFD		AD10 [q] AD15/AD16 [k] Max of BD/DFD	AD10 [q] AD15/AD17A [k] Max of BD/DFD	AD10 [q] AD15 Max of BD/DFD		AD10 [q] AD15 Max of BD/DFD	
Communication Lines [s]	Electrical Supply & Communication Lines [w]	(21)	*2/3* AD15 ≥ 61m Max of BD/DFD				*2/3* AD15 ≥ 61m Max of BD/DFD		*2/3* AD15 ≥ 61m Max of BD/DFD				*2/3* AD15 ≥ 61m Max of BD/DFD	
Overhead power lines >15 kV [t]	Electrical Supply & Communication Lines [w]	(22)												
Underground cables	Electrical Supply & Communication Lines [w]	(23)	AD3 ≥ 15m				AD3 ≥ 15m		AD3 ≥ 15m				AD3 ≥ 15m	
Major installations [u]	Electrical Supply & Communication Lines [w]	(24)	AD15 Max of BD/DFD				AD15 Max of BD/DFD		AD15 Max of BD/DFD				AD15 Max of BD/DFD	
Minor installations [v]	Electrical Supply & Communication Lines [w]	(25)	AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]				AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]		AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]				AD11 BD ≥ 15m (≥ 45m [x]) AD5 & AD9 [y]	

TABLE 6 HD 1.1 QD for External Quantity Distances

FOOTNOTES FOR TABLES 5 - 6	
a	Barricades are required if protection from low-angle, high velocity fragments is desired; side-rear of an ECM or arch of a HAS suffice as barricade for this purpose.
b	At AD10 damage to unstrengthened buildings may be of a serious nature with resulting casualties. Use AD12 where greater protection is required.
c	Apply AD12 BD (BD = Blast Distance as shown in the table) for embarking/disembarking personnel - Apply AD10 BD for exposed tanker aircrafts
d	DFD should be considered whenever possible to protect against fragment hazards (choose larger of BD/DFD). Whenever full protection is required IBD criteria should be used.
e	Consider also DFD when protection is required against debris throw and primary fragments and apply largest of BD and DFD.
f	E.g. Squadron Ops, Flightline Maint, Fire & Rescue Stations, Alert Crew, POL & LOX facilities, ...
g	In transition to war and war, all facilities may be considered to be directly supporting and the lesser distances used.
h	Transient risk to military aircraft is accepted.
i	Transient risk to aircraft is NOT accepted.
j	Apply larger distances when saturated soils or clay (increased crater radius)(see AASTP-1 Part II § 2.3.3.33. page II-3-10)
k	Reduced QD for large volume 7 or 3 bar ECM (≥500m³) with a NEQ content of < 45000 kg.
l	Applies when doors of HAS are open (fragments can eject from the front without resistance when doors are open)(except when doors are open for aircraft towing, fueling, servicing, run up or taxi and during concurrent servicing operations or short periods when maintenance equipment or AE are being moved into or out of shelters - during these operations doors may be considered being closed)
m	For quantities ≤ 100 l for operational needs only
n	Burried, underground with earth cover ≥ 60 cm (included pipelines)
o	Provided with structural protection against both blast and fragment hazards
p	E.g. bulk storage, railroad tank cars, transfer points, fuel service unrelated, parking area for fuel tank trucks, pipelines, fuel hydrants, fuel bladders, parking for fuel loaded tanker aircrafts
q	Fix refueling points and Fuel Service Trucks both related to Combat Aircraft facilities, including hot pit refueling areas
r	Consider DFD where the POL-facilities are vital (choose the larger of BD and DFD)
s	Public service or military emergency communication lines
t	Overhead electrical power transmission lines > 15 kV or associated substations (UK ≥ 11 kV)
u	Important installations such as the lines of a supergrid network and associated substations should be given greater protection from fragments and debris; this is also appropriate for microwave, ultra high frequency (UHF) reflectors.
v	Such as those serving the buildings of the explosives area.
w	QD should be greater than one span between the poles or pylons.
x	For power generating stations and substations.
y	Emergency Power Supply Shelter for the Support of HAS

AD Table 7			Airfield Distances HD 1.2 PROPAGATION PREVENTION *a*							
			CAPA *≤ 10 000 kg NEQ*		**READY SERVICE** *≤ 10 000 kg NEQ ; load density ≤ 20 kg/m³*					
					ECM				**MAGAZINE**	
			UNBAR (a)	**BAR** (b)	**REAR** (c)	**SIDE** (d)	**FRONT** (e)	**FRONT** (f)	**UNBAR** (g)	**BAR** (h)
CAPA	**BAR**	(1)	No QD ***bd*** 2.4MCE 1/3	No QD	No QD		No QD ***bd*** 2.4MCE 1/3	No QD	No QD ***bd*** 2.4MCE 1/3	No QD
	UNBAR	(2)	No QD ***b*** 4.8MCE 1/3				No QD ***b*** 4.8MCE 1/3		No QD ***b*** 4.8MCE 1/3	
RS	**READY SERVICE**	(3)	No QD		No QD		No QD	No QD	No QD	
 **RS**		(4)								
 **RS**		(5)	No QD ***b*** 4.8MCE 1/3	No QD			No QD ***b*** 4.8MCE 1/3		No QD ***b*** 4.8MCE 1/3	No QD
 **S**		(6)	No QD				No QD		No QD	
 **RS**		(7)	No QD ***bd***	No QD	No QD		No QD ***bd***	No QD	No QD ***bd***	No QD
 **RS**		(8)	10m ***b*** 4.8MCE 1/3				No QD ***b*** 4.8MCE		No QD ***b*** 4.8MCE	

 **LOW DENSITY**	**PTRD**	(9)	½D1 ***b*** ½D2 135m ***c***	½D1 ***b*** ½D2 200m ***c***	No QD ***bd*** ½D2 ≥ 270m	½D1 ***b*** ½D2 ***d*** ½D2 ≥ 270m	½D1 ***b*** ½D2 135m ***c***	½D1 ***b*** ½D2 200m ***c***
 **MEDIUM DENSITY**		(10)	D5 ***b*** D6 185m ***c***	D5 ***b*** D6 270m ***c***	20m ***bd*** D6 ≥ 200m	D5 ***b*** D6 ***d*** D6 ≥ 200m	D5 ***b*** D6 185m ***c***	D5 ***b*** D6 270m ***c***
 **HIGH DENSITY**		(11)	D1 ***b*** D2 270m ***c***	D1 ***b*** D2 400m ***c***	30m ***b*** 60m ***d*** D2 ≥ 400m	D1 ***b*** D2 ***d*** D2 ≥ 400m	D1 ***b*** D2 270m ***c***	D1 ***b*** D2 400m ***c***
	**IBD**	(12)			30m ***b*** 60m ***d*** D2 ≥ 400m	D1 ***b*** D2 ***d*** D2 ≥ 400m		
VULNERABLE CONSTRUCTIONS		(13)	D1 ***b*** D2 270m ***c***	D1 ***b*** D2 400m ***c***	30m ***b*** 60m ***d*** D2 ≥ 400m	D1 ***b*** D2 ***d*** D2 ≥ 400m	D1 ***b*** D2 270m ***c***	D1 ***b*** D2 400m ***c***

FOOTNOTES	
a	For asset preservation: use HD 1.1 tables
b	Apply for for SsD 1.2.2
c	Apply this distance when the PES is other than an open AE of SsD 1.2.1 with an MCE>50 kg
d	Apply for SsD 1.2.1 with MCE ≤ 50 kg
D1	28.127-2.364*LN(NEQ)+1.577*((LN(NEQ))²)
D2	-167.648+70.345*LN(NEQ)-1.303*((LN(NEQ))²)
D3	0.36*D1
D4	0.36*D2
D5	0.67*D1
D6	0.67*D2

TABLE 7 HD 1.2 QD for Propagation Prevention

<table>
<tr><td colspan="3" rowspan="5">AD Table 8</td><td colspan="8">Airfield Distances HD 1.3 [b]</td></tr>
<tr><td colspan="2">CAPA
≤ 10 000 kg NEQ
PROPAGATION PREVENTION [e]</td><td colspan="6">READY SERVICE
≤ 10 000 kg NEQ ; load density ≤ 20 kg/m³</td></tr>
<tr><td colspan="2"></td><td colspan="4">ECM</td><td colspan="2">MAGAZINE</td></tr>
<tr><td>UNBAR</td><td>BAR</td><td>REAR</td><td>SIDE</td><td>FRONT UNBAR</td><td>FRONT BAR</td><td>UNBAR</td><td>BAR</td></tr>
<tr><td>(a)</td><td>(b)</td><td>(c)</td><td>(d)</td><td>(e)</td><td>(f)</td><td>(g)</td><td>(h)</td></tr>
<tr><td rowspan="2">CAPA</td><td>BAR</td><td>(1)</td><td colspan="2" rowspan="2">$0.22Q^{1/2}$ ≥25m
$0.22Q^{1/2}$ (25m≤D≤ 60m) [ac]</td><td rowspan="2">25m</td><td rowspan="2">25m [c]
$0.22Q^{1/2}$ ≥25m</td><td rowspan="2">60m [c]
240m</td><td rowspan="2">60m [c]
$0.22Q^{1/2}$ ≥25m [d]
240m</td><td colspan="2" rowspan="2">$0.22Q^{1/2}$ ≥25m
$0.22Q^{1/2}$ (25m≤D≤ 60m) [ac]</td></tr>
<tr><td>UNBAR</td><td>(2)</td></tr>
<tr><td>RS</td><td rowspan="6">READY SERVICE</td><td>(3)</td><td colspan="2">No QD [c]
10m</td><td colspan="2">No QD</td><td colspan="2" rowspan="2">No QD [c]
$0.22Q^{1/2}$ ≥25m</td><td colspan="2">No QD [c]
10m</td></tr>
<tr><td>RS</td><td>(4)</td><td colspan="2">No QD [c]
$0.22Q^{1/2}$ ≥ 25m</td><td colspan="2">No QD [c]
10m</td><td colspan="2">No QD [c]
$0.22Q^{1/2}$ ≥ 25m</td></tr>
<tr><td>RS</td><td>(5)</td><td colspan="2">60m [c]
$0.22Q^{1/2}$ ≥ 25m</td><td>No QD [c]
25m</td><td>$0.22Q^{1/2}$ ≥25m
25m [c]</td><td>240m</td><td>25m [c]
$0.22Q^{1/2}$ ≥25m [d]
240m</td><td colspan="2">60m [c]
$0.22Q^{1/2}$ ≥ 25m</td></tr>
<tr><td>RS</td><td>(6)</td><td colspan="2">25m [c]
$0.22Q^{1/2}$ ≥ 25m</td><td colspan="2">No QD [c]
10m</td><td colspan="2">25m [c]
$0.22Q^{1/2}$ ≥25m</td><td colspan="2">25m [c]
$0.22Q^{1/2}$ ≥ 25m</td></tr>
<tr><td>RS</td><td>(7)</td><td colspan="2" rowspan="2">$0.22Q^{1/2}$ ≥25m
$0.22Q^{1/2}$ (25m≤D≤ 60m) [ac]</td><td rowspan="2">25m</td><td rowspan="2">25m [c]
$0.22Q^{1/2}$ ≥25m</td><td rowspan="2">60m [c]
240m</td><td rowspan="2">60m [c]
$0.22Q^{1/2}$ ≥25m [d]
240m</td><td colspan="2" rowspan="2">$0.22Q^{1/2}$ ≥25m
$0.22Q^{1/2}$ (25m≤D≤ 60m) [ac]</td></tr>
<tr><td>RS</td><td>(8)</td></tr>
<tr><td>LOW DENSITY</td><td rowspan="3">PTRD</td><td>(9)</td><td colspan="2">60m [c]
$3.2Q^{1/3}$ ≥60m</td><td colspan="4">60m [c]
$3.2Q^{1/3}$ ≥60m</td><td colspan="2">60m [c]
$3.2Q^{1/3}$ ≥60m</td></tr>
<tr><td>MEDIUM DENSITY</td><td>(10)</td><td colspan="2">$4.3Q^{1/3}$ ≥60m</td><td colspan="4">$4.3Q^{1/3}$ ≥60m</td><td colspan="2">$4.3Q^{1/3}$ ≥60m</td></tr>
<tr><td>HIGH DENSITY</td><td>(11)</td><td colspan="2" rowspan="2">$6.4Q^{1/3}$ ≥60m</td><td colspan="4" rowspan="2">$6.4Q^{1/3}$ ≥60m</td><td colspan="2" rowspan="2">$6.4Q^{1/3}$ ≥60m</td></tr>
<tr><td></td><td>IBD</td><td>(12)</td></tr>
<tr><td>VULNERABLE CONSTRUCTIONS</td><td></td><td>(13)</td><td colspan="2">$6.4Q^{1/3}$ ≥60m</td><td colspan="4">$6.4Q^{1/3}$ ≥60m</td><td colspan="2">$6.4Q^{1/3}$ ≥60m</td></tr>
</table>

FOOTNOTES	
a	Maximum capacity when D (distance) ≥ 60m
b	This table only offers AD's that provide at least a high level of protection. For guidance on virtual complete protection see AASTP-1 Part I Tables
c	Apply for AE of SsD 1.3.2
d	The PES has a barricade with a vertical wall facing the door and is preferably backed with earth. Such a barricade permits the use of the reduced QDs in Annex IA (§ 1.3.6.6)
e	For Asset preservation apply HD 1.1 tables

TABLE 8 HD 1.3 QD for Propagation Prevention (Table 8)

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 09.10

Third edition
March 2021

Security principles and systems

UN SaferGuard
Securing ammunition, protecting lives

IATG 09.10:2021[E]

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

Effective and efficient security is an essential element of any conventional ammunition stockpile management programme, as it reduces and/or mitigates the risks of sabotage, loss, theft, leakage and proliferation (collectively these are generally known as diversion). It can be used to identify future procurement requirements or surpluses. The systematic control of ammunition stockpiles is in keeping with a philosophy of 'due care' and therefore States should take a pro-active, rather than re-active, stance in ensuring that ammunition is accounted[3] for and secured to the highest standards.

This module provides guidance for practical conventional ammunition stockpile management. It sets out sensible and practicable measures that will assist in preventing the theft, leakage and proliferation of conventional ammunition stockpiles. These measures are reasonable and achievable and will enhance any conventional ammunition stockpile management programme.

[3] Inventory management is covered in IATG 03.10 *Inventory Management.*

Security principles and systems

1 Scope

This IATG module establishes the guiding principles, defines procedures and introduces technical security systems for the effective and efficient security of ammunition storage areas in support of a conventional ammunition stockpile management programme.[4]

This module should be read in conjunction with IATG 03.10 *Inventory Management*, which contains the actions to be taken on discovery of a loss or theft of ammunition or explosives.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term ‘diversion’ refers to *the shifting of weapons, ammunition or explosives from the legal market or owner to an illegal market or owner as a result of losses, theft, leakage or proliferation from a stockpile or other source*.

The term ‘security’ refers to *the result of measures taken to prevent the theft of explosive ordnance, entry by unauthorised persons into explosive storage areas, and acts of malfeasance, such as sabotage*.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **‘can’ indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

[4] These principles and techniques are very similar to those for the security of weapons contained within MOSAIC 05.20 *Stockpile management: Weapons* from which much of this IATG is derived.

4 International instruments

Article 11 of the UN Firearms Protocol[5] requires that *States **shall** take appropriate measures, ... to require the security of firearms, their parts and components and ammunition at the time of manufacture, import, export and transit through its territory*. These requirements, already agreed by many states, are a core component of this IATG.

5 General

To be most effective, it is important that the technical systems required for effective security are included during the resource allocation process of conventional ammunition stockpile management. The financial costs of security are minimal, when compared to the potential value of the ammunition stockpile, yet they have the potential for high impact on preventing the theft and illicit proliferation of conventional ammunition. Costs should be measured against the potential impact of poor security, (i.e. political impact, reputational consequences and overall financial costs), not just on simple financial loss accounting.

6 Principles and aim of conventional ammunition stockpile security (LEVEL 1)

6.1 Principles of stockpile security

The following principles of physical security should be applied to ammunition storage and processing areas:

A) there shall be an effective accounting system for all ammunition stocks held in all APBs and ESH at all ASA and a system of regular stock checks;

B) physical security systems should be derived from an effective risk assessment process;

C) physical security should be built into new storage facilities at the design stage;

D) an effective perimeter security infrastructure shall be in place;

E) access shall be controlled at all times;

F) access shall be restricted to authorised personnel only;

G) only trusted individuals, who have been security cleared, shall be nominated as authorised personnel to work within the facility; and

H) temporary personnel shall be accompanied at all times.

6.2 Aim of stockpile security

Absolute security is theoretically impossible as no secured facility can ever be 100% impervious to a determined attack or to theft/diversion from within. The aim of stockpile physical security should therefore be to:

A) deter and reduce any attempted incursions or internal thefts;

B) thwart any attempted security breach;

C) immediately detect a security breach or threat;

D) assess the scale of any security breach or threat;

[5] United Nations General Assembly Resolution A/RES/55/255. *Protocol against the illicit manufacturing of and trafficking in firearms, their parts and components and ammunition supplementing the United Nations Convention against Transnational Organized Crime*. 08 June 2001. 'The Firearms Protocol'. (Entered into Force on 03 July 2005).

E) delay the time necessary for the illegal removal of ammunition and explosives from storage areas; and

F) allow security personnel to respond and take appropriate action.

7 Stockpile risk assessment[6] (LEVEL 1)

A risk assessment should examine conventional ammunition stockpile security systems to determine:

a) the financial value of the facility and contents within it;

A) active hazards to conventional ammunition security and their frequency, (i.e. the probability of stockpile leakages through espionage, theft or diversion, or stockpile damage/destruction due to sabotage or other forms of attack);

B) passive hazards and their frequency, (i.e. natural catastrophes such as floods, earthquakes, fires etc);

C) attractiveness indicators for active hazards to conventional ammunition security (based upon the content of a given facility and its susceptibility to direct or surreptitious attack);

D) vulnerability to espionage, theft or diversion; and

E) vulnerability to sabotage or terrorist attack.

This information, when used properly, will allow the responsible authority to establish management priorities in the most cost-effective and secure manner. Residual risk of loss, theft or diversion should then be kept to a minimum.

The risk assessment should also formally identify those ammunition items that may be classified as being attractive to criminals and terrorist organisations (ACTO). Although arguably all ammunition items may be of some use to criminals and terrorists, ACTO classified ammunition is usually that ammunition that would significantly increase terrorist capability. Table 1 lists those items that should be classified as ACTO, and that should be subject to more stringent security than other ammunition items. States may wish to add items to the basic ACTO list:

ACTO Item	Potential Terrorist Use
MANPADS	▪ Attacks on civil aviation.
Detonators	▪ Initiation of Improvised Explosive Devices (IED). ▪ Usually strictly controlled on civilian explosives market.
Bulk Explosive	▪ Used as main charge for IEDs. ▪ More powerful than home-made or commercial explosives.
Man-portable Anti-Tank Missiles	▪ Attacks on VIP vehicles.
Hand Grenades	▪ Concealable weapon that can be used in confined spaces.
Small arms ammunition	▪ Close Quarter Assassinations.

Table 1: ACTO ammunition items

[6] One risk assessment methodology can be found in UFC 04-020-01, *DoD Security Engineering Facilities Planning Manual,* Chapter 3. 11 September 2008.

8 Physical security of conventional ammunition stockpiles

8.1 Development of physical security systems (LEVEL 1)

There are no international standards for the implementation of physical protective security systems. There are, however, a range of European Standards (EN) and national guidelines[7] that form international good practice for security equipment that can be utilised for the protection of ammunition storage areas and facilities. They are used as informative standards within this IATG.

The security requirements for each location should be determined by the assessment of criteria that shall include:

A) the type of assets to be protected and the role of the unit or users;

B) the value of assets (whether monetary or in terms of utility to illicit users) to be protected;

C) the threats to those assets, (see Clause 7);

D) the protection level desired against such threats, which may include cost benefit analysis; and

E) any design constraints imposed by the organisation storing the conventional ammunition.

The following components should be examined and considered during the development of a physical security system:

A) b) security regulations and standard operating procedures (SOP);

B) security plan;

C) staff selection and vetting;

D) access control;

E) physical security of buildings and structures; and

F) physical security of perimeter.

8.2 Security regulations (LEVEL 1)

Comprehensive security regulations[8] shall be compiled which should include the requirements of this module if compliance is to be met. Such regulations should be:

A) published as a legal authority;

B) available to all appropriate personnel;

C) clear and consistent with no legal or operational contradictions;

D) applicable to all ammunition stockpiles within a state; and

E) regularly reviewed.

Security regulations, which are a legislative and regulatory issue, should be supported by effective standing operating procedures (SOP) that lay down clear operational activities and responsibilities. SOPs should contain the following information as a minimum:

A) outline the scope of the instructions;

---

[7] A comprehensive national standard that may be of use is the *DoD 5100.76-M, Physical Security of Sensitive Conventional Arms, Ammunition and Explosives (AAE). 17 April 2012.*

[8] This could take the form of legislation, regulatory or statutory instruments.

B) nominate the individual in charge of security at the location (appointment, location and telephone number). This will usually be the Security Officer;

C) outline any generic and known security threats;

D) list all those at the location with security responsibilities (security officers, safety officers, armaments officers, transport officers, stores officers, accounting officers etc);

E) individual terms of reference for those with security responsibilities, written in simple unambiguous language;

F) explain the access control policy;

G) rules for the control of security keys;

H) inventory and accounting procedures;

I) detailed security procedures to be followed in the different areas of the ammunition storage facility;

J) action on discovery of incursion, thefts, losses or accounting surpluses; and

K) action in response to alarms.

8.3 Security plan (LEVEL 1)

The security plan is the foundation to effective stockpile management of conventional ammunition and shall be based on the requirements of the security regulations. A written security plan shall be developed for each stockpile location.

Security plans can differ dependent on local requirements, local security organisation etc, although there should be common essential elements in each plan. Annex C contains a model plan that may be adopted by stockpile management organisations.

The security plan should be updated regularly to reflect any factors that may change. It should be a flexible document easily adaptable to changing circumstances and requirements. Security classification of the plan shall be the responsibility of the designated security officer at the conventional ammunition storage facility.

8.4 Staff selection and vetting systems (LEVEL 2)

Physical security and ammunition inventory management systems are all vulnerable to failure should staff not accept their responsibilities, fail to follow SOPs or become subverted. This means that organisations shall make every effort to ensure that staff are;

A) selected who do not have criminal convictions and are unlikely to possess criminal tendencies;

B) trained effectively; and

C) likely to remain loyal, well motivated and appropriately rewarded.

Conversely, poorly paid, inadequately trained and under-motivated staff are more likely to be involved in malfeasance (including laxity in carrying out duties, being susceptible to bribery, failure to follow procedures or even active involvement in conventional ammunition theft and sale).

Stockpile management organisations should ensure that appropriate procedures are developed and followed for the security vetting[9] of staff prior to employment in ammunition storage areas and that they are security vetted at regular intervals throughout their employment. It should also be a

[9] Security vetting is a process used to perform background checks on an individual's suitability for a particular appointment. It normally consists of: 1) confirming an individual's identity; 2) looking at associations that may cause a conflict of interest; and 3) determining vulnerabilities in an individual's life through which improper pressure could be applied.

condition of their contracts that they shall report any relevant changes in personal circumstances to security vetting staff. A history of gender-based or intimate partner violence, even if not classified as a criminal matter in some jurisdictions, should also be considered a disqualifying factor.

It should be noted that the 'human factor' plays a crucial role in safe and secure ammunition management and hence constitutes one of the weakest links in any physical security system. Only adequately paid and trained personnel who receive organizational recognition for their work and are provided with prospects for personal and professional development will develop a high degree of resilience against subversion. Therefore, early and adequate investments in the selection, training and well-being of staff should be considered at least as important as improvements to the physical infrastructure.

8.5 Access control

8.5.1 Keys (LEVEL 1)

Keys to ammunition storage areas, buildings, containers and intruder detection systems (IDS) shall be stored separately to other keys and shall not be left unsecured or unattended at any time. They shall be accessible only to those individuals whose duties require them to have access to the conventional ammunition storage areas. A roster of authorised personnel (custodians) should be kept by the authority responsible for ammunition security.

A record shall be kept each time an individual removes keys from the secure key cabinet.

The number of keys shall be kept to an absolute minimum, and master keys shall be prohibited.

8.5.2 Combination locks (LEVEL 2)

The main advantage of combination locks is that they can be easily re-coded, while key and lock systems must be entirely replaced in case one of the keys is lost. Conversely, there is no physical way of controlling and limiting the access (such as counting or retaining keys) to a facility. Hence, the use of combination locks is often limited to applications where it is undesirable for management personnel to leave the premises with keys (e.g. centralized key safe-boxes or access doors).

The combinations to locks shall be dealt with in the same manner as keys. Mechanical combination locks must not remain in open position, as the combination may be visible for unauthorized personnel.

Combinations should be changed at regular intervals and must be changed immediately when individuals change or move appointments and if it is suspected that unauthorized personnel gained knowledge of a combination.

Records of combinations should be held in sealed envelopes by the security officer even if they are logged onto secure computer systems.

Every combination lock guarded facility or container must have a record of access by individual, date and time prominently displayed on its door.

8.5.3 Entry to ammunition storage areas (LEVEL 1)

Strict personnel and vehicle access control shall be established for all areas storing conventional ammunition. Entry to ammunition storage areas should be authorised in writing by the authority responsible for ammunition security.

Vehicles and individuals should be subject to random inspection and search upon entry to and exit from ammunition storage areas.

8.6 Physical security infrastructure for buildings and structures

8.6.1 Doors and gates (LEVEL 2)

Access doors and gates shall be sufficiently robust and comply with national security standards. As a minimum, the doors should be made of solid hardwood with steel on the outside face. Door frames should be rigidly anchored to prevent disengagement of the lock bolt by prying or jacking of the door frame. Door and gate hinges should be located on the inside and should be of the fixed pin security type or equivalent. More detailed information on the construction of doors to achieve various levels of security may be found in LPS 1175 *Specification for testing and classifying the burglary resistance of building components, strong-points and security enclosures*.[10]

Access doors and gates shall be secured with high security padlocks (Clause 8.6.3).

8.6.2 Windows (LEVEL 1)

Windows and other openings to ammunition storage buildings shall be kept to a minimum and provided with appropriate locks and security bars or grilles. For new ESH no windows is preferred.

8.6.3 Locks and padlocks (LEVEL 2)

Padlocks for the gates and explosive storehouses should be compliant with European Standard EN 12320:2012, *Building hardware – Padlocks and padlock fittings – Requirements and test methods*.

8.6.4 Intrusion detection systems[11, 12] (LEVEL 3)

Buildings and structures used for the storage of conventional ammunition should be fitted with appropriate intrusion detection systems (IDS). IDS should be fitted to all doors, windows and other openings. Interior motion or vibration detection systems may also be fitted.

All alarm signals from such systems should be received at a central control or monitoring system from which a response force can be dispatched. The response force should respond to activated IDS (to include system tampering or compromise) as soon as possible, but the response shall be no later than 15 minutes after receipt of the alarm signal.

If IDS line security is unavailable, two independent means of alarm signal transmission from the alarm area to the monitoring station should be provided and any visible lines must be inspected weekly. Where possible, one of the two independent means of alarm signal transmission should be a secure wireless link. The dual transmission equipment shall continuously monitor the integrity of communications links.

IDS transmission lines should have electronically monitored line supervision in order to detect evidence of tampering or attempted compromise.

A daily record should be maintained of all alarm signals received which should be reviewed to identify and correct IDS reliability problems. The log should reflect the following:

A) nature of the alarm, (nuisance, system failure or illegal entry);

B) date, time and location of alarm; and

[10] Loss Prevention Standard (LPS) 1175 *Specification for testing and classifying the burglary resistance of building components, strong-points and security enclosures.* Issue 6. Building Research Establishment (BRE) Global. 24 May 2007.

[11] Also referred to as alarms.

[12] DoD 5100.76-M, *Physical Security of Sensitive Conventional Arms, Ammunition and Explosives (AAE).* 17 April 2012.

C) action taken in response to the alarm.

IDS should be tested weekly to ensure the proper functioning of the alarm sensors. Any visible lines must be inspected monthly and the inspection documented by the owner or user, except as noted above when IDS line security does not exist, for which inspections of visible lines are conducted weekly.

IDS should have a protected independent backup power source.

8.7 Physical security infrastructure for the perimeter

8.7.1 Perimeter security fencing

8.7.1.1 General

A fence or wall forms a useful barrier and also delineates the boundary of a protected or restricted area. The level of protection offered by a fence will depend on its height, construction, the material used to increase its performance or effectiveness such as topping, perimeter intrusion detection systems (PIDS), lighting or close-circuit television (CCTV).

The type of fence used should reflect the type of threat i.e. terrorist, criminal, vandals or armed attack. Fences are graded according to the level of protection they offer, Class 4 offering the highest security and Class 1 the lowest.

The effectiveness of any security barrier will depend to a large extent on the level of security at the points of entry. Gates shall be constructed to the same security standard as the fence and control of entry shall be maintained, otherwise the security of the fence will be negated. The perimeter fence shall have a minimum number of pedestrian and vehicular access gates, consistent with operational requirements.

Signs should be prominently displayed on all approaches to the perimeter to indicate to civilians that they are approaching a restricted area to which access is not permissible. If appropriate, such signs should also indicate the presence of armed guards and dogs.

8.7.1.2 Class 1 security fencing (LEVEL 1)

A fence designed with no particular security requirements and is at least 1.5m high. Such a fence is only intended to mark a boundary and to offer a minimum of deterrence or resistance to anyone other than a determined intruder. There will be occasions when the use of other perimeter security systems may be appropriate.

Picture 1: Class 1 fencing

Picture 1 shows a standard BS 1722 Part 10[13] chain link fence, approximately 2.9m high constructed with chain link fabric and a barbed wired topping. Supporting posts can be either reinforced concrete or tubular steel.

Chain link fences offer limited delay to attack and should be considered as a basic perimeter fence measure to delineate a boundary. Chain link does not host alarm systems well due to the nature of its construction.

[13] BS 1722-10:2006, *Fences. Specification for anti-intruder fences in chain link and welded mesh*. November 2006. www.bsi-global.com. This has been included as it is a good example of best practice in security fencing, and all fences are tested prior to classification within the standard.

8.7.1.3 Class 2 security fencing (LEVEL 1)

Picture 2: Class 2 security fencing

An anti-intruder fence that offers a degree of resistance to climbing and breaching by an opportunist intruder not having particular skills and only using material and breaching items that are readily to hand. A Class 2 fence should be supported by other perimeter security systems.

Picture 2 shows a standard BS 1722 Part 10 Anti-Intruder fence, 2.9m high constructed with welded mesh fabric and a barbed wire topping.

8.7.1.4 Class 3 security fencing (LEVEL 2)

Picture 3: Class 3 security fencing

An intermediate security barrier designed to deter and delay a resourceful attacker who has access to a limited range of hand tools. The design and construction will offer resistance to attempts at climbing and breaching. A Class 3 fence should normally be supported by other perimeter security systems.

Picture 3 shows an Intermediate Security Welded Mesh Fence. This fence complies with BS 1722 Part 14. The fence is 4m high, including barbed tape concertina topping. It is constructed using narrow aperture welded mesh to resist climbing and cutting.

An intermediate security fence offers a good balance of delay to attack versus cost.

8.7.1.5 Class 4 security fencing (LEVEL 3)

Picture 4: Class 4 security fencing

A high-security barrier designed to offer the maximum deterrence and delay to a skilled and determined intruder who is well equipped and resourced. It should be designed and constructed to offer a high degree of resistance to a climbing or breaching attack. A Class 4 fence shall be supported by other perimeter security systems.

Picture 4 shows a High Security Welded Mesh Fence. This fence is based on BS 1722 Part 14 but is 4.8m high including barbed taped concertina topping. It is constructed using narrow aperture welded mesh with an additional layer up to 3m.

High security fences provide the highest level of delay to attack; however, they are expensive to construct. Class 4 security fences should always be used in conjunction with CCTV and an intruder detection system.

8.7.1.6 Clear zones (LEVEL 2)

Zones clear of vegetation should be established and maintained for a minimum of 4m within a security fence and 10m outside the security fence (real estate permitting).

8.7.1.7 Drainage (LEVEL 1)

Drainage structures and water passages that penetrate the fence having a cross-sectional area of greater than $0.25m^2$ should not be permitted or shall have bars and grilles preventing access at each end. Access to any existing structures and passages should be prevented.

8.7.2 Perimeter illumination (LEVEL 2)

Exterior and internal perimeter illumination shall be of sufficient intensity to allow detection of unauthorised activity by the guard force. All access points to a storage area should have direct illumination above all entry points. Switches shall be installed in such a manner that they are only accessible to authorised personnel.

An automatic backup generator and power system is essential on high risk and high value sites.

All perimeter illumination systems of the facility should radiate slightly outwards in order to facilitate night vision of the guard force and restrict that of those looking into the inner perimeter. The perimeter lighting should be placed inside the compound where it will be difficult to sabotage or destroy.

8.7.3 Perimeter intrusion detection systems (PIDS) (LEVEL 3)

8.7.3.1 General

Perimeter Intrusion Detection Systems, (PIDS), is a generic term which covers a wide range of technologies designed to provide advance warning of an intruder gaining access to a secure area.

All detection systems demand a compromise between detection capability and unwanted or nuisance alarm[14] rates. By their nature PIDS are designed to operate in a less favourable environment than internal intruder detection systems.

Perimeter fences around structures and buildings used for the storage of conventional ammunition should be fitted with appropriate PIDS. All alarm signals from such systems should be received at a central control or monitoring system from which a response force can be dispatched. The response force should respond to an activated PIDS as soon as possible, but the response shall be no later than 15 minutes after receipt of the alarm signal.

The performance of any PIDS will depend not only on the intrinsic characteristics of the technology employed but also on the specific site conditions under which it is deployed. *For this reason, it is strongly recommended that specialist technical advice is sought before any system is procured.*

Installation of a PIDS shall not be taken in isolation. To be effective it should operate as part of an integrated security system. This may include physical measures such as fences and barriers, providing both detection and delay together with visual surveillance systems and perimeter illumination providing alarm verification. Not least will be the integration with site security procedures and the guard force.

The specific type of PIDS employed should depend upon the site conditions, operational requirement and other constraints that will be placed on its operation.

8.7.3.2 PIDS types

There are a range of PIDS types, which may be considered for deployment, including:

A) buried detection systems;

B) fence mounted systems;

C) electric fence systems;

D) field effect systems;

E) continuity monitoring systems;

[14] Caused, for examples, by animals or weather.

F) free standing systems;

G) taut wire systems; and

H) rapid deploy systems.

The range of systems and factors involved in deployment means that it is not realistic to provide a cost estimate until the system requirements have been refined further.

8.7.3.3 PIDS records and tests

A daily record should be maintained of all alarm signals received, which should be reviewed to identify and correct PIDS reliability problems. The log should reflect the following:

A) nature of the alarm, (nuisance, system failure or illegal entry);

B) date, time and location of alarm;

C) personnel involved; and

D) action taken in response to the alarm.

PIDS should be tested quarterly to ensure the proper functioning of the alarm sensors.

8.7.4 Visual surveillance systems (LEVEL 3)

Visual surveillance may be used to increase the effective range and area of ground covered by the individuals of the security staff, thereby minimising staff requirements. Technology is available that can provide day, low-light and night coverage, but such technology should not be used to replace an appropriate level of physical presence by security staff.

Visual surveillance systems, usually CCTV or motion-initiated systems, may be used to:

A) cover all gates, doors, perimeters and interiors of conventional ammunition storage facilities;

B) provide constant, real time monitoring; and

C) record activity for review in the event of loss or theft.

D) Available camera systems technology, which can be supported by a range of data transmission technologies, includes:

E) normal visible light range;

F) low light capable; and

G) infra-red.

The requirements of Clause 8.7.3.3 for records and tests should also apply to visual surveillance systems.

8.7.5 Patrols and dogs (LEVEL 1)

A guard and response force[15] should check the security integrity of ammunition storage areas during non-duty hours at both prescribed and random occasions. These checks should be recorded, with these records maintained for a minimum of 90 days.

[15] This may include military personnel, police or civilian security personnel.

Staff should be properly trained and equipped to perform their duties in accordance with the appropriate SOP. Trained working dogs may be used as a complementary measure to the guard and response force.

Irregular spot checks and unannounced test call outs of guard force and back up personnel by night and by day are essential to check and practice both individuals and procedures.

9 Aspects of diversion[16]

9.1 background to diversion

The product for the clandestine arms market is overwhelmingly small arms and light weapons (SALW), but, in order to be of any effect, weapons require ammunition. Significant quantities of ammunition may be necessary to ensure the sustainability of violence.

The aim of an effective security system should be to reduce the risks of diversion due to loss, theft, leakage or proliferation to an absolute minimum. There can be no such thing as 100% absolute security because of human factors, but security levels should be as close to 100% as possible.

[16] Information in this Clause is from *Guns, Planes and Ships: Identification and Disruption of Clandestine Arms Deliveries*. Griffiths H and Wilkinson A E A. (ISBN 978 66 7728 069 7). SEESAC. August 2007.

Annex A
(normative)
References

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

a) BS 1722-10:2006 *Fences. Specification for anti-intruder fences in chain link and welded mesh*. November 2006. (www.bsi-global.com);

b) EN 12320:2012 *Building hardware – Padlocks and padlock fittings – Requirements and test methods*;

c) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

d) IATG 03.10 *Inventory Management*. UNODA;

e) Loss Prevention Standard (LPS) 1175 *Specification for testing and classifying the burglary resistance of building components, strong-points and security enclosures.* Issue 6. Building Research Establishment (BRE) Global. 24 May 2007;

f) United Nations General Assembly Resolution A/RES/55/255. *Protocol against the illicit manufacturing of and trafficking in, their parts and components and ammunition supplementing the United Nations Convention against Transnational Organized Crime*. 08 June 2001. 'The Firearms Protocol'. (Entered into Force on 03 July 2005).

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[17] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[17] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

a) *Guns, Planes and Ships: Identification and Disruption of Clandestine Arms Deliveries*. Griffiths H and Wilkinson A E A. (ISBN 978 66 7728 069 7). SEESAC. August 2007;

b) *Handbook of Best Practices on Conventional Ammunition*, Chapter 3. Decision 6/08. OSCE. 2008. www.osce.org/fsc/33371;

c) DoD 5100.76-M *Physical Security of Sensitive Conventional Arms, Ammunition and Explosives (AAE)*. US Department of Defense. 12 April 2012. http://dtic.mil/whs/directives/corres/pdf/510076m.pdf; and

d) UFC 04-020-01 *Security Engineering Facilities Planning Manual*. US Department of Defense. 11 September 2008. http://wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-4-020-01

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[18] used in this guideline and can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[18] Where copyright permits.

Annex C
(informative)
Model for a security plan[19] (LEVEL 1)

C.1 Name, location and telephone number of the establishment security officer.

C.2 Scope of the plan.

C.3 Content and value of the stocks.

C.4 The generic security threats.

C.5 Detailed geographic map of the site location and its surroundings.

C.6 Detailed diagrams of the layout of the site, including all its buildings, entry and exit points, and of the location of all features such as electricity generators/substations; water and gas main points; road and rail tracks; wooded areas; hard and soft-standing areas etc.

C.7 Outline of physical security measures for the site, including but not limited to details of:

A) fences, doors and windows;
B) lighting;
C) Intruder Detection System (IDS);
D) Perimeter Intrusion Detection System (PIDS);
E) automated access control systems;
F) guards;
G) guard dogs;
H) locks and containers;
I) control of entry and exit of persons;
J) control of entry and exit of goods and material;
K) secure rooms;
L) hardened buildings; and
M) CCTV.

C.8 Security responsibilities (including but not limited to the following personnel, as applicable):

A) security officer;
B) safety officer;
C) armament officer;
D) production manager;
E) transport officer;
F) heads of department;
G) stores/supply officers;

[19] Quoted from Best Practice Guide on National Procedures for Stockpile Management and Security. FSC.GAL/14/03 Rev 2. OSCE. 19 September 2003.

H) foreman in charge of operations/accounting/movement;

I) workers; and

J) all personnel authorised to have access to the site.

C.9 Security procedures to be followed in production/process areas; storage areas; servicing; processing; trials; quality assurance; climatic and other tests as well as further activities in respect of weapon stockpile management.

C.10 Control of access to storage and processing rooms, buildings, structures and areas.

C.11 Procedures for handling and transport of conventional ammunition.

C.12 Control of security keys – those in use and their duplicates.

C.13 Accounting – audits and stock checks.

C.14 Security education and briefing of staff.

C.15 Action on discovery of loss/surplus.

C.16 Details of response force arrangements (e.g. size, response time, orders, activation and deployment).

C.17 Action to be taken in response to activation of alarms.

C.18 Action to be taken in response to emergency situations (e.g. fire, flood, raid etc).

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 10.10

Third edition
March 2021

Demilitarization, destruction and logistic disposal of conventional ammunition

UN SaferGuard
Securing ammunition, protecting lives

IATG 10.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

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United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

There are a limited number of international treaties,[3] agreements or instruments[4,5] that refer to or require the mandatory destruction of ammunition and explosives. However, the principles of sound stockpile management and the inherent risks and hazards present during the storage of stockpiled ammunition mean that demilitarization or destruction should be a key component of conventional ammunition stockpile management programmes.

A recent report from the Group of Government Experts (GGE) established pursuant to UN General Assembly resolution 61/72[6] identified that '*poorly managed ammunition stockpiles pose an excessive risk because they can become unstable and threaten public safety with explosions or contamination. Moreover, unsecured and poorly managed stockpiles of ammunition may be easily diverted to illicit use, which can increase fatalities arising from various forms of armed violence*'. The GGE recommended that a '*whole life management*' approach be adopted towards the stockpile management of conventional ammunition; such an approach includes the demilitarization or destruction of ammunition at the appropriate stage of its life cycle.

Demilitarization is an increasingly important aspect of munitions management. With a drive for higher performance and greater safety, new munitions and fillings render old munitions obsolete and munitions stockpiles cost money both to establish and maintain, so surplus munitions are an unwelcome expense and potentially a risk. The process of disposal is being shaped by a number of factors. Foremost is increasingly stringent environmental regulation restricting and modifying the methods. But other factors are also significant such as transhipment regulation, restrictions on proliferation of conventional weapons, and resource recovery, either through financial pressure or policy.

All munitions have a finite service life and will at some stage need to be either expended or disposed of. Disposal can involve dumping, resale and demilitarization. Dumping is banned at sea as a result of the London Convention and related agreements. Dumping on land is severely restricted if not banned in most jurisdictions. Resale is an attractive option in terms of recovering value from munitions, however, munitions must be serviceable to resell, and this option is restricted by issues of proliferation and security. This leaves demilitarization as the primary method of disposal. Demilitarization means removing or otherwise neutralising the military potential of an item, in this case a munition. This may or may not involve the destruction of the munition, but it does require that the energetic material is destroyed or converted[7].

Techniques available for demilitarization range from the relatively simple open burning (OB) and open detonation (OD) destruction techniques to highly sophisticated industrial (demilitarization) processes. Security concerns and practical considerations, including safety and economies of scale, indicate that the most effective option is often the demilitarization of surplus or obsolete ammunition. This should preferably be achieved using an environmentally sound demilitarization process, whereby ammunition is stripped down to its component parts and compounds that are then recycled.

Surplus destruction or demilitarization removes many of the safety and security risks associated with surpluses, including problematic transfers and re-transfers, accumulations of unstable ammunition,

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[3] Currently Article 4 of the *Anti-Personnel Mine Ban Treaty (Ottawa Convention), 1997* and Article 3 (2) of the *Convention on Cluster Munitions (CCM)*, 2008 require the destruction of these ammunition types for those States that have ratified the treaties.

IMAS 11.20 (Second Edition incorporating Amendments 1 through 5) *Principles and procedures for open burning and open detonation operations*. 1 January 2003. IMAS[5] NATO STANAG 4518 (Edition 2) and AOP 4518 (Edition A Version 1) *Safe Disposal of Munitions, Design Principles and Requirements, and Safety Assessments*. NATO Standardization Organization (NSO). 2017

[5] NATO STANAG 4518 (Edition 2) and AOP 4518 (Edition A Version 1) *Safe Disposal of Munitions, Design Principles and Requirements, and Safety Assessments*. NATO Standardization Organization (NSO). 2017

[6] UNGA A/63/182 *Report of the Group of Government Experts established pursuant to General Assembly resolution 61/72 to consider further steps to enhance cooperation with regard to the issue of conventional ammunition stockpiles in surplus*. UN. 28 July 2008.

[7] Previous 2 paragraphs from MSAIC2005.

and stockpiles that are at risk of theft or sabotage. The logistics of destruction or industrial demilitarization of conventional ammunition can, however, be very challenging because of the inherent risks and hazards during processing operations and the large tonnages and quantities of individual items involved. Decisions to demilitarize or destroy need to recognize a number of factors that can affect the efficiency and cost of the process, including the types and volumes of ammunition earmarked for demilitarization/destruction, the physical condition of the ammunition, the methods or technologies currently available and factors relating to domestic capacity. The most influential factor is likely to be economies of scale in that the more ammunition that requires demilitarization/destruction, the larger the economies of scale and therefore the wider range of available technology. Consequently, national authorities may wish to consider ammunition demilitarization/destruction on a co-operative basis in order to achieve larger economies of scale and hence more cost-effective demilitarization/destruction.[8]

Stockpile demilitarization/destruction can be carried out by different types of organisations, such as commercial companies, international organisations or military units. Despite differences in approach, common core activities exist which carry common responsibilities. This IATG module provides guidance and requirements for ammunition stockpile demilitarization and destruction. There are so many inter-relational factors involved in ammunition stockpile demilitarization and destruction that it would not be appropriate to provide a ‘template solution’ as part of this guide.

It is, of course, possible to reduce the amount of ammunition that needs to be disposed of at the end of its service life. Effective through life management, where ammunition is rotated throughout its life and expended before shelf life expiry date, is a tried and trusted method of reducing waste. This must be coupled with accurate accounting and stock control and the use of good storage facilities to minimise the deterioration of ammunition due to environmental influence.

[8] For example, the NATO Support and Procurement Agency (NSPA) (on request) manages ammunition demilitarization and destruction on behalf of member States. This means that ammunition from a number of States can be dealt with under a single, larger, contract leading to cost savings for individual States.

Demilitarization, destruction and logistic disposal of conventional ammunition

1 Scope

This IATG module establishes the guiding principles and introduces technical methodology for the safe planning and execution of ammunition demilitarization and destruction activities in support of a conventional ammunition stockpile management programme. It includes Logistic Disposal of surplus ammunition stockpiles. Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

2 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply:

The term 'demilitarization' refers to *the complete range of processes that render weapons, ammunition and explosives unfit for their originally intended purpose*.[9]

The term 'destruction' refers to *the process of final conversion of weapons, ammunition and explosives into an inert state so that it can no longer function as designed*.

The term 'disposal' refers to *the removal of ammunition and explosives from a stockpile by the utilisation of a variety of methods, (that may not necessarily involve destruction*').

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

[9] Demilitarization not only involves the final destruction process but also includes all of the other transport, storage, accounting and pre-processing operations that are equally as critical to achieving the final result.

3 Disposal options

Definitions are an important area for stakeholders in the area of ammunition disposal. For example, the term disposal does not necessarily mean that ammunition has been destroyed or demilitarized. Ammunition could have been disposed of by sale, which is very different to the demilitarization or destruction of ammunition. There are six traditional methods for disposing of surplus ammunition:

Method	Explanation	Advantages	Disadvantages
Sale Gift	Ammunition is either sold or gifted to another country. As a precondition for sale, ammunition should be in a serviceable condition.	▪ Inexpensive for the donor country.	▪ Old ammunition is unattractive to reputable end users. ▪ Possibility of accidents causing casualties and damaging weapon systems and infrastructure. ▪ Ammunition may not be legal to move in accordance with international instruments. ▪ Transfers the eventual destruction problem to another location. ▪ Can be politically sensitive, not recommended by international agencies.
Increased use at training	Live firing is significantly increased during training of security forces.	▪ Makes cost effective use of the ammunition. ▪ Improved training standards in security forces.	▪ Additional wear takes place on gun barrels, which will not last long enough to destroy significant stockpiles. Hence additional costs in barrel replacements. ▪ Could negate confidence and security measures between neighbouring States. ▪ Only limited stocks could realistically be destroyed this way. ▪ Larger calibre ammunition will require large training areas, which are often unavailable. ▪ Disposal of fuzed ammunition may lead to a higher incidence of “blinds”, resulting in an increase in the need for Explosive Ordnance Disposal (EOD) action on ranges. ▪ Older ammunition may cause accidents, with casualties and damage to equipment.
Deep Sea Dumping This is now banned by international treaty.	The dumping of ammunition in deep water at sea in coastal or international waters.	▪	▪ Banned by international treaty for some States. (See Clause 5.4). ▪ Long-term environmental impact of decaying ammunition on seabed is unknown. ▪ Previous shallow water dumping has led to pollution and dangerous munitions being washed ashore or being caught in fisherman’s nets. ▪ Will not be supported by UN programmes.

Method	Explanation	Advantages	Disadvantages
Disposal by Landfill. This is now banned by international treaty.	The shallow or deep burial of ammunition and explosives.	▪	▪ Long-term environmental impact of decaying ammunition on the ground and water table is unknown. ▪ There may be long term risks of spontaneous explosion due to degradation of safety mechanisms and chemical deterioration of the propellant and explosive content. ▪ Restricts future use of land for development. ▪ Will not be supported by UN programmes. ▪ Possibility of ammunition being recovered by criminals.
Destruction / Demilitarization	The physical destruction of ammunition, or the use of industrial processes to demilitarize ammunition and recover raw materials for reuse and recycling.	▪ Proven technologies exist. ▪ Guarantees destruction or demilitarization. ▪ Can be environmentally benign. ▪ Can make effective use of recovery, reuse and recycling of components and materials. ▪ Several organisations are fairly advanced in developing mobile demilitarization facilities.	▪ Can be expensive, however, with rental options available, this technology should become more acceptable to donors due to environmentally benign filtering and purification techniques. ▪ The idea that these programs can be self-financing is unproven because, despite much effort, there will be some cost. ▪ OBOD can pose environmental risks (however, may be the only feasible option for disposal of unsafe ammunition).

Table 1: Traditional methods of ammunition disposal

The technology for mobile industrialised demilitarization techniques has reached a more advanced, more easily affordable stage. Therefore, this option should be considered before embarking on an OBOD reliant disposal programme.

4 International legislation, instruments and agreements

5.1 Anti-Personnel Landmine Ban Convention[10]

Article 4 of this convention, which entered into force on 01 March 1999, requires that, *except as provided for in Article 3, each State Party undertakes to destroy or ensure the destruction of all stockpiled anti-personnel mines it owns or possesses, or that are under its jurisdiction or control, as soon as possible but not later than four years after the entry into force of this Convention for that State Party.*

5.2 Convention on Cluster Munitions[11] [12]

Article 3(2) of this convention, which entered into force on 01 August 2010, requires that State Parties shall *destroy or ensure the destruction of all cluster munitions referred to in paragraph 1 of this Article as soon as possible but not later than eight years after the entry into force of this Convention for that State Party. Each State Party undertakes to ensure that destruction methods comply with applicable international standards for protecting public health and the environment.*

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[10] *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction*. Ottawa. 18 September 1997. (Entered into Force on 01 March 1999)

[11] *Convention on Cluster Munitions*. Dublin. 30 May 2008. (Entered into Force on 01 August 2010).

[12] As at 31 May 2017, a total of 100 were States Parties', and a further 19 States are signatories to the convention.

5.3 UN Firearms Protocol

Article 6 of the UN Firearms Protocol[13] requires that States that have ratified the treaty *shall adopt, within their domestic legal systems, such measures as may be necessary to prevent illicitly manufactured and trafficked firearms, parts and components and ammunition from falling into the hands of unauthorized persons by seizing and destroying such firearms, their parts and components and ammunition unless other disposal has been officially authorized, provided that the firearms have been marked and the methods of disposal of those firearms and ammunition have been recorded.* These requirements, already agreed by many states, are a core component of this IATG for illicitly manufactured and trafficked ammunition that may be seized.

5.4 International instruments (environmental)

Ammunition and explosives are considered to be hazardous or industrial waste and as such fall under the remit of international treaties that have been signed and ratified:

A) *the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, 29 December 1972;

B) *the 1996 Protocol to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (Amended 2006)*; and

C) *the Convention for the Protection of the Marine Environment of the North-East Atlantic*, 1998.[14] [15]

Ammunition and explosives shall therefore not be dumped at sea by States that have ratified and signed the above treaties and should not be dumped at sea by non-participant States.

The United Nations shall not support any ammunition disposal activities that utilise deep sea dumping.

5.5 Supra-national legislation (environmental)

Supra-national legislation that covers emissions into the atmosphere from the incineration of hazardous waste is the European Union Council Directive 2000/76/EC *The incineration of waste,* 04 December 2000, amended by Regulation (EC) No 1137/2008 of 11 December 2008.

European Union Council Directive 2008/98/EC *Waste*, 19 November 2008, contains provisions on the management of waste. These should be applied to industrial ammunition demilitarization processes.[16]

The directives provide a comprehensive standard and are in use by all European Union countries and those countries with associate status. States should reflect the requirements of these directives in their own national environmental legislation where it relates to the destruction of ammunition.

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[13] United Nations General Assembly Resolution A/RES/55/255. *Protocol against the illicit manufacturing of and trafficking in firearms, their parts and components and ammunition supplementing the United Nations Convention against Transnational Organized Crime*. 08 June 2001. 'The Firearms Protocol'. (Entered into Force on 03 July 2005).

[14] Also known as the *OSPAR Convention*.

[15] Entered into force on 25 March 1998 and replaced the 1972 *Oslo Convention*.

[16] Article 2, Paragraph 1(e) of the subsequent European Union Council Directive 2008/98/EC *Waste and repealing certain Directives*, 19 November 2006 excluded explosive waste from the provisions of Directive 2008/98. However, non-explosive hazardous waste products from the processing of explosives during demilitarization operations would be covered by this directive.

5.6 International standards (environmental)

5.6.1 ISO 4220:1993 Measurement of air pollution

ISO 4220:1983 *Ambient air - Determination of a gaseous acid air pollution index - Titrimetric method with indicator or potentiometric end-point detection*, whilst not specifically legislation, lays down internationally accepted standards for the determination and measurement of air pollution from industrial processes. These standards should apply to any pollution control systems used during industrial demilitarization operations, but only in terms of the measurement of emissions. The standard does not provide any guidance on what the overall emission limits should be; this remains the responsibility of the national authority.

5.6.2 ISO 9612:2009 Acoustics

ISO 9612:2009 *Acoustics - Determination of occupational noise exposure – Engineering method* may be applied to open detonation destruction operations.

5 Demilitarization cycle

The physical demilitarization or destruction process of conventional ammunition is only one process of the complete demilitarization or destruction cycle. The processes in this cycle should be considered in parallel with the technical factors, (see Clause 7), before a final disposal solution is produced. The cycle is complex, comprehensive and wide-ranging and includes activities such as transportation and storage, processing operations, equipment maintenance, staff training and accounting. Safety, security and environmental risks have to be balanced into a comprehensive solution for each task, taking all international and local factors into account. The full cycle is shown schematically at Annex C.

6 Technical factors

7.1 General

There are a wide range of technical factors that will determine the overall ammunition demilitarization or destruction plan, not least that of experienced and qualified personnel for demilitarization[17] and potentially high funding requirements. There is a global shortage of qualified personnel experienced in developing ammunition demilitarization facilities and programmes.

In order that the demilitarization programme is developed efficiently and safely, national authorities may wish to consult with appropriate regional and international organisations that are experienced in the development of demilitarization programmes, as well as the commercial companies and NGOs with the practical experience of operational demilitarization.[18]

[17] There is wider experience available for the destruction of conventional ammunition by open burning and open detonation.

[18] The EU Explosives Certification (EU-ExCert) scheme (www.euexcert.org) has recently been developed to establish a stable framework for the vocational education of people in the European explosives sector. Training and education institutions as well as social partners will have a tool for competency development and assessment. New training methods will also be developed in order to ensure that the explosives sector has access to enough trained and experience staff and that the current shortfall in qualified and experienced staff is overcome. Other regions should consider the development of a similar type of system.

7.2 National legislation

Details of applicable international legislation, instruments and agreements can be found in Clause 5. National environmental legislation shall dictate the emission levels to be met[19] which will in turn dictate the type of technology required to meet these emission levels, (also see Clauses 5.4, 5.5, and 5.6). Should this technology be too expensive, or not available, then agreement needs to be reached with the environmental authorities for an exemption. National environmental legislation should be based on the appropriate normative references at Annex A (from Clauses 5.3 and 5.4).

7.3 Chemistry of explosives

The stability in storage and degradation or deterioration rates of the explosive content should influence the degree of urgency for disposal, type of transport that can safely be used and destruction/demilitarization methodology.

7.4 Knowledge of ammunition design

A detailed knowledge of the ammunition design is essential to the formulation of a safe demilitarization/destruction plan. This knowledge should also include the type and rate of evolution of gases should a thermal destruction technique be under consideration as this will be a requirement for the design of a pollution control system that can meet the air emission levels laid down by national legislation.

7.5 Quantity for disposal

The most influential factor is likely to be economies of scale, in that the more ammunition that is requiring demilitarization or destruction, the larger the economies of scale and, therefore, the wider range of available technology at an affordable price. Consequently, national authorities may wish to examine the problem of ammunition demilitarization and destruction on a cooperative or regional basis in order to achieve larger, and hence more cost effective, economies of scale. With the advent of new, mobile facilities a collaboration between several states in a region becomes more practical and, with rental available, more cost effective.

7.6 Available technology

See Clause 9.

7.7. Safe systems of work

Safe systems of work are a pre-requisite when handling and processing any types of ammunition and explosives. Formal risk management processes shall be developed to support ammunition demilitarization or destruction in accordance with the requirements of ISO Guide 51 and IATG 02.10 *Introduction to risk management principles and processes*.

7.8 Security

Stockpile security is obviously an important issue. Every effort should be taken to ensure the physical security of ammunition during storage, transportation and processing in accordance with the requirements of IATG 08.10 *Transport of ammunition* and IATG 09.10 *Security principles and systems.*

7.9 Logistics

[19] Although donors may insist on higher standards if national legislation is less than the international norms at Clause 5.4.

7.9.1 Logistic factors

The demilitarization or destruction of ammunition stockpiles is primarily a logistics problem. The technology exists to destroy most ammunition types, yet the major phases of the demilitarization/destruction cycle involve logistics. The demilitarization or destruction methodology should be dependent on logistic factors such as: 1) the availability of suitably qualified and trained manpower; 2) location and type of ranges and demolition grounds; 3) distance from storage to demilitarization facilities; 4) the availability of transport; and 5) the availability of water supply, power etc. States must ensure all these factors are included when considering different demilitarization options.

7.9.2 Transport of ammunition

Ammunition should be transported in accordance with the requirements of IATG 08.10 *Transport of ammunition.*

7.10 Transparency and accounting

The transparency of the demilitarization or destruction programme is an important security and confidence building measure. International organisations, national ambassadors, media and non-governmental organisations (NGO) should be invited to witness the destruction process. They may also be given access to the surplus or unserviceable ammunition account in order that they can verify the ammunition demilitarized or destroyed against the declared surplus stockpile levels.

Ammunition should be accounted for in accordance with the requirements of IATG 03.10 *Inventory management*.

7.11 Staff competencies

The logistic disposal of ammunition and explosives is based on the first principles taught to every ammunition technician or ammunition technical officer and their national equivalents. Staff planning demilitarization and destruction, or engaged as the OIC Disposals for destruction by open burning or open detonation, should either be trained ammunition technical personnel or fully compliant with the related, detailed criteria in the following competency standard:

Test and Evaluation Protocol 09.30/01/2014 Version 1.0 30 October 2014 Explosive Ordnance Disposal (EOD) Competency Standards

7 Priority for demilitarization or destruction

The demilitarization and destruction of surplus ammunition stockpiles in countries that do not currently adopt a ‘through life management’ approach to stockpile management does not often follow logical destruction priorities. Small arms ammunition often has priority as donors have budgets to support the demilitarization or destruction of these natures. Yet the destruction of the large stockpiles of other generic ammunition natures has been identified as a humanitarian and security priority. The hazards that certain ammunition natures present to local communities and the associated large costs of destruction mean that States shall determine demilitarization or destruction priorities.

Conventional ammunition should be destroyed in the priority order shown in Table 2:

Priority	Ammunition	Remarks
1	Ammunition that poses the greatest risks to the civilian community in terms of explosive safety.	▪ This will usually be specific types of ammunition stored in a stockpile very close to the civilian community. Not all the ammunition in the Explosive Storage Area will require destruction. ▪ This ammunition can be identified by surveillance (chemical analysis and visual inspection) and proof (performance) as part of ongoing stockpile management processes.
1	Ammunition that is a security concern, e.g. Attractive to Criminal and Terrorist Organisations (ACTO).	▪ Detonators, Shoulder Launched Anti-Tank Rockets, Man Portable Air Defence Systems (MANPADS), Bulk Explosives etc. ▪ Or enhance security measures at current storage locations to reduce risk of proliferation.
2	Ammunition that must be destroyed in order to meet treaty obligations.	▪ Anti-Personnel Mines and Cluster Munitions for those States that have ratified the relevant treaty.
2	Small arms ammunition.	▪ <20mm calibre. ▪ Classed as Priority 2 as an Armed Violence Prevention (AVP) matter. The proliferation of this ammunition is particularly undesirable.
3	Ammunition that needs to be destroyed to release storage space.	▪ Usually as part of security sector reform and downsizing of armed forces.
3	Remaining ammunition types.	▪ May be done in order of ease of destruction.

Table 2: Demilitarization or destruction priorities

In order to determine demilitarization or destruction priorities it may be necessary to conduct an Ammunition Technical Assessment of the complete stockpile in order to determine 'at risk' ammunition.[20]

Donors should ensure that one of their major priorities is capacity building of national institutions to develop and guarantee continuance of a longer-term nationally financed, safe, efficient and effective destruction of ammunition to appropriate technical standards.

8 Demilitarization and destruction technology and techniques

9.1 Open burning (OB) and open detonation (OD) (LEVEL 1)

Open burning (OB) and open detonation (OD) are usually regarded as the easiest way of stockpile destruction and are often the only cost-effective option for States that have small quantities of ammunition for destruction (<1,000 tonnes), or do not have access to, or the resources to develop, more sophisticated ammunition demilitarization technology. OB or OD are sometimes the safest methods for disposal of unsafe ammunition.

There is obvious potential for environmental pollution and States should complete a formal environmental impact assessment before they select either of those options.[21]

[20] Examples available from UNDP for Croatia and Montenegro.

[21] *SALW ammunition destruction – environmental releases from open burning (OB) and open detonation (OD) events*. SEESAC, 30 May 2004, provides useful data on the emissions to air to be expected from OBOD processes.

Open burning (OB) is usually used for the destruction of propellants and pyrotechnic compositions and has potential for significant environmental impact, producing harmful chemicals. Unconfined high explosives may also be destroyed by burning but only in small quantities to reduce the risk of burning to detonation. When using OB techniques on high explosives, the danger area has to be calculated the same as for the explosives being destroyed by detonation – high explosives do not always react as expected. OB is generally done on concrete pads or specially designed burning trays (metal pans) to improve operational efficiency.

Open detonation (OD) uses serviceable explosive as donor charges to destroy surplus or unserviceable ammunition by sympathetic detonation.[22] It allows for the destruction of ammunition without the need for special equipment, but it does have disadvantages:

A) large 'danger areas' are required to ensure safety from blast and fragmentation. Significantly greater safety distances are required for protection from OBOD operations than those required for ammunition storage, for which quantity-distances (QD) are detailed in IATG 02.20;

B) production is weather and time dependent (normally restricted to daylight hours);

C) it is labour intensive;

D) there is a possibility of ammunition being thrown out of a poorly planned/laid demolition pit, resulting in it not being destroyed, hence requiring further Explosive Ordnance Disposal (EOD) clearance;

E) environmental impact through noise, air and ground pollution (harmful chemicals produced), geology (water table and ground-shock); and

F) requires trained personnel to carry out the task (the level of training they require should not be under-estimated).

OBOD operations should be planned and conducted in accordance with Annex D.[23] Appropriate safety distances that take into account increased hazards from blast and fragments shall be applied. Additional consideration should also be given to the risk differences of OBOD of commercial explosives as compared to military ammunition, which may present greater blast and fragment threats. Explosive Ordnance Disposal (EOD) or other internationally accepted safety distances[24] and requirements shall be used for the protection of the public and other exposed sites (ES) from OBOD operations.

For larger stockpiles the sheer amount of ammunition requiring destruction, with the resultant logistic challenges on a demolition area, will mean that industrial demilitarization may be a more efficient and cost-effective approach.

9.2 Industrial demilitarization (LEVELS 2 and 3)

9.2.1 General

Industrial demilitarization of ammunition combines the skills of mechanical, production, chemical and explosives engineering and is a highly specialist operation to plan. Appropriate technical advice should be taken and internationally accepted documents reviewed before planning and developing such an activity. Other possible demilitarization options are detailed in NATO AOP 4518 (Edition A Version 1).

[22] The process of sympathetic detonation is the 'induced detonation of an explosive or ammunition item containing high explosive by exploding another high explosive charge adjacent to it'.

[23] Developed from IMAS 11.20 *Principles and procedures for open burning and open detonation operations*.

[24] AASTP-1 Edition B Version 1, Part IV, Chapter 7 *Destruction of ammunition and explosives*. NATO Standardization Organization (NSO). December 2015.

9.2.2 Advantages and disadvantages of industrial demilitarization

Industrial scale demilitarization has significant advantages:

A) mechanical disassembly using machines, thereby increasing operational efficiency and reducing risk to personnel;

B) destruction (usually incineration) in environmentally controlled systems; and

C) the ability to operate 24 hours a day, up to 365 days a year.

Major disadvantages of industrial demilitarization are the high costs of design, project management, construction and commissioning, although their operating costs are generally lower than OBOD (when amortisation of the development capital is discounted).[25]

In many cases the development of such purpose-built demilitarization facilities to enable States to destroy their ammunition stockpiles will be well beyond available resources and therefore may not be a practical option. Factors such as low ammunition stockpile levels, cost, location and safety may mean that OBOD is the only pragmatic and feasible option.

9.2.3 Pre-processing

In many cases it may be necessary to disassemble or breakdown ammunition prior to the destruction process. Consequently, ammunition will be destroyed at the component level rather than the complete round. This could be necessary because of limitations on the amount of contained explosive that can be incinerated, the ammunition design or the requirement for different components to have separate destruction methods. This could require the movement of exposed bare explosive to the final destruction facility.

Table 4 summarises the technology options, which may be used singly or in combination:

Technology	Remarks
Manual disassembly **(LEVEL 2)**	▪ Uses human resources, usually on a process line, to physically remove components and breakdown ammunition using simple hand tools. ▪ Labour intensive and there is an obvious degree of risk.
Mechanical breakdown **(LEVEL 2)**	▪ Technology includes: 1) band saw; 2) guillotine; 3) cracker mill; 4) rock crusher; 5) punch; 6) hydraulic press; and 7) lathe.
Mechanical disassembly **(LEVEL 2)**	▪ Technology includes: 1) pull apart; 2) de-fuzing; and 3) de-priming.
Mechanical removal **(LEVEL 3)**	▪ Uses hydraulic press, water-cooled mechanical cutting or similar technique to remove cast explosive such as RDX, HMX. ▪ Only suitable for 'straight walled' ammunition. ▪ Requires removal of ogive and base/boat-tail by cutting
Robotic disassembly **(LEVEL 3)**	▪ Expensive technology that requires very large quantities and economies of scale to be cost effective. Usually used for the conversion of small arms ammunition from military to civilian use. Also often used for guided missiles containing cluster munitions.
Cryo-fracture **(LEVEL 3)**	▪ Developed originally for the demilitarization of chemical munitions. ▪ This involves freezing the ammunition body in liquid nitrogen to make it more brittle and hence easier to crack open by mechanical breakdown.
Hydro-abrasive cutting **(LEVEL 3)**	▪ The use of abrasive entrained in, or directly injected into, high pressure water jets to cut open ammunition. Only suitable for large economies of scale. Requires a waste water collection and treatment facility to prevent ground water pollution.

Table 3: Demilitarization pre-processing technology

[25] Labour costs account for a large percentage of the OBOD costs but these are much lower in lesser-developed countries. OBOD can be a cheaper option dependent on the economy of scale.

9.2.4 Explosives removal

Technology is often required to remove the explosive filling from the metal body of the ammunition after initial pre-processing (although explosives removal can be considered as a pre-processing operation it is also a major industrial process in terms of improving the recycling and re-use of military explosives for commercial use, hence a separate clause in this IATG).

Table 4 summarises the technology options.

Technology	Remarks
Hot steam/water melt out[26] **(LEVEL 2)**	▪ Hot water or steam is used to melt out TNT and TNT derivative (TNT/RDX) fillings, which melt at approximately 80^{0}C. [27] ▪ Conversely RDX melts at 206^{0}C and therefore RDX filled munitions are not suitable for this technique. ▪ The waste explosive is then often reprocessed and used in commercial blasting explosives. ▪ Can also be used for white phosphorus ammunition if the process is all done under water. ▪ The ammunition body will require further processing as a thin residue of explosive will remain. (See car bottom furnace below).
Water jet washout **(LEVEL 3)**	▪ High pressure water is focused on the explosive, which is then washed out of the ammunition body using a rotating nozzle. ▪ Suitable for RDX and PBX[28] ammunition. ▪ Requires a waste water treatment facility to prevent ground water pollution.
Solvent washout **(LEVEL 3)**	▪ Uses a solvent that will easily dissolve the explosive, which is then extracted and reprocessed. (Methyl alcohol, methylene chloride, acetone or toluene are options). ▪ Large quantities of solvent are required. ▪ It is not a cheap process. ▪ It is best considered when high value explosive such as HMX needs recovering for re-use.

Table 4: Demilitarization explosives removal technology

9.2.5 Physical destruction during demilitarization

The smaller ammunition calibres (<20mm) may be destroyed by incineration with no pre-processing necessary in a demilitarization programme. Large calibre ammunition may require pre-processing unless it is to be destroyed in a contained detonation chamber.

Table 5 summarises the technology options:[29]

[26] Microwave melt out is a new technology under development that has future potential to replace this system.

[27] WARNING. Do NOT attempt to steam out explosive compositions of TNT and Aluminium or Aluminium Powder as they will detonate.

[28] Plastic or Polymer Bonded explosives.

[29] There are also experimental techniques including: 1) super critical water oxidation; 2) plasma arc pyrolysis; 3) electro-chemical oxidation; and 4) biodegradation. All these techniques are designed for the conversion of specific types of explosive waste. Their limitations and lack of general production experience means that they are unlikely to be suitable for the majority of States and are therefore not yet considered further in this IATG. As each technology develops they will be included in future editions of this IATG.

Technology	Remarks
Rotary kiln incineration[30] **(LEVEL 3)**	▪ This is the controlled thermal destruction of ammunition within a high temperature (>500^{0}C) oven that rotates. ▪ It is proven technology from the 1950s and is still among the most efficient destruction systems available today. ▪ It must be operated in parallel with a pollution control system to treat the exhaust gases. ▪ Dependent on design it can destroy ammunition of <20m calibre or an explosive filling of less than 1kg with no pre-processing required. ▪ Transportable versions are approximately 33% of the cost of static systems yet have up to 70% of the capability albeit with lower explosive limits which restricts them to small arms ammunition, detonators, primers, fuzes, propellant and pyrotechnics.
Fluidised bed incineration **(LEVEL 3)**	▪ Only suitable for the incineration of explosive waste and not complete munitions. ▪ The waste is pumped as a slurry onto hot silicon oxide (sand) particles, which act as a liquid because of the high temperature. ▪ It is a specialised system that is only really suitable for those States with excessively large stockpiles. (>100,000 tonnes). ▪ Can cause problems if trying to dispose of pyrotechnics. This method is NOT suitable for the disposal of pyrotechnics as the metal contents will form eutectic salts and these will reduce "fluidity".
Car bottom furnace **(LEVEL 3)**	▪ Usually used in combination with a rotary kiln furnace and heated through a heat exchanger. ▪ Used to remove trace explosive contamination from munition parts after explosive removal, although it can deal with small calibres in limited quantities. ▪ A larger version is sometimes referred to as a Hot Gas Decontamination Facility. ▪ Supports demilitarization rather than being a system in its own right.
Contained detonation chamber (CDC) **(LEVEL 3)**	▪ Effectively uses open detonation techniques within a protected structure, which has an integral pollution control system. ▪ Production rates are limited but is a useful system for States with smaller stockpiles of ammunition that do not justify capital investment in explosive removal technology. ▪ Ammunition of up to, and including 155mm calibre, can be destroyed in the appropriate chamber.
Hot detonation chamber (HDC) **(LEVEL 3)**	▪ Destruction of explosives, propellants and munitions by 'cook-off' in a heated detonation chamber. The explosive material is destroyed through either burning, deflagration or detonation (dependent on the type of ammunition). ▪ Operation temperature is around 500^{0}C. ▪ No additional donor charges are necessary. ▪ High capacity, automatic process from loading to emptying with low energy consumption.
Moving bed reactor (MBR) **(LEVEL 3)**	▪ Developed for smaller calibre ammunition (105mm) (2002). Technology concept proven. ▪ New technology for large calibre ammunition (155mm) (2010). ▪ HE munitions are heated in a vertical chamber containing over 50 tonnes of constantly moving and re-circulating 25cm diameter steel balls. ▪ The steel balls present a mass to the blast wave, the kinetic energy of which is then absorbed because of the mass and dissipated because of all the interstitial boundaries. ▪ The steel balls also trap the fragmentation.

Table 5: Demilitarization destruction technology

[30] Also often generically referred to as Explosive Waste Incinerators (EWI).

9.2.6 Pollution control systems (LEVEL 3)

Pollution control systems (PCS) for ammunition demilitarization destruction technology shall:

A) destroy volatile organic compounds (VOC);

B) neutralise acid gases; and

C) filter out particulate and solid matter.

The final emissions to air, solid waste and liquid waste shall fall within the emission and waste toxicity levels contained within the appropriate national environmental legislation.

Table 6 summarises the technology options.

Technology	Remarks
Afterburner	▪ Required in all PCS to destroy the VOC. ▪ Minimum requirements are 850^{0}C for >2sec. ▪ The VOCs then burn to carbon dioxide, water and acid gases, which are treated further downstream in the PCS. ▪ Can be ammonia injected to reduce nitrogen oxides.
Acid gas neutralisation	▪ Sorbents, usually sodium bicarbonate and charcoal, are added to neutralise acidic gases and reduce dioxin formation. ▪ Safe and inert solid waste (sodium chlorides, sulphates and nitrates) is produced that can be safely sent to landfill.
Wet scrubbing	▪ Neutralises acid gas by the addition of compounds in a fine spray. ▪ Its efficiency is reduced because of the high exhaust gas temperature on entry to the 'wet scrubber' system. ▪ Can require an expensive waste water filtration and treatment system.
Activated carbon adsorption	▪ Required to remove high mercury (Hg) levels. ▪ Process gas is drawn through a bed of activated carbon granules for a gas residence time of just less than 3 seconds. ▪ The fixed bed requires renewal on a bi-annual basis.
Baghouse fabric filtration	▪ Uses fabric filter bags to remove particulate waste. A typical bag-house comprises an array of long, narrow bags, each about 25 cm in diameter, that are suspended upside down in a large enclosure. ▪ Prone to bag-house fires, which can require replacement of the entire bag-house if not caught quickly enough.
Ceramic filtration	▪ Use hollow ceramic filters to remove particulate and solid waste. ▪ Individual filters are generally 1.0m x 0.06m and there are typically 256 filter elements in a system, giving a filtration area of 48m^2. ▪ Filters down to 1 micron and is fire resistant. ▪ Also supports bed of sorbent, thereby improving overall acid gas neutralisation efficiency. ▪ Regarded as one of the most effective filtration systems.
Online monitoring	▪ Required to monitor emission to air levels. Systems will require: • Tribo-electric (Particulate) • Flame ionisation (VOC) • pH of solution (HCl, HF) • Velocity (Flow Rate) • Zirconia Electrode (O_2) • Thermocouple (Temperature) • Pressure (Diaphragm Strain) ▪ It also requires a data processing system to calculate and display emission rates, concentration and history.

Table 6: Pollution control system (PCS) technology

The emission levels to air and water from pollution control systems during ammunition demilitarization operations may comply with those in Tables 7and 8, which are generally regarded as international best practice:[31] [32]

Serial	Polluting substance		Limit value (mg/m^3)
Daily average values			
1	Total Dust		10
2	Gaseous and vaporous organic substances, expressed as total organic carbon		10
3	Hydrogen Chloride	HCl	10
4	Hydrogen Fluoride	HF	1
5	Sulphur Dioxide	SO_2	50
6	Nitrogen Monoxide and Nitrogen Dioxide[33]	NO NO_2	400
7	Dioxins and Furans		0.0000001[34]
8	Carbon Monoxide[35]	CO	50

Table 7: Emission to air daily average limit values

Serial	Polluting substance	Limit values[36]	
1	Totally suspended solids as defined by Directive 91/271/EC	95% / 30mg/l	100% / 45mg/l
2	Mercury and its compounds, expressed as mercury (Hg)	0.03 mg/l	
3	Cadmium and its compounds, expressed as cadmium (Cd)	0.05 mg/l	
4	Thallium and its compounds, expressed as thallium (Tl)	0.05 mg/l	
5	Arsenic and its compounds, expressed as arsenic (As)	0.15 mg/l	
6	Lead and its compounds, expressed as lead (Pb)	0.2 mg/l	
7	Chromium and its compounds, expressed as chromium (Cr)	0.5 mg/l	
8	Copper and its compounds, expressed as copper (Cu)	0.5 mg/l	
9	Nickel and its compounds, expressed as nickel (Ni)	0.5 mg/l	
10	Zinc and its compounds, expressed as zinc (Zn)	1.5 mg/l	
11	Dioxins and furans, defined as the sum of the individual dioxins and furans in accordance with Annex 1 to the Directive.	0.3 mg/l	

Table 8: Waste water discharge daily average limit values

9.2.7 Recovery, recycling and reuse (R3) (LEVEL 3)

Certain demilitarization techniques result in the production of 'special' or 'hazardous' waste which itself requires destruction or disposal in an environmentally benign manner. This should be done by a specialist environmental disposal company.

[31] Annex IV to Directive 2000/76/EC of the European Parliament and of the Council on the *Incineration of Waste*, 04 December 2000. (Emission limit values for discharges of waste water from the cleaning of exhaust gases).

[32] Annex V to Directive 2000/76/EC of the European Parliament and of the Council on the *Incineration of Waste*, 04 December 2000. (Air emission limit values).

[33] Expressed as Nitrogen Dioxide for existing incineration plants with a nominal capacity of 6 tonnes per hour or less.

[34] 0.1 ng/m^3.

[35] Annex V(d) to Directive 2000/76/EC of the European Parliament and of the Council on the *Incineration of Waste*, 04 December 2000. (Emission limit values for discharges of waste water from the cleaning of exhaust gases).

[36] Expressed in mass concentrations for unfiltered samples at discharge point.

The salvage of metallic scrap, or explosive waste, can result in an income stream. Some explosive fillings of ammunition may be useful to the commercial explosive industry whilst scrap steel is always in demand. Ammunition demilitarization programmes should aim to recover, recycle and reuse (R3) the maximum amount of waste possible. In the case of reclaimed explosive fillers, they will often contain a minor amount of contaminants from the recovery process and hence may not fulfil the tight quality requirements for re-use in military explosive ordnance. Instead, such explosives can be used as precursors for commercial blasting explosives. However, note that the cost of reclaiming military explosives, and then mixing with commercial slurry explosives, can be far greater than purchasing commercial slurry explosives.

9.2.8 Future techniques

States, commercial companies and INGOs should aim to develop more environmentally benign techniques for the demilitarization of ammunition and explosives.[37] Several are currently developing mobile, environmentally friendly demilitarization systems.

9 Management of stockpile demilitarization or destruction

The demilitarization or destruction management process that should be followed is shown in outline in Annex E. In practice, the process may not be linear and the activities may not always be consecutive. Nevertheless, the process indicates the general sequence and logical progression from defining the problem to the final demilitarization or destruction of the stockpiled ammunition. The four stages of the management process (planning, preparation, destruction and verification activities) are addressed below.

10.1 Planning

Planning is the collection, assessment and processing of information, selection of an appropriate way to proceed, and subsequent formulation of the detailed method by which a task is to be carried out.

Planning for stockpile demilitarization or destruction requires accurate and timely information on the quantity, storage location, type and technical design of the ammunition, together with a knowledge of the available demilitarization or destruction technology. Finance will obviously have an influence, but until the destruction of the stockpile has been planned it is difficult to calculate the real costs. Indeed, once the real costs have been identified, it may be necessary to re-plan the destruction operation in an attempt to find a more cost-effective route.

For new stockpile demilitarization or destruction programmes, the planning process should ideally start with a formal assessment of the country situation. This assessment, which may take the form of an Ammunition Technical Assessment, will draw heavily on existing information provided by the military, research agencies and, if applicable, commercial companies. Technical expertise is essential during the planning process and countries can request the support of the UN,[38] or regional organisations,[39] to assist in the planning process.

[37] See Footnote 27 for some examples of ongoing work.

[38] UNDP BCPR and UNMAS have previous experience of either ammunition demilitarization or destruction projects.

[39] NSPA and OSCE also currently provide this capability. Other regional organisations should be encouraged to develop a similar capability.

10.2 Preparation

Preparation should include all enabling activities that help clarify the demilitarization or destruction requirement and develop the capacity of a national authority and demilitarization/destruction organisation to carry out a demilitarization or destruction task. All aspects of the demilitarization and destruction cycle at Clause 7 should be considered.

10.2.1 Ammunition account

The accuracy of the national ammunition account is very important to ensure that future monitoring and verification activities do not identify accounting errors once the stockpile demilitarization or destruction process has started. A 100% stock check of the ammunition stockpile should take place prior to the commencement of the demilitarization or destruction process. Any accounting errors should then be rectified at this point which also contributes to security and confidence building measures.

Ammunition should be accounted for in accordance with the requirements of IATG 03.10 *Inventory Management of Ammunition*. The accounting system must also account for all sub-components.

10.2.2 Storage at demilitarization or destruction facility

Sufficient stocks of ammunition should be stored at the demilitarization or destruction facility to ensure that destruction is a continuous process. This ammunition should usually be stored in accordance with the safety requirements of IATG Series 02 *Risk management* and IATG Series 06 *Explosives facilities (storage and operations)* although temporary storage in accordance with IATG 04.10 *Temporary storage* may be permitted.

10.2.3 Selection of demilitarization or destruction technology

See Clauses 8 and 9 for factors and technologies that will influence the final selection.10.2.4 Development of demilitarization or destruction facility

National authorities should be aware that the development of even relatively simple demilitarization or destruction systems can be a time consuming process. Safety shall be paramount, therefore there is little opportunity to 'fast track' many of the necessary processes.

The development of OBOD processes will take weeks to months, whilst the development of industrial demilitarization processes can take months to years. This time requirement should be incorporated into the planning and preparation processes. That said, with the advent of the option to rent mobile facilities, the development time is replaced by preparation time for the facility, which will reduce the timeframe considerably.

10.2.5 Funding (resource mobilization)

The funding of ammunition demilitarization or destruction programmes comes from many sources. Funding may be provided by the host government, from donor governments, the United Nations or other international organisations. Funds may be held in trust funds or some other form of controlled accounts. Regardless of the source of funding it is important that the funds match the true cost of demilitarization or destruction and that a long term commitment is provided by the donor. This is particularly important for major projects that require the demilitarization/destruction organisation to make major investments in staff, infrastructure and expensive new equipment such as furnaces and pollution control systems.

The cost of ammunition destruction is probably the most important factor as the destruction of large quantities of conventional ammunition is expensive. Little data is publicly available on the costs of ammunition demilitarization.

Donors should recognize that the costs associated with the structural development, technical training, and equipment procurement of demilitarization facilities mean that the initial costs per tonne will be high in the first year but subsequent demilitarization is a lot cheaper as economies of scale take effect and national capacity has been built. This is sometimes a problem when the donor single-year funding cycle is applied as the decreasing cost of demilitarization in subsequent years is often difficult to specify.

If equipment is rented, these costs will substantially reduce, making a mobile facility more attractive to donors as it will come within a single-year funding cycle, without an investment budget.

10.2.6 Training

Demilitarization programmes require well-qualified managers and well-trained workers. The majority of training should be conducted at the demilitarization facility, not only for cultural and linguistic reasons, but also for access to details of the ammunition stockpile and destruction technology. Training programmes should be included in all contracts for the procurement of equipment.

A rented facility would come with everything required, including trained personnel. Training for local labour would be required, but this could be carried out by the technical personnel provided with the rented facility.

10.3 Physical demilitarization or destruction

Throughout the demilitarization or destruction process occupational health and safety shall be a priority. Similarly, an effective quality management system should be implemented.

10.3.1 Safety and occupational health

Managers of ammunition demilitarization or destruction programmes shall achieve a safe working environment by providing effective management and supervision, by developing working practices that contribute to risk reduction, by selecting equipment with inherently safe design, by providing appropriate training, and by making available effective personal protective equipment (PPE). Given the wide range of possible technical solutions, it is not possible to provide a precise and complete set of specifications that apply to all situations. Thus, ammunition demilitarization/ destruction organisations should develop and maintain management procedures and processes that will enable safety and occupational health (S&OH) risks to be identified, evaluated and reduced in a systematic and timely manner for each demilitarization or destruction task and for each demilitarization or destruction worksite.

10.3.2 Explosive safety procedures

The need for effective and safe operational procedures is essential. Standing operating procedures (SOPs) should be prepared for all operational procedures, practices and drills. SOPs are instructions that define the preferred method of conducting an operational task or activity. Their purpose is to establish recognisable and measurable degrees of uniformity, consistency and commonality within an organisation with the aim of improving operational effectiveness and safety. SOPs should reflect local requirements and circumstances but shall remain flexible and responsive to new concepts and technologies.

10.3.3 Quality assurance

Demilitarization or destruction involves the establishment and monitoring of management processes and operational procedures before and during the ammunition demilitarization or destruction process. Internal quality assurance will be conducted by demilitarization/destruction organisations themselves, but external inspections by an external monitoring body should also be conducted.

The purpose of quality assurance is to confirm that management practices and operational procedures for destruction are appropriate, and will achieve the stated requirement in a safe, effective and efficient manner. Monitoring should involve structured discussions with management and employees and formal inspections of SOPs, reports and records.

The national authority may appoint an agent to carry out the monitoring and inspections of the demilitarization/destruction organisation and its sub-units under its authority and responsibility, exercised under conditions agreed in the contract or formal agreement. Any agent so appointed by the national authority shall be required to have all the facilities, qualified staff, management systems and SOPs necessary for adequate monitoring.

More detailed guidance on quality management is included in Clause 11 of this IATG.

10.4 Verification and accounting

10.4.1 General

Records should be kept in accordance with IATG 03.10 *Inventory management*.

10.4.2 Media operations

Transparency of the demilitarization or destruction process is an important pre-requisite as a security and confidence building measure. The role of the media in obtaining national and international visibility of the demilitarization or destruction of an ammunition stockpile should not be underestimated. The national authority, in conjunction with the demilitarization/destruction organisation, should develop a media plan during the planning phase of the operation. This plan should include:

a) press releases;

b) access to the demilitarization or destruction site by journalists and film crews at short notice; and

c) video and photographic record of destruction.

10.4.3 Post project review

Wherever possible, demilitarization/destruction organisations should conduct a formal post project review (PPR). This will identify lessons-learned during the planning, preparation and demilitarization or destruction phases of the operation. The PPR should include a report on the suitability of the equipment, procedures, training and support. Issues of concern should be identified and prioritised, and solutions proposed. The requirement for PPRs should be included in demilitarization or destruction contracts by donors and national authorities. PPRs should be distributed to the appropriate international organisations, regional organisations, donors and sponsors. Where PPRs highlight shortcomings in established equipment or procedures, particularly issues involving safety, they should be more widely distributed.

10 Quality management (LEVEL 3)

The effective management of demilitarization or destruction operations shall aim to destroy ammunition stockpiles in a safe and efficient manner. This is achieved by developing and applying appropriate management processes, by establishing and continuously improving the skills of managers and workers, by obtaining accurate and timely information on the stockpile, by applying safe and effective operational procedures, and by using appropriate and efficient equipment. But management is not just about planning and supervising current tasks, it is also about reviewing current practices and procedures to improve safety, effectiveness and efficiency. In the case of the disposal of ammunition by industrial demilitarization a quality management process should be developed and applied.

The process and procedures that aim to achieve this continuous improvement to an organisation's management system and operational practices is commonly referred to as quality management. One method of demonstrating quality management for an organisation is to become ISO 9001:2015 compliant. There is much general information and training materials available for ammunition demilitarization organisations that choose to adopt the ISO 9001:2008 approach.

A summary of how the ISO 9001:2015 approach can relate to the demilitarization of ammunition stockpiles is given in Annex F. ISO 9001:2015 is a series of international standards for quality systems. They specify requirements and recommendations for the development of a management system, the purpose of which is to ensure that the 'products' or 'services' delivered meet the agreed needs. In this case, the product is the safe and efficient demilitarization of the ammunition stockpile.

Managers of ammunition demilitarization organisations should be encouraged to examine how to apply the principles of quality management to ammunition stockpile demilitarization. In doing so they should take particular note of two issues. Firstly, how special processes should be planned, implemented, monitored and reviewed. Secondly, the responsibilities of all managers and workers to identify and take advantage of opportunities for improvement to the process.

11 Environmental management

Destruction and demilitarization organisations may address the issue of environmental management through compliance with the ISO 14001:2015(E) *Environmental management systems* standard.

An environmental management system that is ISO 14001:2015 compliant provides a management tool enabling an organisation of any size or type to:

A) identify and control the environmental impact of its activities, products or services;

B) improve its environmental performance continually; and

C) implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

ISO 14001:2015 does not specify levels of environmental performance. If it did the levels of environmental performance would have to be specific to each business activity, and this would require a specific Environmental Management Standard (EMS) for each business. That is not the intention as environmental performance levels, such as emission to air limit values, are the responsibility of the State.

The intention of ISO 14001:2015[40] is to provide a framework for a holistic, strategic approach to the organisation's environmental policy, plans and actions. The standard provides the generic requirements for an environmental management system. The underlying philosophy is that whatever the organisation's activity, the requirements of an effective EMS are the same.

[40] ISO 14004:2016 *Environmental management systems - General guidelines on principles, systems and support techniques*. This provides general guidelines on environmental management systems.

Annex A
(normative)
References

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

A) AASTP-1 Edition B Version 1, Part IV, Chapter 7 *Destruction of ammunition and explosives*. NATO Standardization Organization (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

B) CWA 15464-1:2005. Humanitarian Mine Action. EOD Competency Standards. Part 1. *General requirements*. CEN. 18 November 2005;

C) CWA 15464-2:2005. Humanitarian Mine Action. EOD Competency Standards. Part 2. *Competency matrix*. CEN. 18 November 2005;

D) CWA 15464-3:2005. Humanitarian Mine Action. EOD Competency Standards. Part 3. *EOD Level 1*. CEN. 18 November 2005;

E) CWA 15464-4:2005. Humanitarian Mine Action. EOD Competency Standards. Part 4. *EOD Level 2*. CEN. 18 November 2005;

F) CWA 15464-2:2005. Humanitarian Mine Action. EOD Competency Standards. Part 5. *EOD Level 3*. CEN. 18 November 2005;

G) Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on their Destruction. Ottawa. 18 September 1997;

H) Convention on Cluster Munitions. Dublin. 30 May 2008;

I) Convention for the Protection of the Marine Environment of the North-East Atlantic. (Entered into Force 25 March 1998);[41]

J) European Union Council Directive 2000/76/EC *The incineration of waste,* 04 December 2000, amended by Regulation (EC) No 1137/2008 of 11 December 2008.

K) European Union Council Directive 2008/98/EC *Waste*, 19 November 2008;

L) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

M) IATG 02.10 *Introduction to risk management principles and processes*. UNODA;

N) IATG 03.10 *Inventory management*. UNODA;

A) IATG 04.20 *Temporary storage*. UNODA;

B) IATG 08.10 *Transport of ammunition*. UNODA;

C) IATG 09.10 *Security principles and systems*. UNODA;

D) IMAS 09.30 (Second Addition, Amendment 5) *Explosive Ordnance Disposal*. IMAS October 2014. IMAS. www.mineactionstandards.org;

E) IMAS 11.20 (Second Edition incorporating Amendments 1 through 6) *Principles and procedures for open burning and open detonation operations*. June 2013.

F) ISO Guide 51:2014 *Safety aspects – Guidelines for their inclusion in standards*. ISO. 2014;

[41] Also known as the OSPAR Convention.

G) ISO 4220: 1983(E) *Determination of a gaseous acid air pollution index - Titrimetric method with indicator or potentiometric end-point detection n*. ISO. 1983;

H) ISO 9001:2015(E) *Quality management systems – requirements*. ISO. 2015;

I) ISO 9612:1997(E) *Guidelines for the measurement and assessment of exposure to noise in a working environment.* ISO. 1997;

J) ISO 14001:2015(E) *Environmental management systems – Guidelines*. ISO. 2015;

K) London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 29 December 1972, (amended by the London Protocol 1996);

L) London Protocol to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1996, (Amended 2006);

M) SALW ammunition destruction – environmental releases from open burning (OB) and open detonation (OD) events. SEESAC. 30 May 2004;

N) NATO STANAG 4518 (Edition 2) and AOP 4518 (Edition A Version 1) *Safe Disposal of Munitions, Design Principles and Requirements, and Safety Assessments*. NATO Standardization Organization (NSO). 2017; and

O) United Nations General Assembly (UNGA) Resolution A/RES/55/255. *Protocol against the illicit manufacturing of and trafficking in, their parts and components and ammunition supplementing the United Nations Convention against Transnational Organized Crime*. 08 June 2001. 'The Firearms Protocol'. (Entered into Force on 03 July 2005).

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[42] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[42] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this module:

A) *A Destruction Handbook – small arms, light weapons, ammunition and explosives*. UN Office for Disarmament Affairs (UNODA). 2001;

B) *Conventional Ammunition in Surplus – A Reference Guide*. Small Arms Survey. ISBN 2-8288-0092X. January 2008;

C) *Handbook of Best Practices on Conventional Ammunition*, Chapter 5. Decision 6/08. OSCE. 2008;

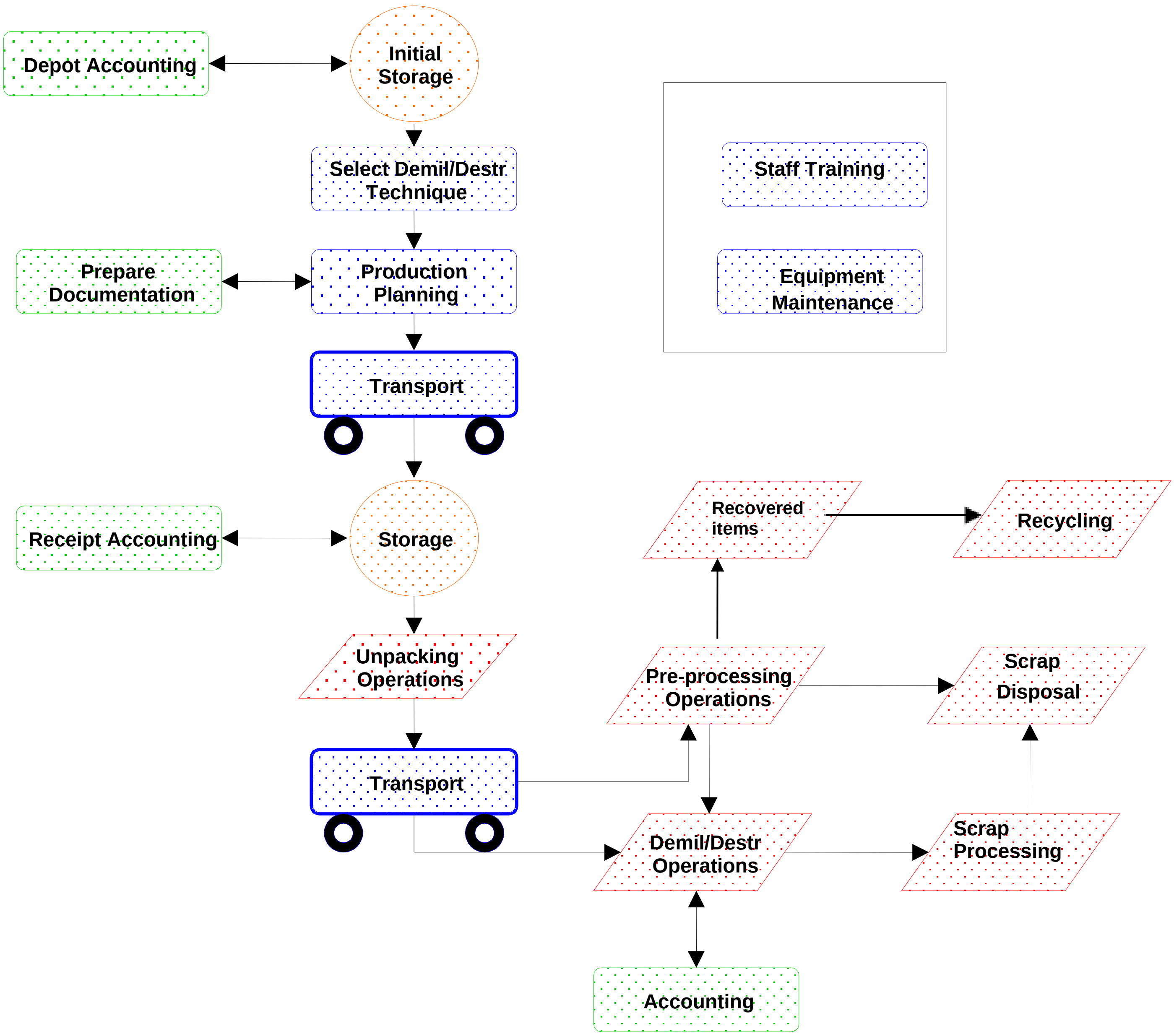
D) ISO 14004 *Environmental management systems - General guidelines on principles, systems and support techniques*. ISO. 2016; and

A) UNGA A/63/182, *Report of the Group of Government Experts established pursuant to General Assembly resolution 61/72 to consider further steps to enhance cooperation with regard to the issue of conventional ammunition stockpiles in surplus*. UN. 28 July 2008.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[43] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[43] Where copyright permits.

Annex C
(informative)
The demilitarization or destruction cycle



Annex D
(normative)
Procedures and principles for OBOD operations

D.1 Scope

The purpose of this Annex to the IATG is to explain the principles and procedures for the conduct of large-scale Open Burning and Open Detonation (OBOD) operations. It includes recommendations as to the layout of demolition grounds and the contents of Standing Operating Procedures (SOPs) in order to ensure a safe system of work.

D.2 Priorities and principles

The destruction of ammunition and explosives is a potentially hazardous task. The risks are minimised if the correct procedures are followed. If they are not, the possibility of serious accident becomes very high.

The following priorities, that shall always be observed, are:

D.2.1 Safety

The safety of both personnel and property is paramount. If a method is not safe it shall not be used.

D.2.2 Security

Both the items destroyed and the explosives used to destroy them are attractive to terrorists and criminals. The security of target and donor explosives shall be ensured at all times. This includes any explosive items for recycling.

D.2.3 Accounting

This links with security. Any loss shall be promptly identified, investigated and reported.

D.2.4 Speed of Work

This shall never be achieved at the expense of the first three priorities.

There are many different detailed disposal procedures, but certain principles apply to all disposal tasks.

D.2.5 Know the ammunition

Know in detail both the item being destroyed and the explosives used to destroy it. Unless the design characteristics of both are known, it will not be possible to determine a safe and effective means of disposal.

D.2.6 Plan the task carefully

Do not leave the planning until arrival at the disposal site. Work out the programme and procedures, in detail, well in advance.

D.2.7 Create a safe working environment

Create and maintain a safe working environment so that it is safe for the Demolition Party, other personnel, property, livestock, vehicles and equipment. Inspect the area on arrival

D.2.8 Give and obey directions precisely

The disposal site is no place for ambiguity or misunderstanding. Directives must be clearly understood by all personnel.

D.2.9 Observe all the safety precautions and use only the approved methods.

Do not take short cuts, they kill.

D.2.10 Clear the disposal area prior to departure

No disposal task is complete until the demolition area has been cleared of all hazards and contamination. Implicit in this is also the clearance of all rubbish and litter. Inspect the area prior to departure.

D.2.11 Summary

Almost all known accidents that have occurred would not have happened had the priorities and rules given above been obeyed. After every accident, the Officer in Charge (OIC) of Disposals concerned shall be called upon to explain why it was not prevented.

D.3 Authority for disposal

The responsibility for authorising ammunition disposals is vested in the national authority.

No ammunition disposal should take place without the prior approval of the national authority. The exceptions to this rule are:

a) Ammunition identified during surveillance or repair tasks which the local Ammunition Officer considers to be dangerous; and

b) Blinds and stray ammunition, which by definition are potentially dangerous. (See IMAS 09.30 *Explosive Ordnance Disposal* for further details).

Foreign ammunition should be destroyed using the appropriate procedure based on sound first principles. Should no procedure exist, then instructions for its disposal must be requested from the national authority. Foreign ammunition is not to be broken down without the specific authority and instructions from the national authority.

D.4 Methods of local disposal - general

There are three methods of local destruction:

A) open detonation;

B) open burning; or

C) incineration.

The method used with a particular ammunition type will obviously depend upon its type of explosive filling and design.

D.4.1 Detonation

Non-HE ammunition can be disposed of by inclusion in mixed stacks during large-scale demolitions. The quantities of such items included in a mixed stack have to be kept down to a small percentage of the overall stack.

D.4.2 Burning

This is generally used with propellant (bagged or loose), smoke, pyrotechnic and lachrymatory stores but is also suitable for certain plastic-bodied items. It can also be used as an alternative to detonation for certain explosives, ie composition explosive, TNT, nitro-glycerine based explosives and black powder - but detonation is the cleaner method. Local legislation related to the environmental impact of open burning must always be taken into account.

D.4.3 Incineration

A specialised form of burning, involving an external heat source, authorised for certain types of ammunition. with minimal explosive content.

D.5 Siting of disposal sites

D.5.1 Definition

A disposal site is in an area authorised for the destruction of ammunition and explosives by detonation and burning. These in turn are referred to as demolition grounds and burning grounds and may be co-located on a disposal site.

NOTE 1 The national authority shall approve and formally licence disposal sites within ammunition depots only after professional ammunition technical advice.

D.5.2 Hazards of detonation

The hazards created by detonation are:

a) flash and heat;

- a) blast and noise;
- b) ground shock;
- c) fragments; and
- d) toxic smoke.

D.5.2.1 Flash and heat

These effects are localised but still significant. Flash could injure the eyes, but the reddish flash produced by most detonations is unlikely to do so. Heat will start fires if combustible materials are present: dry grass, undergrowth, trees or peaty soil.

D.5.2.2 Blast and noise

These have greater range. Blast can cause injury or damage - but persons and equipment would have to stand unprotected and reasonably close to a detonation to be affected by blast. Injury and damage are far more likely to be caused by fragments.

Noise presents a greater problem. At close range, it can cause ear damage and at a greater range it will have a nuisance effect that will generate complaints from the general public.

D.5.2.3 Ground shock

The main effect will be on persons and equipment relatively close to the detonation - although rock strata can sometimes transmit the effect for considerable distances. It is another potential source of public nuisance and complaint.

D.5.2.4 Fragmentation

These are the real killers. In practice, the size of the "danger area" is determined by the maximum range of fragments. All persons, property and equipment that are within this range and which are not adequately protected are in hazard.

D.5.3 Properties of demolition grounds

To overcome the above hazards, demolition grounds require the following properties:

D.6.5.1 Isolation

This is the most important requirement. They must be as remote as possible from a person and all his/her artefacts.

D.5.3.2 Deep soil

Free of rocks and stones with no peat (which could burn underground).

D.5.3.3 No secondary fire hazards

Demolition grounds should not be located over pipelines, near power cables or near fuel storage areas.

D.5.3.4 No radio/radar transmitters

Major demolitions are normally initiated using electric cable or radio control (RC) systems and, as such, are vulnerable to external electro-magnetic force (EMF) influence. Consequently, demolition grounds shall not be situated near radar installations, radio transmitters or near high-voltage power lines.

D.5.3.5 High ground

High ground reduces the effects of blast and ground shock and is also relatively well drained. The latter property aids digging. However, high ground also tends to increase fragment range.

D.5.4 Hazards of burning

The hazards created by burning ammunition are:

a) intense heat;

e) Intense light; and

f) toxic fumes (occasionally).

But there are no blast, ground shock or fragmentation hazards unless the demolition burns to detonation. When burning HE natures, danger areas always have to be calculated based on the potential for a high order detonation no matter how many times the burn has been a success.

D.5.4.1 Properties of burning grounds

To counter these hazards burning grounds require the following properties:

a) no secondary fire hazards;

g) an adequate water supply;

h) sufficient isolation to prevent heat or fume casualties; and

i) sandy soil with no peat.

An isolated, sandy, barren area is the most suitable site. Avoid sites near high cliffs as these encourage rising hot air currents that can carry burning debris considerable distances. Where possible, 'wet' the area with fire hoses prior to, and after, the burn.

D.6 Approval of disposals sites and SOPs

Formal approval, (commonly referred to as licensing), of the disposal site and its associated SOPs shall be given by the national authority prior to the commencement of disposal activities on a site. Such approval shall be based on consideration of the following factors:

D.6.1 Reference to publications

All SOPs are in effect the local interpretation of regulations issued by a higher authority. The SOPs should open by listing all such regulations (and any related local SOPs).

SOPs should not reproduce large slabs of information contained in other publications. Rather they should concentrate on detailing how these regulations are to be applied under local conditions.

D.6.2 Maps and grid references

Maps shall be sent to the national authority with the draft standing orders. These shall include:

A) a map of the area upon which the grid reference, name and area of the site are marked. This information should be repeated in the body of the SOPs; and

B) a larger scale sketch map of the disposals site showing its layout (a schematic layout is at Appendix 1 to Annex D). This sketch map shall be included as an Annex to the SOPs. The layout of the disposals site is worked out with careful regard to safety and, once approved by the national authority, shall be mandatory. Any required changes shall be re-approved by the national authority.

D.6.3 Locations of sentries and Observation Posts

Sentries have to be placed so that they control all access routes into the disposal site. In ammunition depots sentries will normally be located on the edge of the disposal site in Splinter/Fragment Proof Shelters (SPS). When SPS are not available, e.g on open ranges, the sentries must be located outside the danger area.

D.6.4 Marking of the site

Disposal sites shall be marked with notice boards sited so that they are visible on all possible approaches. In ammunition depots, the disposal site shall also be fenced.

D.6.5 Location of the firing point

This shall be close enough to blows for the OIC Disposals to be able to hear partial explosions. The firing point is normally inside the danger area and within an SPS.

D.66 Communications

Good communications are essential to safety and the following telephone links are required:

A) firing point to emergency services. Fire, Medical, Police via the local main (military or civil) exchange;

B) firing point to sentries; and

C) sentries to firing point. There shall also be a back up system e.g radio, whistles, vehicle horns.

The SOPs shall list all the emergency telephone numbers and lay down an accident telephone drill. If radios are used, a list of emergency frequencies and vital call signs is to be included.

D.6.7 Explosive limits

These are determined by two main limiting factors:

A) maximum fragmentation range. This determines the danger area and all persons and equipment must be either outside this area or under shelter in SPS. The perimeter of the disposal site shall contain the danger area. The size of the disposals area will therefore limit the permissible size of blows. No blows shall be permitted above the level where fragments may travel further than the perimeter; and

B) ground shock and noise effect. The local "tolerance" level of the public to the effect of shock and noise on themselves and their property has to be determined and may impose lower limits than the fragment range.

A method of determining the explosive limit for a new disposals area is as follows:

A) from Explosive Ordnance Disposal (EOD) or ammunition technical advice;

B) position observers in communication with the firing point at the perimeter and at all sensitive points; and

C) carry out a series of blows, gradually increasing in net explosive content (NEC) until the theoretical limit is reached. Stop before this point if the observers report that the local "tolerance" level for noise and vibration has been reached. Check with the observers on this after each blow.

The end result of the trial shall be an explosive limit, which will ensure that:

A) a person standing unprotected at the disposals area perimeter is safe from blast and fragmentation. This person should also be safe from toxic fumes regardless of the wind direction;

B) there is no possibility of injury to persons or damage to property outside the perimeter of the disposal site; and

C) the effect of noise is kept to a tolerable level.

Where it is intended that more than one type of activity will be carried out in a disposal site, e.g burns, demonstration, White Phosphorus (WP) and pyrotechnic burning tanks, then a location for each type of activity has to be specified, and separate explosive limits have to be laid down for each type of activity.

D.6.8 Personnel limits

The number of persons present shall be the minimum required to ensure efficiency. Certain tasks are subject to mandatory personnel limits given in the detailed procedures for these tasks.

D.6.9 Spectators

Spectators shall be allowed at official demonstrations only. Civilian spectators (or their organisations) shall be required to sign a standard indemnity form before the demonstration commences.

D.6.10 Orders for sentries

These are normally contained in a separate Annex to the local SOPs and shall cover the following points:

A) their duties. "To keep all approaches to the disposal site under observation and to prevent any intrusions";

B) reporting. To report to the OIC Disposals any intrusions that they cannot prevent; and

safety. To remain under cover in their SPS when disposals are in progress.

D.6.11 Contraband

This includes all fire making, smoking materials and cell phones. These shall be kept under control in a locked container by the OIC Disposals. Smoking shall only take place in a designated area - remote from all explosives - at times decided by the OIC Demolitions. Cell phone usage shall be strictly prohibited except in an emergency, and only then in a declared safe location

D.6.12 Eating and drinking

This has also to be controlled to prevent the ingestion of explosive particles or contaminated materials. The OIC Disposals shall ensure that personnel wash and scrub their hands before meal and refreshment breaks.

D.6.13 Transport discipline

The points to be covered are:

D.6.13.1 Vehicle routes

These shall be laid down (preferably using hard core tracks) and shall not cross firing or telephone cables unless they are adequately buried and protected.

If possible, develop a one-way circuit to avoid delays and vehicle accidents.

No vehicle shall approach to within 30 metres of the disposal pits or ammunition being unpacked and prepared for disposal.

D.6.13.2 Unloading and parking

Engines shall be switched off when vehicles are loaded or unloaded.

Vehicles shall be parked in a designated parking area outside the danger area during blows.

D.6.13.3 Segregation of loads

Separate vehicles shall be required for Condition A ammunition, Condition D ammunition, WP stocks and personnel. A person in charge of loading/unloading shall be nominated.

D.6.14 Dress

Special dress is called for with certain disposal tasks. In addition to personnel protection issues, consideration should be given to the electrostatic nature of some clothing. In all other cases the dress should be appropriate to the weather conditions. Sentries require adequate protection against bad weather. Clothing shall be of appropriate sizes and forms to provide equal levels of protection to both male and female personnel.

D.6.15 Safety precautions peculiar to the disposal site

Mandatory use of ear protectors by the firing party Limitations on WP disposals and burns are required when the wind direction may carry fumes towards a sensitive area.

D.6.16 Accident procedures

The mandatory requirements shall be:

A) the disposals party shall include at least one person trained and equipped to administer first aid;

B) this person shall stay readily available outside the danger area, or under cover at the firing point SPS, to deal with casualties; and

C) there shall be an established casualty evacuation procedure and standby medical cover must be available.

Following an accident, the following procedure shall be implemented:

A) stop disposals, make safe prepared demolitions, carry out first aid and casevac/call on back up medical aid;

B) inform higher authority. Note all details pertinent to the eventual enquiry;

C) take photographs if possible; and

D) render safe and repack all ammunition and explosives that have been unpacked and prepared for disposals - segregate awaiting investigation.

D.6.17 Records and reports

A permanent disposals diary shall be kept. This shall be completed daily and signed by the OIC Disposals.

D.7 Planning and preparation

The first step should be to prepare a list of the items awaiting local disposals. Confine the list to those items where local disposal has been approved by the national authority. Do not anticipate approval.

Select the most suitable disposal method and location:

A) if the list is confined to small quantities of items with low NEC use a local disposal area (with a small explosive limit);

B) if the list contains larger quantities of items with NEC in excess of the explosive limit of the local disposal area, the programme will have to take place at a more distant disposals area with a larger explosive limit. These must be selected well in advance;

C) determine the best method of disposal for each item. This will necessitate knowing the make up of each item. You must achieve safety and complete destruction of the item and its filling(s);

D) determine the types and quantities of serviceable explosive required to effect disposal;

E) breakdown the list of items for disposal into individual serials;

F) ensure that the total NEC per pit (including serviceable demolition explosives) does not exceed the explosive limit for the disposals area; and

G) ration out high capacity items between the pits to enhance the effect of the serviceable demolition explosives. The combination of items within blows will influence the method of disposal chosen.

Produce a Demolition Order, the disposals programme and list:

A) date, time and location;

B) nominal roll of personnel in disposals party;

C) list of ammunition to be destroyed;

D) list of serviceable explosives required;

E) breakdown of disposals by serials and pits;

F) safety and casualty evacuation arrangements;

G) administration arrangements, (accommodation, food, transport);

H) route(s) - if applicable; and

I) list of stores required. Duplicate essential items.

Give notice of disposals as required, in organisation orders and to the general public. Means of communication should account for literacy and access differentials between men/women, as well as for the presence of linguistic minorities and transient populations to ensure maximum reach.

Earmark and check explosives, ammunition and equipment. The equipment should also be tested for serviceability at this point.

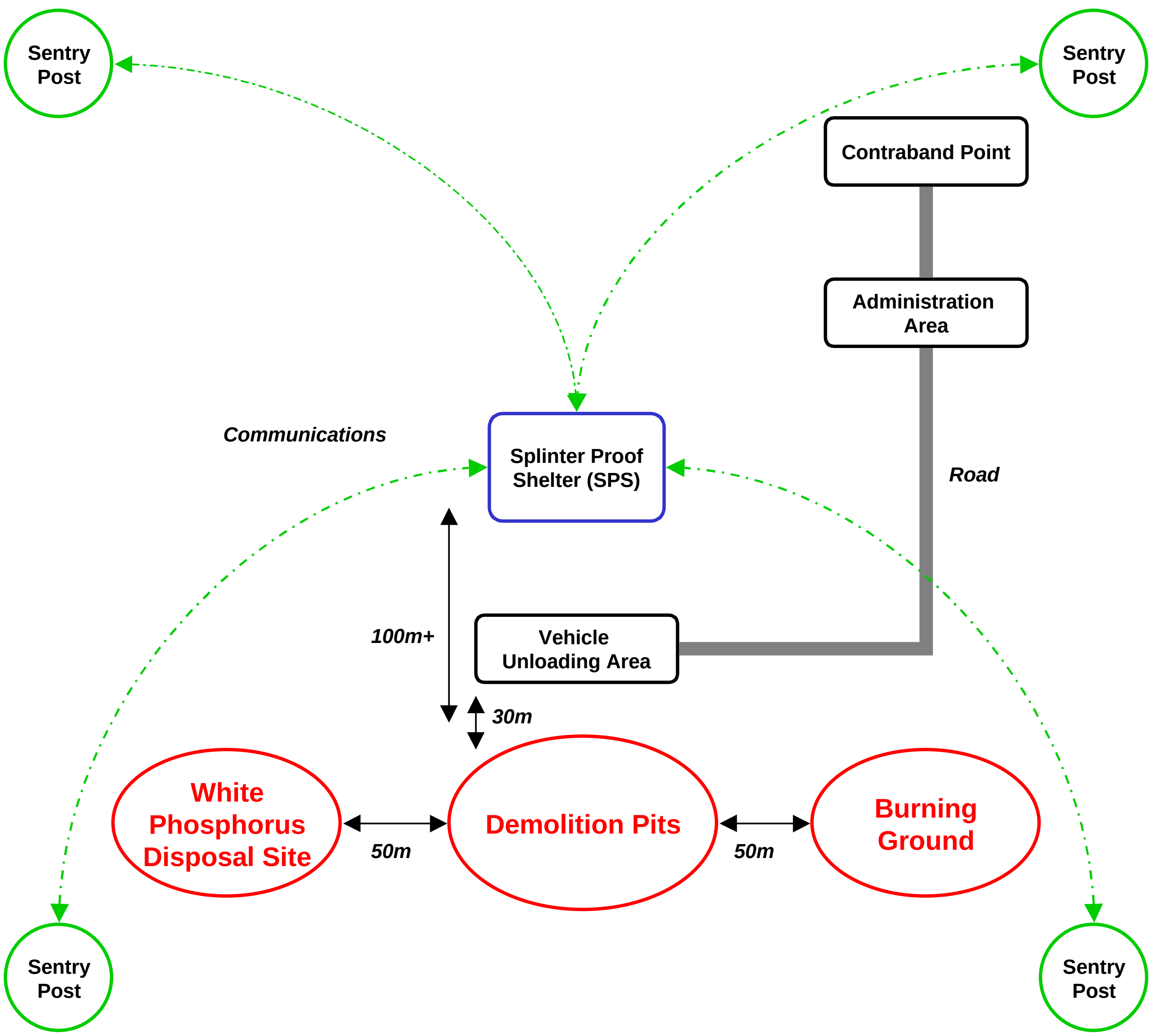
Brief personnel who are involved in the disposal programme.

D.8 Conduct of disposals

Detailed instructions should be given in local technical instructions for particular disposals tasks.

Procedures for the control of disposal activities at the disposal site are given at Appendix 2 to Annex D.

Appendix 1 to Annex D
(Informative)
Schematic layout of a disposal site



Appendix 2 to Annex D
(Normative)
Control of disposals activity

2.D.1 On arrival before disposals commence

2.D.1.1 Contraband

The Officer in Charge (OIC) of Disposals shall apply contraband restrictions and advise all personnel of smoking break arrangements.

2.D.1.2 Briefings and nominal roll

The OIC Disposals shall:

A) check the nominal roll and brief all personnel;

B) establish the nominated first aid person and his/her equipment in the first aid point. This must be in a Splinter/Fragment Proof Shelter (SPS) if inside the danger area;

C) instruct the sentries on their duties and the means of communication. Post the sentries and instruct them to hoist the red flags;

D) detail the routes for vehicles and personnel; and

E) detail the parking area. All vehicles shall be parked outside the danger area while disposals are in progress.

2.D.1.3 Safety checks

The OIC Disposals shall:

A) check the telephone links both to the exchange and to the sentries. Phone around the system with final warning of disposals (as required by local instructions);

B) check the routes are clear of suspect Unexploded Ordnance (UXO) and, if any are present, treat them as blinds. This shall be checked before and after each blow;

C) ensure that routes do not cross cables unless these are adequately buried;

D) nominate a safety vehicle. This is to be equipped with a stretcher and blankets. It is to remain available for the evacuation of casualties throughout the disposals programme. Primary and secondary drivers should be nominated and the keys kept ready at all times. Drivers should be familiar with the route to emergency services;

E) when disposing of ammunition by burning await the arrival of Fire Brigade cover or establish and test fire fighting parties and equipment;

F) check the demolition pits (where applicable). OIC Disposals shall check again for suspect UXO before and after each blow. He/she shall establish a safe and firm route into the pit and firm working areas and create sandbag “steps” and working platforms as necessary;

G) ensure that personnel do not walk over or stand on undercuts; and

H) where appropriate, e.g with bare explosives, establish hand washing facilities. Give instructions that all persons who handle explosives shall wash and scrub their hands before they eat or drink, even if gloves have been used when handling explosives.

2.D.1.4 Unloading of ammunition

The OIC Disposals shall:

A) order the unloading of ammunition. Serviceable and unserviceable items shall be kept separate. A nominated individual shall control the accounting and issues for each series;

B) ensure that vehicles avoid soggy ground. Vehicles should keep to hard standing or rubble tracks. Create sandbag “stepping stones” for personnel as necessary;

C) ensure vehicles do not approach within 30 metres of the disposal pits or of unpacked ammunition and explosives; and

D) ensure engines are switched off during loading and unloading. Keys should remain readily available in case of emergency.

2.D.2 During disposals

2.D.2.1 Supervision and control

The OIC Disposals shall remain free to supervise all activity. He/she shall not become responsible for the activities of one group or area to the exclusion of others.

The nominated person shall remain free to guard the ammunition and explosives. He/she shall control and account for the issues to pits for disposal.

2.D.2.2 Safety

2.D.2.2.1 General

Observe all safety precautions.

2.D.2.2.2 Preparation of demolition or burn

Safe areas away from the edge of the pits shall be earmarked for the unpacking and preparation of ammunition and explosives. Serviceable and unserviceable items shall be prepared in separate areas:

A) protect sensitive items when unpacked. Do not step on or over ammunition or explosives - this includes detonating cord;

B) do not “dribble” plastic explosive (PE) or other explosives during preparation;

C) eliminate all contaminated material; and

D) avoid the inclusion of packages on stacks as much as possible. Check all surplus packaging is free from explosive (FFE) and remove to a central empty package point.

Site undercuts and stack positions in the pits so that the blast and fragmentation/debris effects are minimised and directed away from sensitive areas. As far as possible blow uphill - this facilitates drainage.

Test the firing cables between each blow. Repair cables and retest as necessary before detonator is attached.

2.D.2.3 Stack configuration

In terms of the stack configuration, the OIC Disposals should aim for:

A) minimum use of serviceable explosives compatible with complete destruction of the item(s) being disposed of;

B) make the best use of the explosive fillings of items to effect destruction;

C) the correct mixture of high capacity and low capacity items etc in mixed stacks;

D) no air gaps and the minimum of metal/material between explosive fillings;

E) stacks and their exploding chains are to be stable enough and sufficiently shielded so as not to be affected by detonations in other pits; and

F) do not place un-bagged earth directly onto stacks. Tamp with sandbags - this facilitates digging out partial explosions.

2.D.2.4 Preparation of detonating cord

Ensure that the detonating cord:

A) is as straight as possible and not crossed over;

B) has taped junctions of at least 100 mm and spare ends of at least 300 mm. The cut ends should be taped over to prevent moisture ingression, prevent spillage of loose explosive and thereby reduce the risk of a misfire due to detonating cord failure; and

C) all junctions must be outside the pit and the main lead must extend at least two metres out of the pit. This facilitates dealing with misfires.

2.D.2.5 Tools and explosives

Tools and explosives shall be carried in separate marked boxes. Loose items shall not be carried on the person. Detonators shall be carried in totally enclosed, marked metal boxes.

2.D.2.6 Misfires

Misfire procedures shall be produced prior to demolitions and are dependent on the type of exploder being used and the type of initiator. However, safety times should not be less than the following:

A) For electrical misfires, wait 10 minutes after the last attempt to initiate the serial before approaching demolition site.

For igniferous means, wait 30 minutes after the last attempt to initiate the serial, or the last sign of smoke or burning (whichever is latest) before approaching demolition site.**2.D.3 At close of work**

The OIC Disposals shall:

A) arrange a full search of the disposal area, ensure that it is FFE and free of all litter contamination;

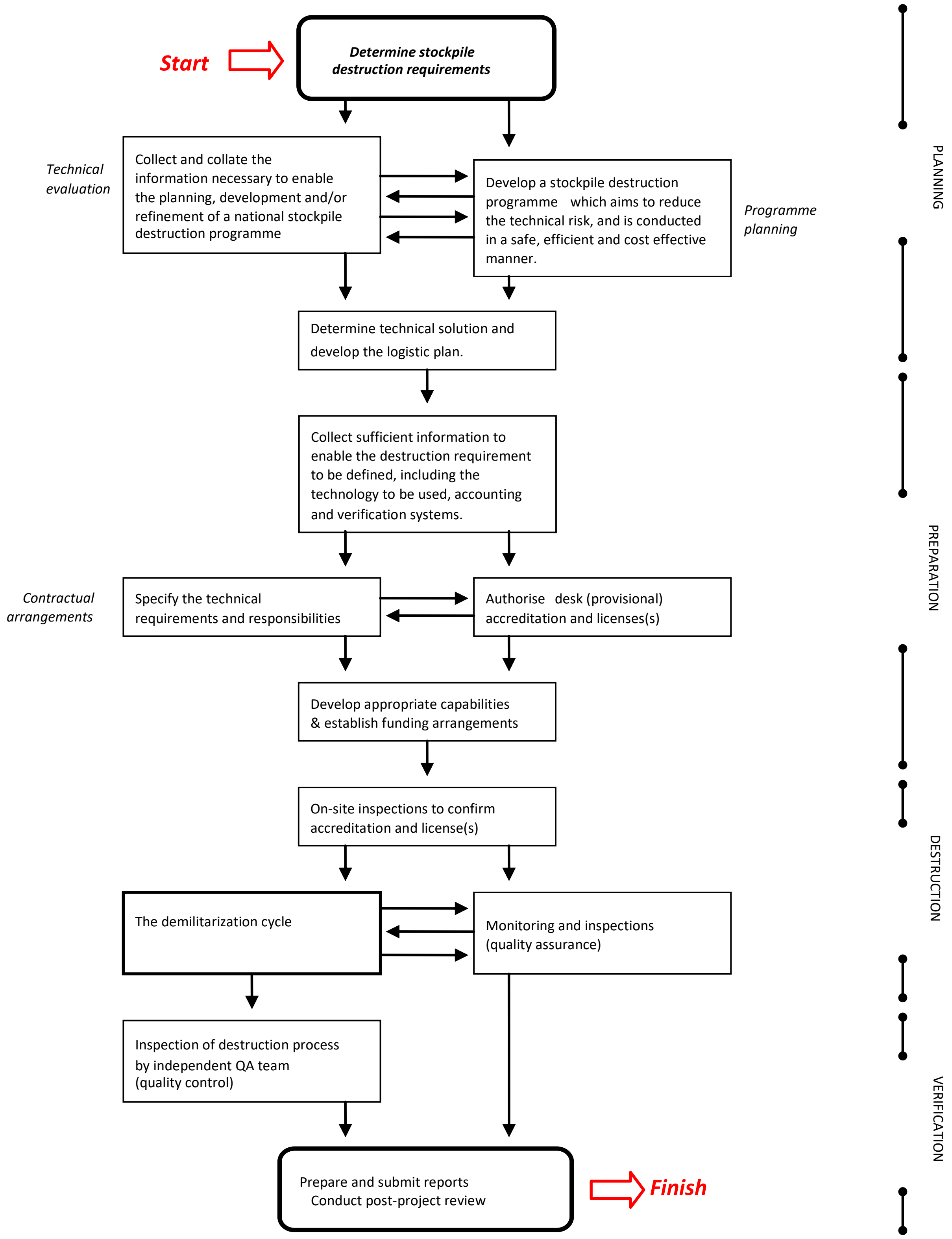
B) ensure that empty packages are re-inspected, sealed and marked FFE;

C) reconcile the closing stocks of ammunition and explosives with the record of what has been destroyed. Do not allow personnel to leave the disposals area until all discrepancies have been satisfactorily investigated and explained;

D) take a declaration from each person in the disposals party that he/she has no explosives, ammunition or accessories in his/her possession before he/she leaves the disposals area; and

E) complete and sign the disposals diary.

Annex E
(informative)
Stockpile destruction management schematic



Annex F
(informative)
Stockpile demilitarization and ISO 9001:2015 (LEVEL 3)

This Annex should only be used to support large-scale ammunition demilitarization operations.

The concept of total quality management (TQM) and the development of quality management systems (QMS) evolved in the 1980s and were used by management to achieve levels of excellence in manufacturing. Those companies that embraced the philosophy to change their organisations and empower their staff achieved remarkable levels of performance and a clear competitive edge. During the 1990s this approach has been applied to the public sector and 'non-profit' organisations with similar improvements in performance.

Quality management systems comprise three components: (1) standards and common procedures that define the rules, norms and required performance of an organisation; (2) an internal management system (such as ISO 9001:2015)[44] that encourages an organisation to achieve these standards; and (3) institutional arrangements, such as national and international professional bodies that establish the rules, norms and required performance and monitor the performance of its member organisations.

Organisations that seek ISO 90012015 accreditation are required to comply with an agreed set of criteria: the 5 major standard clause 'areas' that define the agreed criteria. The interpretation of the criteria depends on the role of the organisation and whether it delivers a product or service. Many professional bodies have produced guidelines that relate to their own business sectors and professions. Currently no agreed international criteria or guidelines exist for ammunition stockpile destruction.

The 5 major standard clause 'areas' of ISO 9001:2015 need to be modified to reflect the role of organisations engaged in ammunition stockpile demilitarization.

The relevance of these clauses to ammunition stockpile demilitarization can be established by mapping them onto the IATG 10.10: compliance clauses, as shown in Appendix 1 to Annex F. The resulting matrix provides a deeper and more comprehensive understanding of the total quality requirements of ammunition stockpile demilitarization. For example, a demilitarization organisation seeking ISO 9001:2015 accreditation would be expected to demonstrate how its internal quality assurance and quality control procedures would be used to identify critical non-conformities, an action that is currently required in many contracts.

Such an approach would provide a common framework to assess and evaluate the suitability and preparedness of contractors and sub-contractors as part of any contractual, accreditation or licensing procedures. It would generate transparency and this, in turn, would improve confidence in the product.

[44] ISO 9001:2015(E) *Quality management systems – requirements*. ISO. 2015.

Appendix 1 to Annex F
(informative)
IATG 10.10 and ISO 9001:2015 (LEVEL 3)

IATG 10.102020 Clauses →		Terms and definitions	Disposal options	International legislation	Demilitarization cycle	Technical factors	Priority for destruction	Demilitarization technology	Management of stockpile destruction	Quality management	
ISO 9001:2015 Clauses ↓		Clause 3	Clause 4	Clause 5	Clause 6	Clause 7	Clause 8	Clause 9	Clause 10	Clause 11	
4	**Quality Management System**										
4.1	General requirements		X	X	X	X			X	X	
4.2	Documentation requirements								X		
5	**Management Responsibilities**										
5.1	Management commitment									X	
5.2	Customer focus									X	
5.3	Quality policy	X								X	
5.4	Planning				X		X	X	X		
5.5	Responsibility, authority and communication			X	X	X	X	X	X	X	
5.6	Management review								X		
6	**Resource Management**										
6.1	Provision of resources							X	X		
6.2	Human resources								X		
6.3	Infrastructure					X		X	X		
6.4	Work environment							X	X	X	
7	**Product Realization**										
7.1	Planning of product realization			X	X	X	X	X			
7.2	Customer-related processes			X							
7.3	Design and development			X		X		X			
7.4	Purchasing							X			
7.5	Production and service provision			X		X		X			
7.6	Control of monitoring and measuring equipment										
8	**Measurement, analysis and improvement**										
8.1	General				X	X			X		
8.2	Monitoring and measurement			X		X		X	X		
8.3	Control of nonconforming product			X				X			
8.4	Analysis of data			X	X	X		X	X		
8.5	Improvement								X		

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 11.10

Third edition
March 2021

Ammunition accidents and incidents: unit reporting and technical investigation methodology

UN SaferGuard
Securing ammunition, protecting lives

IATG 11.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

The reporting and investigation of conventional ammunition accidents and incidents is a key component in ensuring the safety of the conventional ammunition stockpile during storage, handling and use. As there is no such thing as perfect safety, it is inevitable that personnel using conventional ammunition during training, or on operations, will themselves be at risk of fatality or injury. Accidents or incidents[3] involving conventional ammunition are a regular occurrence, even in the best trained military and security forces, yet most of them are preventable. Reporting and investigating accidents and incidents will establish lessons for others to learn and ultimately contribute to improved safety for all.

As a fundamental preventative measure any accidents or incidents should be immediately reported and investigated in order that the appropriate action can be taken to prevent reoccurrences. Such actions may include the revision of operating systems and procedures, rectification of ammunition faults, and/or the imposition of bans or constraints on the use, storage, handling, transport or disposal of the ammunition type involved. The use of an ammunition accident reporting system assists the development of such actions; the aim is safety improvement not the allocation of blame.

The use of a proven and agreed methodology to technically investigate all ammunition accidents and incidents: 1) supports the consistency of investigation standards between individuals; 2) ensures that the appropriate actions are taken, and questions asked by the investigator; and 3) improves the quality of investigation reports.

[3] Details on the appropriate response to ammunition incidents is contained within IATG 01.60 *Ammunition faults and performance failures.*

Ammunition accidents and incidents: unit reporting and technical investigation methodology (LEVEL 1)

1 Scope

This IATG module introduces and explains the methodology and techniques for ammunition accident investigation in order to contribute to an overall safe, effective and efficient conventional ammunition management system.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'ammunition accident' refers to *any incident involving ammunition or explosives that results in, or has potential to result in, death or injury to a person(s) and/or damage to equipment and/or property, military or civilian.*

The term 'incident' refers to *a generic term that includes all accidents, performance failures and faults involving ammunition or where ammunition is present.*

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 General

As a fundamental preventative measure to support safe conventional ammunition stockpile management any accidents or incidents involving ammunition and explosives should be immediately reported by users and appropriately investigated in order that the appropriate action can be taken to prevent reoccurrences. Such actions may include:

A) the revision of operating systems and procedures, including training;

B) the imposition of a ban on the use, storage, handling, transport or disposal of the ammunition type involved;

C) after investigation, the imposition of constraints on the use, storage, handling, transport or disposal of the ammunition type involved;

D) rectification of the fault by repair; or

E) withdrawal of the ammunition from service use.

The national authority or ammunition stockpile management organisations should nominate an appropriate investigating authority and ensure that it is provided with technically qualified staff and resources that are necessary to provide an effective and efficient capability.

It shall be a mandatory requirement for users or stock-holding units to report any accidents or incidents involving ammunition and explosives to the investigating authority. All accidents and incidents should be reported, and users or stock-holding units shall not make the decision that accidents are minor or not worth reporting.

Ammunition accidents arising out of manufacturing and/or technical inspection failures are shown, by experience, to be rare. The majority of reported cases are usually due to a functioning failure in the combination of weapon and ammunition and, in the majority of instances, this is aggravated by mishandling on the part of the user.

Notwithstanding the previous comment, in the investigation of any accident or incident involving ammunition or explosives, all possible causes are to be considered, particularly when a straightforward explanation is not at once apparent. It is essential to remain objective and open-minded about the causes of any accident. The most probable causes must first be eliminated using positive factual evidence before speculation into remote possibilities. Even then, theories are not to be advanced unless a reasoned case can be made fully supported by evidence.

Factual evidence supported by witnesses’ statements, preferably corroborated and carefully examined, shall be the basis of all conclusions.

Ammunition accident/incident investigations should be conducted by a qualified Technical Investigator nominated by the appropriate national authority. The Technical Investigator should determine what happened and why, and not attribute blame or negligence to any named individual.

5 Ammunition accidents

An ammunition accident, irrespective of cause or however minor, is any incident involving ammunition and explosives that results in death or injury to a person(s) and/or damage to equipment and/or property, military or civilian.

Examples of ammunition accidents are:

A) a breech explosion occurs in a weapon, injures the firer and causes damage to the working parts;

B) a battle simulation charge explodes in close proximity to a soldier causing flash burns and temporary deafness; or

C) a ricochet of a small arms bullet hits and damages a vehicle parked on the range.

6 Rationale for reporting ammunition accidents

There are a number of reasons why an effective system for the reporting and investigation of ammunition accidents should be developed and utilised by national authorities:

A) safety can be improved as immediate action[4] and may be taken to prevent a reoccurrence;

B) hazardous practices, which are not necessarily the fault of the user, may have developed in the use of the ammunition that have not previously been identified. Improved safety practices can be developed to prevent a reoccurrence;

C) to meet the requirements of safety legislation;

D) to provide information for potential use in possible claims procedures;

E) to be acceptable to employees, members of the public and management as a fair, thorough and impartial procedure for the investigation of an accident; and

F) information may be obtained than can lead to improvements in training, weapon and ammunition design.

The implications of failure to report an ammunition accident or incident can have lethal consequences. For example, the failure of a user to report could result in a recurrence that may result in fatalities and/or injuries to personnel in other units. In such circumstances, the organisation investigating the first occurrence would have banned the use by forces under its controls of that particular type, lot or batch ammunition worldwide. Therefore, the second accident with fatalities and injuries to personnel could have been prevented. In this instance, the failure to report the initial accident could be considered to be criminally negligent.

It should be noted that many incidents occur that do not result in injury or damage, but which had the potential to do so (a 'near miss'). Consideration should be given to capturing these incidents as well as they can provide similar benefits.

7 Reporting of ammunition accidents (LEVEL 1)

The national authority or the organisation responsible for the stockpile management of conventional ammunition should ensure that a system of reporting and investigating ammunition accidents/incidents is developed, promulgated to all users and is then effectively used. Users should be instructed to immediately report the following information on an ammunition accident or incident to the appropriate investigating authority:[5]

A) name of individual reporting fault or performance failure;

B) user unit;

C) user unit contact person;

D) date and time of ammunition accident;

E) details of any fatalities and/or injuries;

F) location where the ammunition accident has occurred, including map grid reference;

G) type of ammunition involved (full technical name);

[4] Including the use of bans and constraints. See IATG 01.70 *Bans and constraints*.

[5] An example form is at Annex D, which is replicated in IATG 01.60 *Ammunition faults and performance failures.*

H) weapon type involved (full technical name);

I) batch, lot and/or serial number of the ammunition involved;

J) brief description of accident;

K) weather conditions; and

L) action taken by user unit.

8 Actions by user unit (LEVEL 1)

The unit using the ammunition should take the following actions in the event of an ammunition accident/incident:

A) cease firing;

B) give immediate first aid to any injured personnel. In the case of fatal accidents, bodies should not be touched except to confirm death. Out of respect, bodies should be covered until they can be removed from the scene;

C) summon medical assistance if required;

D) cordon off the area to preserve evidence for the investigating authority. Nothing should be moved and everything should remain as it is in situ;[6]

E) record the names of potential witnesses;

F) make safe the individual weapon involved and secure it for the investigating authority. The weapon should only be touched if there is a requirement to make it safe to prevent further injuries;

G) if RF hazards are a potential cause, take immediate action to characterize the RF environment (IATG 5.60 provides further detail); and

H) immediately report the ammunition incident in accordance with the instructions developed as a result of Clause 7 and wait for further guidance from the nominated technical investigator.

Firing may recommence before the arrival of the investigating authority provided there have been no injuries, a different lot, batch or type of ammunition or explosive is used and the scene of the incident remains undisturbed.

9 Actions of the technical investigator (LEVEL 1)

The technical investigator appointed by the investigating authority should:

A) examine the scene of the ammunition accident;

B) examine any weapon involved;[7]

C) visually inspect any pieces of the ammunition involved;

D) recover any pieces of the ammunition that was involved for further technical investigation or destroy, after consultation with the appropriate technical authority, if unsafe to move;

[6] Photographs should be taken prior to moving the casualty for medical treatment if at all possible.

[7] The support of a specialist armourer may be needed to determine that performance failure is not the fault of the weapon.

E) examine other ammunition of the same type, and lot, batch or serial number being used at the same time;

F) question any appropriate witnesses;

G) make an initial technical appraisal of the cause of the ammunition accident and recommend any appropriate bans or constraints to the investigating authority;

H) if appropriate, impose an immediate local ban on the use of the ammunition (by lot, batch or serial number) involved in the ammunition accident; and

I) submit a written ammunition accident report to the investigating authority in the appropriate format.

The ammunition accident should be investigated in accordance with this IATG module.

It is not the job of the Technical Investigator to attribute blame or negligence to any individual.

10 Classification of incidents

The severity of an incident should be classified in accordance with the guidance at Table 1. Any incident in which a munition 'functions' other than in design mode, and as intended by the operator, should be subject to a formal investigation and is to be classified as at least a major accident, irrespective of any lack of injury or damage. This is, technically, also a performance failure but the potential for further incidents of this type means that it shall be investigated as an accident rather than as a performance failure.

Category	Definition for Explosives Incidents
Fatal (personnel) **Critical (equipment)**	An occurrence involving ammunition which causes one or more of the following: ▪ A fatality or severe injuries resulting in long term illness or disability to military personnel or members of the public. ▪ Extensive loss, damage to, or contamination of military or civilian equipment or property at multiple facilities, or to the environment.
Major	An occurrence involving an ammunition which causes one or more of the following: ▪ Severe injuries resulting in hospital treatment to military personnel or members of the public. ▪ Loss, damage to, or contamination of the munition or explosive, or to military or civilian equipment or property at a single facility.
Serious	An occurrence involving ammunition which causes one or more of the following: ▪ Injury requiring medical treatment and time off work but which does not require hospital treatment. ▪ Minor loss, damage to the munition or explosive or minor contamination of, military or civilian equipment, property, or the environment.
Minor	An occurrence involving ammunition which causes one or more of the following: ▪ An injury or illness to military personnel or members of the public. ▪ Cosmetic damage to ammunition not affecting performance or safety.
Near Miss	An occurrence, or potential occurrence, involving ammunition, or an occurrence potentially involving ammunition, which could have caused: ▪ Damage to the ammunition. ▪ Damage to, or contamination of, military or civilian equipment, property or the environment. ▪ Injury to, or illness of, military personnel or members of the public. ▪ Threat to the structural integrity of, or to cause damage to, military or civilian equipment, property or the environment. ▪ Free From Explosives (FFE) Violation.

Category	Definition for Explosives Incidents
Negligent Discharge[8]	A discharge of small arms ammunition (SAA) up to and including 14.5mm calibre[9] from a weapon as a result of preventable human failing, where no injury or damage has occurred and the weapon and munition performed to the designed specification.
Free From Explosive (FFE) Violation	The discovery of ammunition item(s) within containers that have been certified FFE.

Table 1: Classification of ammunition incidents

11 Advice and assistance from, and cooperation with, other agencies

By definition, the Technical Investigator is qualified to make a technical judgement on whether the explosives may have caused the accident, contributed to the accident occurring or contributed to the consequences of the accident. However, in a complex situation where other factors may have contributed to the accident, additional specialist assistance may be essential in determining the true events.

Accidents involving the firing of ammunition in weapons are commonly reported as an ammunition accident even though in the final analysis the weapon, or the user, is found to be at fault. Care is therefore to be taken to ensure that the investigation covers both the weapon and the ammunition. Whenever possible, investigations should be undertaken jointly with an experienced weapon system specialist.[10] This ensures the best knowledge and experience available are brought to bear to establish the factual evidence and relevant details are not overlooked.

Additional specialist assistance could include:

A) more experienced technical investigators;

B) ammunition and weapon system designers;

C) explosive chemists;

D) forensic scientists

E) technical specialists when RF hazards are a potential cause;

F) weapon system specialists, (including gunnery instructors); and

G) police and/or military police.

These specialists may also be required to present reports and evidence in a subsequent legal process, therefore it is important that the Technical Investigator works with them to produce a co-ordinated and factual report.

The need to cooperate with investigators from other agencies, which may well have different terms of reference, powers and objectives, can pose a challenge to the statement in Section 4 "The Technical Investigator should determine what happened and why, and not attribute blame or negligence to any named individual." Nations, with their individual legal systems and standards, need to be aware of and address this challenge.

[8] Some countries use the term Accidental Discharge until such time as investigation has eliminated ammunition defects and weapon faults as potential causes.

[9] Up to and including 14.5mm calibre has been selected as these weapons are usually manually as opposed to system operated.

[10] Armourers for small arms and light weapons.

12 Evidence

The Technical Investigator should not be constrained into only looking at the evidence that can be seen at the scene. The course of events immediately prior to the accident shall always be investigated. Many serious accidents are preceded by a stoppage or misfire, therefore the sequence and cause of these stoppages or misfires and the drill taken to resolve them often lead to a better understanding of the cause of the accident.

12.1 Witness evidence

Eyewitness evidence is often the most important type of evidence available in establishing the actions and procedures being used immediately prior to the incident. Technical Investigators should therefore:

A) make it clear from the start of the interview that the Technical Investigator is there primarily to ascertain the cause of the incident and not to apportion blame;

B) interview witnesses, as soon as possible after the event, while due regard is given to the effects of shock on the personnel involved. Shock can eliminate all memory of events immediately before the accident. Any lapse of time before a witness is questioned may well result in speculation on the cause, thus leading to inaccurate evidence being given without deliberate intent. An examination of the factual evidence visually available may well enable the investigator to spot such inaccuracies immediately; and

C) consider the credibility of the information being given by the witness. If the information is in conflict with the facts, or does not fit into place, this shall be taken into account when compiling the final report.

Witnesses are not necessarily infallible and can sometimes have their own agenda, including a perceived need to defend their part in the accident: Eyewitnesses of ammunition accidents and incidents during storage, transportation, operations and firing ranges are generally from the same group of people. They may have common interests and sympathy for their comrades, which may tempt them to speak defensively in order to reduce any impact on their colleagues. This is a common human behaviour that the technical investigator should be aware of. Even should neutral eyewitnesses be found, they are mostly laypersons and their evidence may not contain the technical level of information necessary to resolve the cause of the incident or accident. Technical investigators should use their professional skills, (analysis of material and forensic evidence, technical knowledge, knowledge of previous accidents etc), to identify the likely cause of the accident or incident

12.2 Collection of forensic evidence

Evidence recovered from the scene is most valuable and will assist the technical investigator to determine the cause of the accident. Although the immediate priorities after an incident are to treat the injured, deal with the immediate emergency and make the workplace safe, care shall be taken to avoid the destruction of any evidence that may be required during investigation. The Technical Investigator should therefore:

a) first determine whether any evidence has been disturbed or removed prior to his/her arrival so that the positioning of items in relation to the incident can be properly established;

b) ensure that the area of the incident is cordoned off to prevent the removal of evidence. Where evidence is scattered over a wide area, or other agencies are on scene, a common approach path shall be established to prevent evidence being destroyed; and

c) where applicable, search the area to ensure that all available evidence is located. The position of each item in relation to the incident must be noted before it is collected.

12.3 Preservation of forensic evidence

The Technical Investigator shall always be aware of the need to preserve forensic evidence. This need may arise from the need for further technical investigation or for use in other investigations. Due regard should be given to the continuity of evidence.[11]

Where evidence is retained by another agency, details shall be included in the report and photographs obtained of what has been retained, by whom, where and their contact details.

Where evidence is to be collected and passed on by the Technical Investigator it shall be bagged and marked to show the details of the accident, the date and a unique serial number.

12.4 Photographic evidence

Photographic evidence is invaluable and should accompany a report whenever possible. Consider pictures of the scene from all angles with posts to show positions of witnesses and other items. A ruler positioned next to small items gives a good idea of scale.

12.5 Comparison firing evidence

A comparison firing of the same ammunition, but of a different lot or batch number, using the same weapon, may give valuable information on whether ammunition production or the weapon may be the cause of the incident.

12.6 X-Ray evidence

Where X-ray equipment is available it may be used to, for example: 1) establish the contents of the ammunition if it is not marked; and 2) establish the condition of mechanical fuzes.

13 Initial investigation actions

13.1 Safety and casualty handling

On arrival at the incident location, the Technical Investigator should first try to get a quick picture of the whole scene before starting the detailed investigation. Priority for action is safety and casualties, but any ammunition and explosives remaining at the scene shall be made safe.

Casualties shall be treated and removed and their positions at the scene noted. Similarly, bodies are a source of evidence and should initially remain at the scene until a doctor has examined them and preliminary investigations are complete. Due regard shall be given to covering the body with a suitable cover.

13.2 Immediate bans and constraints

For incidents involving small arms ammunition (SAA), the Technical Investigator should make an immediate assessment of whether the ammunition is safe to continue being used so as not to disrupt training or operations. If there is no doubt about safety the unit may continue using the ammunition. If there are any indications that continued use of the ammunition could put the user at risk, then a local ban shall be imposed (see IATG 01.70 *Bans and constraints*). This may be the whole stock of the involved nature or just the particular lot number involved. If in doubt, the Technical Investigator

[11] Continuity of evidence is a concept that ensures a formally documented continuity of possession, and proof of integrity of evidence collected. It establishes each person having custody or being in possession of the evidence at each point of the forensic chain.

shall ban the ammunition. This information should be passed to the relevant technical authority to consider if a total ban in accordance with IATG 01.70 *Bans and constraints* should be implemented.

If a local ban is imposed, the Technical Investigator shall explain what actions are needed. The affected ammunition should be segregated in store and appropriately marked.

13.3 Accidental discharges

A Accidental Discharge is a term that is only used with small arms ammunition (SAA) up to and including 14.5 mm in calibre. An Accidental Discharge is deemed to have occurred when:

A) the initiation of the SAA is unauthorised and unintentional or inadvertent;

B) no death, injury or damage to equipment or property is to have occurred; and

C) the weapon and ammunition performed to the designed specification.

If any death, injury or damage has occurred, no matter how minor, or the weapon was found to be at fault, the incident shall be reported as an ammunition accident.

Although the cause of an Accidental Discharge is normally human error, it is still important to report all such occurrences. What may be a ‘one-off’ to an individual unit may be one of many more occurrences elsewhere. If a large number of Accidental Discharges occur in a similar fashion it may indicate a design fault with the weapon, an error in the drills or possibly a training weakness in the case of an error of drill.

14 Further investigation actions

14.1 Checklist

After the initial investigation, the investigation should proceed in accordance with the checklist at Table 2. It is intended as a guideline to supporting further investigation, which should follow this generic sequence:

A) establish at an early stage whether immediate action is needed, such as banning further firing;

B) gather key facts about the event and circumstances surrounding it by interviewing witnesses before their recollection of events alters;

C) gather all necessary physical evidence; and

D) identify and secure key documents (i.e. recent inspection records, training records etc).

REQUIREMENT	CHECK
Obtain basic facts	
▪ Record the names of the injured people / witnesses / people first to the scene.	
▪ Record details of place, time and conditions of the accident.	
▪ Record full details of the ammunition, including exact type, lot, batch or serial number.	
▪ Record substances in use or present (this may just be the explosives involved but could also include other substances such as inflammable cleaners).	
▪ Check that the ammunition was not subject to any bans or constraints.	
▪ Record the quantities of ammunition issued, total fired and, where applicable, that fired through the weapon involved in the accident, any defective and any remaining stock.	
▪ The remaining stock is to be inspected for visible faults.	

REQUIREMENT	CHECK
▪ Record the layout of the area – a sketch will be useful. If possible photographs should be taken.	
▪ Verify the condition of any plant or equipment involved - eg under maintenance, in operation etc.	
Establish circumstances	
▪ What was being done at the time and what happened?	
▪ What were the immediate causes of the incident?	
▪ What were the events leading up to the incident?	
▪ Verify health of individuals prior to accident. Required in order to consider if tiredness or ill health could have been a contributing factor.	
▪ Competence. What instructions and training were given before the event and how much experience in the job did the people involved (including managers and supervisors) have?	
▪ What were the established methods of work and procedures? Were up to date work instructions in use?	
▪ In what way could the behaviour and actions of individuals have influenced the accident?	
▪ What supervision was in place – how effective was it?	
▪ Has something similar happened (or nearly happened) before?	
▪ Identify the preventive measures – did they operate correctly?	
Assess or reassess the risk	
▪ Question the adequacy of existing physical safeguards and work methods.	
▪ Reappraise the intended safeguards and work methods – do they satisfy the intentions of the explosives safety policy, do they meet the appropriate national standards or other authoritative guidance?	
Establish whether initial management response was adequate	
▪ Was the initial reaction adequate?	
▪ Was prompt and appropriate action taken such as: 1) making safe and dealing with any continuing risks; 2) electrical isolation; 3) suitable fire fighting; and 4) effective first-aid response?	
Identify the underlying causes (*Possibilities follow***)**	
▪ *Management or supervision failure?*	
▪ *Lack of competence?*	
▪ *Inadequate or incorrect training?*	
▪ *Shortcomings in original design?*	
▪ *Inadequate performance standards?*	
▪ *Absence of an adequate system for maintenance?*	
Determine action needed to prevent a recurrence (*Possibilities follow***)**	
▪ *Improve physical safeguards?*	
▪ *Use mechanical handling aids?*	
▪ *Introduce better test and maintenance arrangements?*	
▪ *Improve work methods?*	
▪ *Provide and use personal protective equipment?*	
▪ *Make changes to supervision and training arrangements?*	
▪ *Review similar risks in other departments?*	
▪ *Set up a system to assess the risks from new plant and substances at the planning stage?*	
▪ *Review procedures involving contractors?*	
▪ *Update standards and policies?*	
Does the national authority need to (*Possibilities follow***)**	

REQUIREMENT	CHECK
▪ *Identify underlying causes and corrective action?*	
▪ *Implement follow -up action promptly?*	
▪ *Check that follow-up action has been taken?*	
▪ *Analyse data systematically to identify trends and features?*	

Table 2: Ammunition Incident Investigation Checklist

14.2 Detailed questions

The purpose of this sub-clause is to provide guidance on the more detailed questions that need to be asked in investigating an incident. Not all of the questions will be relevant to all incidents.

14.2.1 Ammunition

Table 3 suggests a range of questions relating to the ammunition that may be applicable to ammunition incident investigations.

QUESTION	CHECK
▪ Was the ammunition subject to any bans, constraints or limitations in use at the time of the accident? Were they being followed?	
▪ Are there any known faults or defects with the ammunition?	
▪ Were any faults found with the remaining or unfired stock?	
▪ Were any faults found with the previously fired or affected stock?	
▪ Where applicable, was the ammunition assembled correctly? Were any problems experienced with assembly? Were all the correct components used? Were fuze settings correct?	
▪ Was there any evidence of modification? Was any modification authorised? Where is the modification laid down?	
▪ Was there any evidence of tampering?	
▪ Was any difficulty experienced in chambering or loading of the ammunition? Is there any evidence to suggest the item had not chambered properly? Is there any evidence to suggest a double feed?	
▪ How long had the ammunition been loaded into the weapon prior to the accident?	
▪ How many rounds had been fired without problems prior to the accident? How many rounds were fired without problem after the accident?	
▪ Had there been any stoppages prior to the accident? What was done to rectify the problem?	
▪ Is the damage pattern consistent with any known defect or fault?	
▪ Had the primer or cap been struck? Did it misfire? Was it well struck or lightly struck? Had more than one attempt been made to fire?	
▪ Did the propulsion seem normal when compared to other firings? Is there any evidence of incomplete burning of propellants? Is there any evidence of late functioning of the propellant?	
▪ Was the muzzle flash different compared to other firings?	
▪ Was the recoil abnormal?	
▪ Was the sound of firing different?	
▪ Was the flight normal?	
▪ Was the safety pin removed correctly? Was it difficult to do so? Did it break when removed?	
▪ Did the fly-off lever function as intended? Did the spring reassert itself correctly?	
▪ Was the electrical continuity checked prior to use? Was the electrical continuity checked after use?	
▪ Were there any radio frequency (RF) hazards in the area? What precautions were being taken?	
▪ For igniferous fuses, were the rates of burning within acceptable limits? Did the fuse burn through to the end? Were there any signs of flash through?	

QUESTION	CHECK
▪ When issued, what type of packaging was the ammunition in? Was it unsealed or temporary sealed? Was it damaged in any way?	
▪ Prior to issue, how had the ammunition been stored? Had it been under temporary cover prior to the accident? Had it been carried by the firer in pouches or back packs?	
▪ How had the ammunition been transported to the area? Had it been subjected to excessive movement or rough handling?	
▪ What conditions had the ammunition been through? Had it been subjected to extreme conditions?	

Table 3: Ammunition Incident Investigation – Ammunition Related Questions

14.2.2 Weapon system

Table 4 suggests a range of questions relating to the weapon system that may be applicable to ammunition incident investigations.

QUESTION	CHECK
▪ Was the weapon subject to any limitations in use at the time of the accident? Were the limitations being enforced?	
▪ When was the weapon last formerly inspected?	
▪ Were there any known faults or defects with the weapon type? Were any faults found with the weapon?	
▪ Was there any evidence of wear in the weapon?	
▪ Was the damage consistent with known defects or faults in the weapon?	
▪ When was the weapon last cleaned? Was it prepared for firing? Was it cleaned between firings? Was there any evidence of fouling?	
▪ Was there any evidence of sand, dirt or water in the weapon?	
▪ Was there any evidence of un-burnt propellant in the weapon?	
▪ Had the weapon been correctly assembled? Were the correct fittings used?	
▪ Had the weapon been modified in any way? Was it authorised?	
▪ Was there any evidence of tampering?	
▪ Was the round power rammed?	
▪ Was any problem experienced in chambering or loading?	
▪ Was there any evidence of double loading?	
▪ How many rounds had been fired through the weapon prior to the accident?	
▪ Were there any previous stoppages? Were they caused by the weapon? What did the firer do to clear the weapon?	
▪ Was there any evidence of hard extraction?	
▪ Were any rounds fired through the weapon after the accident?	
▪ What rates of fire were being used? Were they excessive?	
▪ Had the weapon been subjected to extreme temperatures?	
▪ Had the weapon been used in extreme conditions?	
▪ Was the muzzle flash different?	
▪ Was the recoil abnormal?	
▪ Was the sound of firing different?	
▪ How many other weapons of the same type were being used? Did they experience any faults with them?	

Table 4: Ammunition Incident Investigation – Weapons System Related Questions

14.2.3 Drills and procedures

Table 5 suggests a range of questions relating to the drills and procedures used that may be applicable to ammunition incident investigations.

QUESTION	CHECK
▪ Where are the drills or procedures laid down?	
▪ Does the unit hold copies of the relevant publications? Are they up to date and fully amended?	
▪ Was the correct drill or procedure being followed? If not, what drill or procedure was being used?	
▪ What commands were given?	
▪ Were they as laid down in the publication?	
▪ Had any other drill or procedure been demonstrated or taught? If so, when, why and upon whose authority?	
▪ Were the weapon settings correct? Were they checked?	
▪ Was there any evidence of inappropriate behaviour?	

Table 5: Ammunition Incident Investigation – Drills and Procedures Related Questions

14.2.4 Qualifications and authorization

QUESTION	CHECK
▪ Was the firer qualified to use the weapon?	
▪ Was the firer under instruction or supervision?	
▪ Was the loading of the weapon authorised?	
▪ Was the firing of the weapon authorised?	

Table 6: Ammunition Incident Investigation – Qualification and Authorization Related Questions

14.2.5 Skills and experience

QUESTION	CHECK
▪ What qualifications did the user have allowing them to be carrying out the activity which led to the incident?	
▪ How often had the firer handled the weapon or munition?	
▪ What previous experience did the firer have?	
▪ Is it the firer’s personal weapon? Was the firer issued it for a particular role?	
▪ When was the last time the firer had used the weapon or ammunition?	
▪ Had refresher training been carried out?	
▪ Were the range staff competent in the weapon or ammunition? What experience had they?	
▪ When was the last time the range staff used the weapon or ammunition?	

Table 7: Ammunition Incident Investigation – Skills and Experience Related Questions

14.2.6 Circumstances and conditions

QUESTION	CHECK
▪ Under what climatic conditions was the ammunition being used? Wet or dry? Hot or cold?	
▪ Any extremes of conditions?	
▪ Was the ammunition authorised for use in the climatic conditions?	
▪ What were the weather conditions like?	

QUESTION	CHECK
▪ Was it day or night? What were the light conditions? Was artificial light being used?	
▪ What was the type of terrain, flat, mountainous, wooded, built up, desert?	
▪ What was the condition of the area, stony, sandy, muddy or icy?	
▪ Had the weather made conditions worse?	
▪ Did local vegetation get in the way? Were there any overhanging branches?	
▪ Was there any wildlife in the area? Did the wildlife interfere?	
▪ Was the person on duty? How long for? Was he/she under pressure of any sort?	
▪ What was the condition of the range? When was it last inspected? Were there any faults with it?	
▪ Was he/she suffering from worry, stress, illness or fatigue? Were there other problems?	

Table 8: Ammunition Incident Investigation – Circumstance and Conditions Related Questions

14.2.7 Trials

QUESTION	CHECK
▪ What was the aim of the trial?	
▪ Was the trial process adequately defined?	
▪ Was the risk assessment adequate?	
▪ Were appropriate control measures in place taking account of the risks identified in the risk assessment?	
▪ Were the weapon / ammunition under development?	
▪ Was the range authorised for this activity?	
▪ Had a danger area template been established for the weapon and ammunition type?	
▪ Did the accident occur within the danger area template?	

Table 9: Ammunition Incident Investigation – Trials Related Questions

15 Reporting

The Technical Investigator should submit a full technical report to the appropriate national authority as soon as possible. Preliminary reports should be submitted if there is a need for urgent action to immediately improve safety.

Confidentiality during the whole reporting process shall be maintained, as the technical investigation and it results may form part of potential future legal processes.

Annex A
(normative)
References

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

IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[12] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[12] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this module:

a) IATG 01.70 *Bans and constraints.* UNODA;

b) IATG 07.10 *Surveillance and in-service proof*. UNODA.

c) DSA03.OME part 2 provides for the safe storage and processing of Ordnance, Munitions and Explosives (OME). UK MOD. November 2020;[13] and

d) NATO AC/326 Subgroup C document, *Procedures for the Collection, Analysis, and Interpretation of Explosion-Produced Debris - Revision 1*, 27 May 2008 (currently being revised)

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[14] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[13] Used extensively as a source document for information.

[14] Where copyright permits.

Annex C
(informative)
Example Cause and Closure Codes[15]

Table C.1 contains an example system of Cause and Closure Codes that Investigating Authorities may use to promulgate the results of technical investigations and as a simple reference system for the conventional ammunition stockpile management system.

More than one cause or closure code may be awarded to an incident, and the code may be changed as more evidence becomes available during the technical investigation.

Cause or Closure Code	Description	Remarks
0	Open – Under Investigation	
0A	Not Known – Ammunition item not available for examination	
0B	Not Known – Cause can not be identified with available evidence	
0C	Not Known – Cause can not be identified with available evidence, but ammunition item is suspected	
0D	Not Known – Not investigated as Fault or Performance Failure within Acceptable Limits	
0E	Not Known – Cancelled – Re-categorized	
0F	Not Known – Cancelled	
0G	Not Known – Fault or Performance Failure not related to ammunition item, weapon or drill	
1A	Storage – Army Depot	
1B	Storage – Army Unit	
1C	Storage – Field or Emergency	
1D	Storage – On Range	
1E	Storage – On Navy Vessel	
1F	Storage – Navy Depot	
1G	Storage – Transit by Road / Rail/ Air / Sea Stationary Parked	
1H	Storage – Temporary Authorised Location	
1J	Storage – Air Force Depot	
1K	Storage – Air Force Unit	
1L	Storage – Other	Specify on report.
2A	Handling – Mechanical Handling Equipment – Accident	
2B	Handling – Mechanical Handling Equipment – Negligent	
2C	Handling – Manual Handling – Accident	
2D	Handling – Manual Handling – Negligent	
2E	Transportation – Road	
2F	Transportation – Rail	
2G	Transportation – Sea	
2H	Transportation – Air	
2J	Handling – Air Dropped	
2K	Transportation – Cross Country	
2L	Handling – Cause Not Known	
2M	Handling – User Negligent	
2N	Handling – Crane or Overhead Gantry	
2O	Handling – Vertical (VERTRAS) or At Sea (RAS) Replenishment	
2P	Handling – Other	Specify on report.
2Q	Handling – Loading on/off Operating Aircraft	
3A	Design – Ammunition Item Design Fault	
3B	Design – Ammunition Packaging Fault	
3C	Design – Equipment (Ammunition not at fault)	
3D	Design – Range Construction or Maintenance	
3E	Design – Range Construction or Maintenance Suspected	
3F	Design – Inert Component	
3G	Design – Other	Specify on report.

[15] These example Clause and Closure Codes are also contained as an Annex to IATG 01.60 *Ammunition faults and performance failures* to allow for consistency in use.

Cause or Closure Code	Description	Remarks
4A	Tampering – Malicious (Military)	
4B	Tampering – Malicious (Civilian)	
4C	Tampering – Prank (Military)	
4D	Tampering – Prank (Civilian)	
4E	Tampering – Experimental / Curiosity (Military)	
4F	Tampering - Experimental / Curiosity (Civilian)	
4G	Tampering – No evidence to assign other closure code	
4H	Tampering – Other	Specify on report.
5A	Error of Drill – Ammunition Loading / Unloading / Firing	
5B	Error of Drill – Ammunition Handling	
5C	Error of Drill – Equipment	
5D	Error of Drill – Negligent Discharge	
5E	Error of Drill – Incorrect Instruction(s)	
5F	Error of Drill – Malicious	
5G	Error of Drill – Prank	
5H	Error IN Drill	
5J	Error of Drill – Miscellaneous	
5K	Error of Drill – Negligent Supervision	
6A	Equipment / Platform Only Failure – Broken / Damaged / Unserviceable	
6B	Equipment / Platform Only Failure – Poor Maintenance	
6C	Equipment / Platform Only Failure – Ingress of Water / Moisture	
6D	Equipment / Platform Only Failure – Ingress of Dirt / Grit	
6E	Equipment / Platform Only Failure – Design	
6F	Equipment / Platform Only Failure – Production by Manufacturer	
6G	Equipment / Platform Only Failure – Cause Not Known	
6H	Equipment / Platform Failure – Small Calibre Trapped Link	Chain Guns.
6J	Equipment / Platform Failure – Firing Circuit	
6K	Equipment / Platform Failure – Maintenance Error	
7A	Production – Ammunition Item Fault (Not Design)	
7B	Production – Ammunition Packaging Fault (Not Design)	
7C	Production – Incorrect or Temporary Ammunition Packaging	
7D	Production – Inert Component Fault	
7E	Certified Free From Explosive (FFE) Violation	
8A	Defect Points	
8B	Packaging	
8C	Track Spread	
8D	Split Points	
8E	Spread Points	
8F	Missile / Torpedo / Guided Weapon – Guidance Failure	
8G	Missile / Torpedo / Guided Weapon – Hardware / Software Failure	
8H	Missile / Torpedo / Guided Weapon – In Flight / Run Failure	
8J	Missile / Torpedo / Guided Weapon – Explosive Component Failure	
8K	Missile / Torpedo / Guided Weapon – Test Failure	
9A	In Service Deterioration – Beyond Design Shelf / Service Life	
9B	In Service Deterioration – Approaching Design Shelf / Service Life	
9C	In Service Deterioration – Packaging Open and Ammunition Returned	By user unit.
9D	In Service Deterioration – Prolonged Use / Handling by Unit	
9E	In Service Deterioration – No Cause Known	
9F	In Service Deterioration – Prolonged Exposure to Unprescribed Climatic Conditions	
10A	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Planning Activities	
10B	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Supervision	
10C	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Firing	
10D	Unauthorised – Incident/Accident/Performance Failure caused by Unauthorised Other	Specify on report.
Z1	Provisionally Closed – Awaiting Legal Judgement	
Z2	Provisionally Closed – Awaiting Full Written Report	Verbal report only received.

Table C.1: Example Cause or Closure Codes

Annex D
(informative)
Example Ammunition Incident Reporting Form

Ammunition Accident/Incident Reporting Form			
Serial			**IATG Form 11.10 / 01.60**
1	**Person reporting the accident**		
1.1		Name:	
1.2		Rank / Appointment:	
1.3		Unit:	
1.4		Unit Address:	
1.5		Unit Telephone Number:	
2	**Accident details:**		
2.1		Date:	
2.2		Time:	
2.3		Location:	
2.4		Point of Contact *(if different from Serial 1)*	
2.5		Ammunition Type *(including Batch Key Identity)*	
2.6		Fatalities	
2.7		Injuries	
2.8		Weapon Type	
2.9		Weapon Damage	
3	**Action taken by unit**		
3.1		Firing stopped	
3.2		Ammunition of same type isolated	
3.3		Forensic evidence secured	
3.4		Any other information	
4	**Other agencies informed**		
4.1		Service Police	
4.2		Civilian Police	
4.3		Others	

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 11.20

Third edition
March 2021

Ammunition storage area explosions – EOD clearance

UN SaferGuard
Securing ammunition, protecting lives

IATG 11.20:2021[E]

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

WARNING

The clearance of an Ammunition Storage Area that has undergone an unplanned explosive event carries significant risk.

This operation shall only be conducted by suitably qualified and experienced personnel.

The personnel involved in the planning and conduct of such a clearance operation require a technical understanding of the ammunition involved **and** knowledge of appropriate EOD techniques.

The principles and guidance within the IATG and IMAS shall be utilized to formulate a suitable clearance plan

Introduction

It is widely acknowledged that a physical risk exists to individuals and communities from the presence of abandoned, damaged or inappropriately stored and managed stockpiles of ammunition and explosives.

Inadequate or inappropriate stockpile management increases the probability of accidental explosions at ammunition storage areas. A database of such events shows that these events are a global problem, and that a single explosive event can result in dozens of casualties and millions of dollars in damages to nearby buildings, infrastructure, and homes.[3] Research indicates that these incidents are widespread and increasingly common: between 1979 and 2019, there were more than 623 incidents in at least 106 countries and territories.[4] The majority of these may have been preventable with even very limited implementation of effective stockpile management policies and procedures[5]. Whilst other IATG modules provide guidelines for the safety, security and destruction of ammunition and explosives; this IATG concentrates on the management and techniques of the explosive ordnance disposal (EOD) clearance operation once an undesirable explosive event has resulted.

The present set of specifications and guidelines for the Explosive Ordnance Disposal (EOD) clearance of ammunition storage explosions is also included in the International Mine Action Standards (IMAS) as IMAS 09.12.[6] Future updates of IATG 11.20 and IMAS 09.12 will therefore be undertaken in a coordinated manner.

There are a number of examples in the recent past where the post-explosive clearance of ammunition storage areas have been based primarily on 'demining' standing operating procedures (SOP). Whilst this may seem a practical step at the outset, in real terms it is not particularly efficient, or at times even safe. The threat is different, the clearance options much wider, and further technical knowledge is required than that needed for mine and unexploded ordnance (UXO) clearance.[7]

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[3] Small Arms Survey. N.d. Unplanned Explosions at Munitions Sites (UEMS) Database. Accessed Sep 2020. Geneva: Small Arms Survey. Available at http://www.smallarmssurvey.org/weapons-and-markets/stockpiles/unplanned-explosions-at-munitions-sites.html

[4] Small Arms Survey. N.d. Unplanned Explosions at Munitions Sites (UEMS) Database. Accessed Sep 2020. Geneva: Small Arms Survey. Available at http://www.smallarmssurvey.org/weapons-and-markets/stockpiles/unplanned-explosions-at-munitions-sites.html

[5] Berman, Eric G. and Pilar Reina, eds. 2014. Unplanned Explosions at Munitions Sites (UEMS): Excess Stockpiles as Liabilities Rather than Assets. Handbook. Geneva: Small Arms Survey

[6] United Nations, International Mine Action Standards 09.12, EOD clearance of ammunition storage explosions, First Edition Amendment 1, 29 January 2020

[7] This is not to suggest safe clearance operations have not taken place. However, it is unlikely that they were as effective and efficient as possible in terms of operational and explosive efficiency. Effectiveness and efficiency can be improved by the application of ammunition technology and explosive engineering knowledge, combined with planning operations based on first principles. Techniques such as 'rotary kiln furnaces', hydro-abrasive cutting at the logistic level; pollution control systems to international best practices, contained demolition chambers, etc all have the potential to improve clearance efficiency at an ammunition depot explosion beyond 'normal' mine and UXO clearance procedures.

Ammunition storage area explosions – EOD clearance

1 Scope

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

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

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply:

The term 'national authority' refers to *the government department(s), organisation(s) or institution(s) in each country charged with the regulation, management and co-ordination of SALW activities*.

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

The term 'ammunition' (or munition) *is used to refer to a complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions.*[8]

The term "Non-technical Survey" (NTS) refers to the collection and analysis of data, without the use of technical interventions, about the presence, type, distribution and surrounding environment of explosive ordnance (EO) contamination, in order to define better where EO contamination is present, and where it is not, and to support land release prioritisation and decision-making processes through the provision of evidence.

NOTE 1 In common usage, 'munitions' (plural) can be military weapons, ammunition and equipment.

In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

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[8] AAP-6 (Edition 2016), *NATO Glossary of Terms and Definitions*. NATO Standardization Office (NSO).

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Hazards and risks

4.1 In storage

It is an unfortunate fact that ammunition and explosive storage can never be 100% safe in terms of the 'absence of risk', and the best that can be achieved is 'tolerable risk'.[9] This can only be achieved by a wide range of technical responses that are explained in the other IATG modules. It is appropriate, however, to highlight that in terms of national ammunition stockpiles the hazard is the physical presence of the ammunition and explosives, whereas the risk is primarily dependent on:

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

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

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

D) the storage infrastructure and environment.

The concept of tolerable risk can only be achieved if the ammunition management systems and storage infrastructure are to appropriate standards or in accordance with good practices. Past desk studies[10] by the Geneva International Centre for Humanitarian Demining (GICHD), supplemented by further research, initially identified a significant number of recent explosive events that have occurred due to inappropriate storage or explosive safety procedures.[11] These studies clearly indicate that a physical risk exists for communities from the presence of abandoned, damaged or inappropriately stored and managed stockpiles of ammunition and explosives.

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

A) deterioration of the physical or chemical condition of the ammunition and explosives.

B) unsafe storage practices and infrastructure;

C) unsafe handling and transport practices;

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

E) deliberate sabotage.

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

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

[10] *Explosive Remnants of War (ERW) - Undesirable Explosive Events in Ammunition Storage Areas*, ISBN 2-88487-006-7, GICHD, Geneva, November 2002; *Undesirable Explosive Events in Ammunition Storage Areas*, SEESAC, 2002 – 2007; *Undesirable Explosive Events in Ammunition Storage Areas*, Explosive Capabilities Limited, 2008 – 2011, UEMS 2012 – To Date.

[11] There is absolutely no intention on the part of the authors to allocate or imply blame for any of the explosive events referred to in this paper; indeed, the States involved should be congratulated on their transparency in allowing lessons to be learned from these unfortunate events.

complicates impartiality, independence of investigation and can lead to a reluctance to allocate responsibility.

4.2 Post explosion

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

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

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

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

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

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

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

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

H) the ammunition that has been involved in the explosion, but did not deflagrate or detonate, will be very susceptible to the weather; risks will increase significantly during lightning storms and further explosive events initiated by lightning strikes may occur. UV radiation can quickly change the appearance of exposed munitions, obscuring or eliminating key identification features, coloured bands, etc.;

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

J) subsequent bad weather may have led to flooding and mud slides covering up ammunition and UXO; and K)exposed and scattered explosive fillers may contaminate surface and subsurface water. Water may become coloured due to explosive contamination (e.g. 'pink water' for TNT and its breakdown products). Most explosives show both acute and long-term toxicity to humans; for example, people exposed to TNT over a prolonged period tend to experience anemia and abnormal liver functions. Personal protective equipment (PPE) (face masks and protective gloves) may therefore be required when collecting explosives that have been pulverized during an explosion, as will a thorough clean-down procedure. Care must be taken when collecting bare explosive residues as they will invariably be contaminated with foreign particles such as dirt, soil or sand and hence show a significantly higher friction and impact sensitiveness than pure explosives (grit sensitization).

5 Impact and effects

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

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

There are also economic costs in terms of the capital value of the stockpile itself; although this is really a factor for national consideration, the international donor community should be interested, as national finance for replacement stocks could potentially have been committed to social and economic development. Clearance principles

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

A) appropriate threat assessment;[12]

B) planning;

C) good training and technical education;

D) lessons identified from previous operational experience and competency standards;[13]

E) appropriate and effective operating procedures;

F) identification and use of appropriate equipment; and

G) use of Personal Protective Equipment as the 'last resort' safety measure against explosive ordnance hazards.[14]

6 Clearance requirements

The future land use of the ammunition depot involved in the undesired explosion shall be a key factor in determining the exact EOD clearance requirements, and hence the allocation of necessary resources. Future land use—ascertained through broad consultations, inclusive of men and women in the community—should determine the level of clearance required; for example, it would be inappropriate and wasteful in resources to clear the land to a depth of 2 metres if the land was going to be used for forestry. This is consistent with IMAS procedures[15] .

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

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

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

[15] IMAS 09.10 (Edition 2 Amendment 5) *Clearance requirements*. IMAS. June 2013

The specified area to be cleared shall be determined by a non-technical and/or technical survey or from other reliable information that establishes the extent of the hazard area. IMAS 08.10 for non-technical survey and IMAS 08.20 for technical survey can be consulted for guidance.

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

NOTE 1 The priorities for clearance shall be determined by the impact on the individual community balanced against national infrastructure priorities.

Therefore, the clearance requirements should be strategically developed based on; 1) the threat; and 2) future land use. It is very likely that 'surface clearance' may be appropriate for the majority of the land within the danger area radius, whereas sub-surface clearance would be appropriate for the 'crater' areas of the individual storage site[16] explosions. Once the clearance depth requirements have been formally established then the appropriate clearance methodology and technical equipment requirements may be established.

7 Development of EOD clearance methodology

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

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

- the identification of ammunition types, and possible instability or UXO risks;
- the identification of sub-surface risks; and
- an assessment of the UXO and ammunition density across the site and danger area radius (/m^2).

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

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

- effective and appropriate SOPs;
- resource requirements, (including protected heavy lift vehicles to gain access); and
- a training programme to meet SOPs.

D) the time taken for the EOD clearance will always be difficult to estimate due to the large number of variables. The matrix below at Table 1 may be of assistance,[17] as it is based on experience to date, although it will require updating as experience is gained on each operational task.

Ground Preparation Factor [18]						
Type of Terrain	Area (Ha)	Factor [19]	Man Days	Staff Available	Estimated Time (Days)	Remarks
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Short Grass	20	0	0	0	0.0	
Light Vegetation	5	10	50	10	5.0	
Dense Vegetation	5	30	150	14	10.7	Consider other techniques.
Search and Marking Factor						
Type of Search	Area (Ha)	Factor	Man Days	Staff Available	Estimated Time (Days)	Remarks

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

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

[18] This assumes that the ground is prepared by hand or with light mechanical systems. . Preparing the ground in a hazardous area by mechanical means could involve removing or reducing obstacles to clearance e.g. vegetation, soil and metal contamination to make subsequent EOD clearance operations quicker and safer.

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

	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Visual	26	1.3	33.8	20	1.7	
Metal Detector	4	2.5	10	4	2.5	Factor for Low Density UXO and ammunition contamination only to shallow depth =. For High Density UXO and ammunition contamination a much higher factor will need to be applied.
Destruction [20] / Recovery [21] Factor						
UXO / Ammunition Density[22]	**Area (Ha)**	**Factor [23]**	**Man Days**	**Staff Available**	**Estimated Time (Days)**	**Remarks**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Very Heavy (10.0/m^2)	2	180	360	10	36	
Heavy (5.0/m^2)	6	90	540	10	54	
Medium (1.0/m^2)	12	50	600	4	150	
Light (0.2/m^2)	10	10	100	4	25	
Estimated Task Clearance (Days)					**284.9**	

Table 1: Example of EOD clearance planning matrix

8 EOD clearance operation

9.1 EOD clearance process

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

A) establish the radius of the danger area[24] that requires EOD clearance;

B) grid the area from the outside to the inside, (consider the danger area and the ammunition storage area as separate clearance requirements);[25]

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

D) conduct marking operations using appropriately qualified ammunition personnel;[26] [27]

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

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

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

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

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

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

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

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

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

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

G) establish a 'Free From Explosive' (FFE) verification and scrap processing system, including a burning area to prove any scrap where explosive contamination may be present; and

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

9.2 Safe to Move (STM) inspections

9.2.1 STM certification – post explosion hazards (LEVEL 3)

The certification of ammunition that has been involved in an explosion will be complicated by some, or even all, of the following hazards:

A) ammunition may have been projected some distance from the explosion site, (e.g. there have been examples of free flight rockets travelling up to 20km). If the ammunition has been stored in a fuzed state, then it is very possible that the forces imparted to the ammunition during the explosion are similar to the forces required to arm the fuze. Normal evidence of firing such as driving band engravement etc will NOT be present. Therefore, all fuzed ammunition, either within or at any distance from the explosion site, shall be regarded as unexploded ordnance (UXO) and dealt with appropriately;
B) the explosive content of ammunition natures may be either partially or fully burnt out. If partially burnt out then there will be the normal hazards presented by exposed explosive. Additionally, there may be the hazards associated with melted explosives re-crystallising and forming undesirable, more sensitive isomers e.g. TNT;
C) ammunition may have been broken open leading to exposed explosives, electrical leads or sensitive components; and/or
D) propellant may not have burnt during the explosion and fires, therefore exposed propellant may be present. This may spontaneously ignite during EOD clearance operations or subsequent movement; such ignition will be dependent on the chemical condition of the propellant and the ambient temperature.
E) the filling and propellant may have become powderised due to being subjected to a blast. Even if the munition looks undamaged, the shockwave passing through may cause this. This can cause the filling or propellant to become more sensitive, thus presenting a new hazard.

The decision as to whether ammunition is STM post explosion shall only be taken by an individual deemed by the clearance organization to be a Level 5 Ammunition Inspector[28] or an IMAS Level 3+ (EOD) operator (Depot Explosions).[29] Due consideration should be given to the external stimuli experienced by the fuze during 'kick out' from the explosion(s). The movement by hand of fuzed ammunition post-explosion shall only be permitted if:

A) the Level 5 Ammunition Inspector or an IMAS Level 3+ (EOD) operator has personal knowledge of the fuze design and modus operandi, access to the technical drawings and is certain that the fuze can not be armed by the external stimuli it has experienced (for example an Electronic Time Fuze); or

B) should there be any doubts then diagnostic techniques such as X-Ray shall be used to determine the fuze condition of a statistically representative sample.

[28] See IATG 01.90 *Ammunition management personnel competences.*

[29] See Clause 4.2d to IMAS 09.30 *Explosive Ordnance Disposal.* (Amendment 5). The Level 3+ being specifically awarded for for specialist EOD operators who have been trained in areas that needed to address specific hazards, such as the planning, supervision and conduct of EOD clearance of post explosion ammunition depots.

Notwithstanding the competence level of the individuals determining which type of ammunition is safe to move post explosion, a formal risk assessment for each clearance operation shall be carried out in accordance with IATG 02.10 *Introduction to risk management principles and processes.* This is because once the STM decision has been taken the ammunition will be moved by staff at a lower competence level; it is a duty of care issue. The risk assessment shall include an evaluation of the types of fuzing systems that may present particular hazards for the clearance operation.

9.3 Process efficiency

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

Equipment	Use	Examples
Shock Initiation System	▪ Shock Initiation Systems are much easier to handle and cheaper than military detonating cord. It should be considered due to the potentially very large number of 'in situ' demolitions necessary for destruction of the fuzed ammunition.	Several types of Non-Electric initiation systems are available.
Radio Controlled Initiator	▪ The use of this type of system negates the requirement for the deployment of long firing cables. ▪ Safety and control of demolitions is improved as all can be fired from a central point, without the excessive use of firing cable. ▪ RC initiation is quicker to set up and take down than long runs of firing cable.	
Armoured Engineer Vehicles	▪ Specialist armoured vehicles are an efficient alternative for the clearance of the 'explosion craters' and surrounding area, where large quantities of earth require safe processing. These areas are likely to have high density UXO contamination. ▪	
'Alternative' or Deflagration techniques	▪ Deflagration, rather than detonation, techniques may be appropriate for fuzed ammunition that is lying near sensitive locations (power lines, routes, etc). Although detonation must be assumed for the establishment of danger areas, deflagration techniques now routinely achieve a 80% success rate for 'low order' results.	Point Focal Charges

Table 2: Systems for clearance efficiency

9.4 Staff competences

Staff planning or engaged in the EOD clearance of ASA explosion areas should be fully compliant with the following competency standards:

Test and Evaluation Protocol 09.30/01/2014 Version 1.0 dated 30 October 2014 Explosive Ordnance Disposal (EOD) Competency Standards

Annex A
(normative)
References

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

a) AAP-6 (Edition 2016), *NATO Glossary of Terms and Definitions*. NATO Standardization Office (NSO). http://nso.nato.int/nso/nsdd/listpromulg.html;

b) Test and Evaluation Protocol 09.30/01/2014 Version 1.0 dated 30 October 2014 Explosive Ordnance Disposal (EOD) Competency Standards

a) IATG 07.30 *Inspection of ammunition*. UNODA;

b) IATG 08.10 *Transport of ammunition*. UNODA;

c) IMAS 09.10 (Second Edition, Amendment 5) *Clearance requirements*. IMAS. June 2013. https://www.mineactionstandards.org;

d) IMAS 09.30 (Second Edition, Amendment 5) *Explosive Ordnance Disposal*. IMAS. October 2014

e) ISO Guide 51:2014 *Safety aspects – Guidelines for their inclusion in standards*. ISO. 2014.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[30] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[30] Where copyright permits.

Annex B
(informative)
Example EOD Operation Order (OpO)

Copy No of copies

Total pages:

General Staff
Ministry of Defence
BLUETOWN
Redland

Civil: (+99) (12) 26648

July 2020

File Number

EOD OPO 1/11 (LOCATION 1)

References:

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

Time Zone Used Throughout the Order: LOCAL

Task Organisation:[31]

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

[31] Options included, which are task dependent.

1. SITUATION

a. EOD and UXO Background Intelligence.

(1) During the civil unrest in Redland in 2020 there were a number of explosions at the BLUETOWN Ammunition Storage Area (ASA) on the 18 April 2020.

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

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

(4) EOD clearance Operations to clear access roads and the areas around the exploded ESH were carried out in March 2020***.*** As a consequence of these operations there has been significant consolidation of UXOs and access roads appear to be clear

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

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

(7) Since April 2020 there have been at least 14 wounded as a result of explosions in these areas, and the subsequent civilian handling of the unexploded ammunition.

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

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

2. MISSION

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

3. EXECUTION

a. Concept of Operations.

(1) Assembly Phase:

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

(b) Confirm the availability of personnel.

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

(e) Briefings as required.

(2) Deployment Phase:

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

(b) Preparation of administrative and clearance area.

(c) Arrival of main body.

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

(3) Clearance Phase - Area1:

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

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

(c) Demolition of UXO in situ.

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

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

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

(g) Demolition of UXO in situ.

(h) Free From Explosive (FFE) certification of inert metal scrap/ammunition items. Prove free from explosives by burning if there is a possibility of explosive traces remaining in ammunition scrap.

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

(4) Clearance Phase - Area 2

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

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

(c) Demolition of UXO in situ.

(d) Free From Explosive (FFE) certification of inert metal scrap/ammunition items. If there is doubt as to whether these ‘scrap’ items still have traces of explosives in them, prove them by burning.

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

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

(5) Recovery Phase:

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

(b) Return to base location.

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

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

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

(3) If at any stage there is a possibility of area defence weapons (mines etc) being present, stop the task, withdraw, investigate, reassess and replan.

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

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

(6) Identify, mark and remove munitions that are "Safe to Move".

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

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

(9) Dispose of recovered munitions as appropriate.

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

(11) Conduct final clearance.

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

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

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

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

(c) Disposal in situ by alternative deflagration techniques.

(d) Disposal in situ by detonation.

(2) Under Cover Requirements. During the physical clearance of UXO by detonation or deflagration **ALL** personnel, with the exception of the nominated EOD Operator, are to be under cover during the 'detting up'/priming phase and unnecessary equipment and vehicles shall be removed from the danger area

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

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

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

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

(2) A staffed Fire Service tender is to be on site during all demolitions.

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

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

GROUND PREPARATION FACTOR [32]						
TYPE OF TERRAIN	AREA (Ha)	FACTOR [33]	PERSON DAYS	STAFF AVAILABLE	ESTIMATED TIME (DAYS)	REMARKS
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Short Grass	35	0	0			
Light Vegetation	5	10	50			
Dense Vegetation	5	30	150			Consider other techniques.
SEARCH AND MARKING FACTOR						
TYPE OF SEARCH	**AREA (Ha)**	**FACTOR**	**PERSON DAYS**	**STAFF AVAILABLE**	**ESTIMATED TIME (DAYS)**	**REMARKS**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Visual	41	1.3	53.3			
Metal Detector	4	2.5	10			Factor for Low Density UXO and ammunition contamination only to shallow depth (130mm). For High Density UXO and ammunition contamination a much higher factor will need to be applied.
DESTRUCTION [34] / RECOVERY [35] FACTOR						
UXO / AMMUNITION DENSITY [36]	**AREA (Ha)**	**FACTOR [37]**	**PERSON DAYS**	**STAFF AVAILABLE**	**ESTIMATED TIME (DAYS)**	**REMARKS**
	(a)	(b)	(a) x (b) = (c)	(d)	= (c) / (d)	
Very Heavy (10.0/m^2)	30	180	5400			
Heavy (5.0/m^2)	15	90	1350			
Medium (1.0/m^2)	0	50	0			
Light (0.2/m^2)	0	10	0			
ESTIMATED TASK CLEARANCE TIME (DAYS)					**7,014**	

f. Co-ordinating Instructions

(1) Timings

SER	DATE	TIME	EVENT	REMARKS
(a)	(b)	(c)	(d)	(e)
1	11 May 20	0600	Initial EOD Recce.	

[32] This assumes that the ground is prepared by hand or with light mechanical systems.

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

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

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

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

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

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

4. SERVICE SUPPORT

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

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

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

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

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

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

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

SER	DATES	TYPE	QTY	TASK
(a)	(b)	(c)	(d)	(e)
1	21 Apr 20	4 x 4 Car	1	Recce
2	D day onward	4 x 4 Car	1	Safety Vehicle
3	D day onward	4 x 4 Truck	1	Serviceable Ammunition and stores.
4	D day onward	4 x 4 Truck	1	Movement of Unserviceable Ammunition to the Demolition Ground.
5	D day onward	4 x 4 Car	1	Movement of personnel and miscellaneous stores.
6	D +1 onward	Ambulance	1	Medical Support
7	D + 2 onward	Winch Veh/Crane	1	Removal of roof slabs. Completion estimated for D + 5.

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

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

g. Medical.

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

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

(3) Surgery/Hospital.

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

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

h. Copious amounts of drinking water must be supplied in all working areas. Quantity depends on heat and humidity, and the number of people working in each area.

5. COMMAND AND SIGNAL

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

b. EOD Team Ground Commander. To Be Notified.

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

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

(1) Ammunition Recovered for Disposal by Demolition and certificate of disposal when destroyed. (Annex E)

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

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

(4) Scrap Recovered. (Annex H)

(5) Serviceable explosive used. (Annex I)

e. Contact Numbers.

SER	UNIT	NAME	TEL [1]	FAX/EMAIL
(a)	(b)	(c)	(d)	(e)
1	Chief EOD			
2	D/Chief EOD			
3	Ground Commander			
4	EOD Ammunition Specialist			
5	D/EOD Team Ground Commander			
6	Commander 5013			

SER	UNIT	NAME	TEL [1]	FAX/EMAIL
(a)	(b)	(c)	(d)	(e)
7	BFU BLUETOWN			
8	Commander BLUETOWN ASA			

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

Annexes:

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

Distribution: Copy No

External:

Action:

Commander 5013 -
EOD Team Leader -

Internal:

Action:

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

Information:

Chief Engineer -
Chief Ammunition and Armaments -

**ANNEX B TO
EOD OPO 1/11**

TECHNICAL REFERENCES

SER	AMMUNITION NATURE		ASSOCIATED FUZES		REMARKS
	TYPE	"PINK BOOK"[38] REFERENCE	TYPE	"PINK BOOK" REFERENCE	
(a)	(b)	(c)	(d)	(e)	(f)

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

**ANNEX C TO
EOD OPO 1/11**

EQUIPMENT REQUIREMENTS

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

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

**ANNEX D TO
EOD OPO 1/11**

SERVICEABLE EXPLOSIVE REQUIREMENTS

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

Nb. The above list is dependent on the ammunition to be disposed of and the situation.

**ANNEX E TO
EOD OPO 1/11**

AMMUNITION RECOVERED FOR DISPOSAL BY DEMOLITION AND CERTIFICATE OF DISPOSAL

WEEK:		WEEK ENDING:	

SER	AMMUNITION TYPE	WEEKLY TOTAL			OPERATION TOTAL			REMARKS, INCLUDING ITEMS CERTIFIED DESTROYED, DATE AND SIGNATURE
		QTY	AUW (KG)	NEQ (KG)	QTY	AUW (KG)	NEQ (KG)	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)
	TOTALS							

**ANNEX F TO
EOD OPO 1/11**

AMMUNITION DISPOSED OF IN SITU BY DETONATION/DEFLAGRATION

WEEK:		WEEK ENDING:	

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

**ANNEX G TO
EOD OPO 1/06**

AMMUNITION RECOVERED FOR STORAGE

WEEK:		WEEK ENDING:	

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

**ANNEX H TO
EOD OPO 1/11**

SCRAP RECOVERED

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

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

WEEK:		WEEK ENDING:	

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

**ANNEX H TO
EOD OPO 1/11**

SERVICEABLE EXPLOSIVE USED

Ser	Item	Qty	Date used	Where	By (name)	Signature	Remarks

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 12.10

Third edition
March 2021

Ammunition on multi-national operations

UN SaferGuard
Securing ammunition, protecting lives

IATG 12.10:2021[E]

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for 'through-life management' approach to ammunition management. The IATG can be applied at the guidelines' **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module is designed for the guidance of personnel involved in the planning, deployment and operational aspects for the storage, handling and use of ammunition and explosives on multi-national (MN) operations. The deployed ammunition may not necessarily be directly managed by ammunition-qualified personnel.[3]

The principles and procedures for the safe, effective and efficient storage, handling, transport and use of ammunition are the same whether the ammunition and explosives are in an explosive storage area or whether they are held in temporary storage locations. However, it is recognised that the range of procedures during deployed operations will be substantially less than at the base or logistic level.

These guidelines should apply in a deployed environment and establish the minimum safety requirements for deployed multi-national (MN) forces. Compliance with these guidelines is strongly recommended except where compelling operational necessity requires otherwise; at which point an explosion consequence analysis must be completed and approved at the appropriate level to accept the residual risk. Many clauses in the IATG are directly applicable for safe storage during deployed operations. Where appropriate these Clauses have been included in this IATG module for ease of reference.

Planning for Support to Multi-national (MN) Operations

The General Assembly welcomed the continued application of the IATG in the field, including the implementation software and training materials and encourages, in this regard, the safe and secure management of ammunition stockpiles in the planning and conduct of peacekeeping operations, including through the training of personnel of national authorities and peacekeepers, utilizing the IATG.

This module provides basic planning guidance for Troop Contributing Countries (TCC) by detailing key Force-level explosives safety and risk management roles and responsibilities and required competencies. It establishes the minimum IATG requirements that should be applied to ensure the safety of unit personnel and the public by providing a table that points to appropriate IATG modules and clauses to at least meet Risk Reduction Process Level (RRPL) 1 stockpile management requirements, and even higher RRPL if possible. The module additionally requires that all TCC providing ammunition certify that their ammunition deployed in support of a MN operation is 'safe to deploy' and serviceable and with sufficient shelf-life for the deployment..

TCCs supporting MN operations need to be prepared to implement IATG 12.10 requirements when on a UN or MN base. This requires awareness and understanding of such requirements, as well as training of personnel to meet those requirements while in their home countries and prior to arrival at the deployment location.

[3] Usually Ammunition Technical Officers (ATO) or equivalently trained and qualified Explosive Safety Officers (ESO)

Ammunition on multi-national operations

1 Scope

This IATG module introduces guidance for the safe storage and handling of ammunition and explosives on MN operations. These may include; 1) those mandated by the UN Security Council (UNSC)[4]; 2) those undertaken by regional organizations (e.g. African Union); or 3) those undertaken by coalitions.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some, or all, of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'shelf life (service life) expiry date (SLED)' refers to the date on which the shelf life (or service life) of an ammunition item expires. In all modules of the International Ammunition Technical Guidelines, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background

It would be inappropriate to expect personnel not qualified in ammunition management to be aware of all the detailed technical requirements for the safe storage of ammunition and explosives. However, this should not affect their responsibility to protect the health and safety of unit members, the general public and the natural environment.

[4] For UN peace operations, further guidance can be found in the United Nations Manual on Ammunition Management, First Edition 2020, available at: http://dag.un.org/handle/11176/401037. The Manual is firmly based on the IATG.

This module is designed to be used as a reference guideline to the other fundamental clauses within the IATG that should be applied to the handling, storage and transport of ammunition by troop contributing countries (TCC) during MN operations. This should then ensure that the storage complies to a minimum of Risk Reduction Process Level 1.[5]

5 Responsibilities

The Force Commander shall have overall responsibility for all ammunition and explosives safety.[6]

The Force Commander shall also be accountable for striking a balance between safety and operational requirements using the information available. The Force Commander shall be informed when the minimum standards cannot be met and should understand the possible consequences of any reduction in safety criteria.

A checklist for the guidance of the Force Commander is at Annex C.

Before the Force Commander makes any decision to deviate from IATG requirements the Force Commander should consult an appropriately qualified and experienced Explosives Safety Officer. It therefore follows that a competent person of an appropriate rank/grade should be designated in writing as the Force Explosives Safety Officer (FESO), to be responsible to the Force Commander for all explosive safety and security matters. The FESO should ideally be a member of the Force Headquarters staff, but for smaller deployments the FESO may be a member of a TCC unit.

5.1 Risk management

Explosives safety and munitions risk management (ESMRM) is a systematic approach that integrates risk assessment into operations planning, military training exercises, and contingency operations with the goal of identifying potential consequences associated with munitions operations, risk reduction alternatives, and risk decision criteria for key decision makers.[7] The first level of risk management is the application of appropriate Quantity Distances (QD) or Temporary distances (TD), as detailed in IATG 02.20 and 04.20 respectively.

Any relaxation in the safety standards contained within this IATG module shall require a risk analysis. The risk analysis is a systematic procedure that will determine if acceptable levels of force protection and public protection are provided. It should be conducted in accordance with IATG 02.10 *Introduction to risk management principles*. Acceptance of risk shall be made by the Force Commander, after considered judgment of the balance of risk after development, implementation and enforcement of control measures to mitigate the risk, whilst maintaining operational efficiency. The Force Commander may delegate this responsibility to an appropriate level, but any risk assessment that indicates the possibility of fatalities shall be personally signed off by the Force Commander.

The acceptance of any residual risk resulting from a reduction of the guidelines within this IATG module shall be a documented waiver that formally accepts the residual risk. The Force Commander shall personally sign this waiver and risk acceptance document. The Force Commander should also ensure that this residual risk is immediately communicated to the appropriate authorities, (e.g. HQ UN DPO, national governments, etc.).

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[5] See IATG 01.20 *Index of risk reduction process levels within IATG.*

[6] In United Nations peace operations with an integrated mission structure, where the authority for logistic support and engineering falls under the director/chief mission support (D/CMS) and not under the force commander, the responsibility for all ammunition and explosives safety is raised to a higher level in the mission leadership. For United Nations peace operations the weapons and ammunition advisory board (WAAB), which is chaired by the civilian mission chief of staff one level above the Force Commander, is responsible for all aspects of weapons and ammunition management (WAM).

[7] Allied Logistics Publication (ALP)-16, *Explosives Safety and Munitions Risk Management in NATO Planning, Operations, and Operations*

6 Operational planning

6.1 Force Explosives Safety Officer (FESO)

A Force Explosives Safety Officer, of an appropriate rank/grade, shall be designated in writing by the Force Commander, or the Operational Headquarters. The FESO shall be responsible for advising the Force Commander on all ammunition and explosives safety matters, including safe handling and disposal of ammunition and explosives during Disarmament, Demobilization and Reintegration (DDR) processes. The mandate of the FESO to implement explosive safety activities within the deployed force should be considered and designated by the Force Commander.

6.2 Force generation

An appropriately qualified and experienced officer[8] shall be appointed as the Force Explosive Safety officer. This officer shall have the following competencies:

a) have a detailed technical knowledge and understanding of the full scope of IATG;

b) be able to calculate the appropriate Quantity Distances/Temporary Distances (QD/TD) (IATG 02.20/IATG 04.20) to be applied from Potential Explosion Sites (PES) to other PES and to Exposed Sites (ES);

c) be able to plan an Ammunition Storage Area (ASA) in accordance with IATG 02.20/IATG 04.20 (For example, the number of PES required, barricade requirements, appropriate QD/TD);

d) have a detailed knowledge and understanding of lightning protection system and fire prevention requirements;

e) be able to immediately visually identify explosive safety standard shortcomings during a survey or inspection of ammunition storage and maintenance operations;

f) be knowledgeable of accident reporting procedures and capable of investigating ammunition accidents from first principles of ammunition technology and explosive engineering;

g) be able to determine the risk and consequences of deviations from the regulations and communicate with the Operational Commander the mitigating efforts necessary to reduce or eliminate hazards. This will inevitably include the requirement to develop Explosion Consequence Analysis (ECA) reports based on first principles of ammunition technology and explosive engineering, as well as advising the Force Commander on ESMRM;

h) have a detailed knowledge of appropriate mitigation and protective construction design techniques and methodologies;

i) be able to prepare explosives limits licences based on QD, TD and ECA.

j) Explosive Ordnance Disposal (Conventional Munition Disposal) matters;

k) the implementation of MOSAIC 02.30 *Small arms and light weapons control in the context of DDR*

l) the safe collection of ammunition and explosives from the civilian population in accordance with MOSAIC 05.40 *Collection of illicit and unwanted small arms and light weapons*;

m) the safe destruction of weapons recovered from the civilian population in accordance with MOSAIC 05.50 *Destruction: Weapons*; and

[8] The range of competencies required of this appointment means that it is unlikely to be effectively filled by an officer who is not Ammunition Technical Officer (ATO) qualified (or national equivalent).

n) the safe destruction of ammunition and explosives recovered from the civilian population in accordance with IATG 10.10 *Demilitarization, destruction and logistic disposal of conventional ammunition*.

Should a FESO not be identified with the qualifications and experience necessary to advise on j) to n) above, then an appropriately qualified individual should also be appointed to the Force Headquarters.

It is recommended that during the planning process, provision should be made to involve appropriately qualified personnel in the storage, management and safe logistic disposal of ammunition and explosives. This should, ideally, be the FESO designated for the Force.

6.3 Field locations

The aim of the planning phase should be to identify appropriate locations, with adequate outside QD, for the safe storage of TCC ammunition. The following information should be obtained before starting the reconnaissance:

a) maps of the area;

b) environmental and weather information of the area. It must be remembered that high temperatures and high humidity can affect the lifetime, quality and safety of some kinds of ammunition, such as rocket systems, flares, White Phosphorus (WP) etc;

c) type of mission and operation (e.g. peace keeping, peace enforcing);

d) ammunition type, NEQ hazard division (HD), (for flexibility in the use of the storage, all planning should be based upon HD 1.1 material only and compatibility group (CG));

e) type of activities in the Ammunition Storage Area such as maintenance, handling of captured ammunition, packaging etc;

f) any Memorandum of Understanding (MOU) between partners and the host nation;

g) potential threats;

h) suitability of terrain (e.g. flood-prone, swampy, vegetation, ground quality, gradient etc);

i) requirement for specialized buildings (i.e. workshops, receipt and issues area, salvage and office buildings); and

j) availability of utilities (e.g. power, water).

6.4 Certification of the condition of deployed ammunition

TCC of UN peace operations shall certify that all ammunition deployed in support of national contingents is ‘safe to deploy’, serviceable and with sufficient shelf-life for the deployment, or until replacement stocks arrive. The form at Annex E (or national equivalent) shall be completed as appropriate by e.g. the national consignor and distributed as indicated on the certificate. Further details shall be described in a Memorandum of Understanding (MoU).

7 Ammunition management in operations

Table 1 summarises the Clauses in the IATG that should be applied to the management of ammunition storage and transport during MN operations to ensure the safety of unit personnel and the general public. The requirements are listed alphabetically for ease of reference:

Requirement	Summary	IATG Reference	
		IATG #	Clause
Accounting	▪ Accounting systems. ▪ Stack tally cards. ▪ Stocktaking and audits.	03.10	14.2 14.5 14.6
Ammunition Accidents	▪ Actions by user unit. ▪ Reporting format.	11.10	8 Annex C
Classification of Ammunition and Explosives	▪ Ammunition and explosives are classified in accordance with the UN Globally Harmonised System.	01.50	6.1 6.2
Controlled Articles and Contraband	▪ The prohibition of contraband within temporary or field storage.	06.10	5.3
Documentation and Records (Held in Magazine)	▪ Explosive Limits Licence ▪ Humidity Record ▪ PES Log Book ▪ Temperature Record	02.30 06.70 06.70 06.70	7 Annex D Annex C Annex D
Explosives Licence	▪ Required to ensure that safe levels of storage are authorised and maintained.	02.30	7
Faults and Performance Failures during use	▪ System for the reporting of ammunition faults and performance failures when used for training or on operations.	01.60	7 8 Annex C
Fire Safety	▪ Fire alarm systems. ▪ Fire practices. ▪ Fire signs and symbols. ▪ Immediate fire fighting appliances. ▪ Unit immediate actions. ▪ Supplementary	02.50 04.10	7 8.2 10.2 10.3 11.1 11
Mixing Rules	▪ Ensures that ammunition of conflicting compatibility groups are not stored together.	04.10	7.1
Quantity and Separation Distances	▪ These should be developed by qualified ammunition personnel and will be clearly stated on the Explosive Limits Licence.	04.10	6.0 7.4
Transport of Ammunition	▪ In accordance with UN Model Regulations.	08.10	All
Warning Signs	▪ In accordance with the UN Globally Harmonised System.	01.50	6.1 6.1.1

Table 1: Ammunition storage on operations - IATG requirements

8 Storage infrastructure

The storage infrastructure should be in line with the guidance contained within IATG 04.10 *Temporary storage.* Dependent on the type of storage infrastructure available, and particularly for longer-term force deployments, it may also be necessary to consult IATG 05.20 *Types of buildings for explosives facilities* and IATG 05.30 *Barricades*.

9 Deployed unit ammunition inspections

Deployed units holding ammunition and explosives should be formally inspected by ammunition-qualified personnel, usually the FESO, at the frequencies shown in Table 2:

Type of Explosives Licence[9]	Inspection Frequency	Remarks
Standard	Annually	▪ Deployed units are unlikely to hold one of these licences.
Non-Standard	Twice yearly	▪
Authorised Quantity	Twice yearly	▪
	Annually	▪ For those units holding only small arms ammunition.

Table 2: Deployed unit ammunition inspection frequency

The efficiency of the unit in relation to its ammunition responsibilities should, on completion of each periodic inspection, be graded in terms of **Satisfactory** or **Unsatisfactory**. The grading shall be based on the standard found at the time of the inspection and give an accurate picture of the efficiency of the unit.

Small infringements may be corrected as the inspection proceeds but a general comment observing this is to be recorded in the report. Subsequent corrective action may be taken as necessary to correct faults and bring the unit up to an acceptable standard. Accurate reporting is essential to give the chain of command a clear and unambiguous view of ammunition and explosives safety across their area. This grading shall be recorded on IATG Form 12.10A (see Annex D) (or national equivalent) by the Inspector.

When assessing the grading of a unit's efficiency, the Inspector should base his or her judgement on the points listed in IATG 06.70 *Inspection of explosives facilities*, Annex E**.** An unsatisfactory grading should only be given if:

A) there is more than one violation of a major point which is considered to compromise explosive safety;

B) there are four or more minor points violated and no corrective action has been taken during the inspection; or

C) recommendations to resolve a major point or two minor points specified in a previous inspection report have not been carried out.

The Inspector shall also recommend if more specialist inspections are warranted, (e.g. electrical, lightning protection, infrastructure stability etc).

A recommended report format for deployed unit ammunition inspections is at Annex D for information.

10 Recovered ammunition and explosives

A deployed MN force may be required to store ammunition and explosives recovered as part of a DDR process. This requires that a system should be developed to ensure the safe and secure storage of such ammunition and explosives pending their final disposal. Ammunition and explosives should be recovered in accordance with MOSAIC 02.30 *Small arms and light weapons control in the context of DDR and* MOSAIC 05.40 *Collection of illicit and unwanted small arms and light weapons*, which includes the requirement for EOD support.

Recovered ammunition and explosives should be stored in accordance with the principles and requirements contained within IATG 04.10 *Temporary storage*. Recovered ammunition shall not be stored in the same site or building (i.e. PES) as serviceable ammunition.

[9] See IATG 02.30 *Licensing of explosives facilities*, Clause 7.

The recovered ammunition and explosives shall not be stored with the unit's own ammunition. A separate storage location, which may be within the wider explosive storage area, shall be used.

10.1 Disposal of recovered ammunition and explosives

Recovered ammunition and explosives shall be disposed of in accordance with IATG 10.10 *Demilitarization, destruction and logistic disposal of conventional ammunition*.

Annex A
(normative)
References

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

A) IATG 01.20 *Index of risk reduction process levels within IATG*. UNODA;

A) B) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

B) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

C) IATG 01.90 *Ammunition management personnel competencies.* UNODA;

D) IATG 02.10 *Introduction to risk management principles and processes*. UNODA;

E) IATG 02.20 *Quantity and separation distances*. UNODA. 2015;

F) IATG 02.30 *Licensing of explosives facilities*. UNODA. 2015;

A) IATG 04.10 *Temporary storage.* UNODA;

B) IATG 07.10 *Surveillance and in-service proof*. UNODA;

C) IATG 08.10 *Transport of ammunition*. UNODA;

D) MOSAIC 05.40 *Collection of illicit and unwanted small arms and light weapons*;

E) MOSAIC 05.50 *Destruction: Weapons*. ;

F) MOSAIC 02.30 Small arms and light weapons control in the context of DDR;

G) United Nations Manual on Ammunition Management, First Edition 2020. DPO-DSO.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[10] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[10] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this guideline:

A) AASTP-1, Edition B, Version 1, *NATO Guidelines for the Storage of Military Ammunition and Explosives*. NATO Standardization Office (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

B) AASTP-5, Edition 1, Version 3, *NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations*. NATO Standardization Organization. June 2016; and

C) ALP-16 (Edition A Version 1) Explosives Safety and Munitions Risk Management in NATO Planning, Operations, and Operations. NATO Standardization Organization. April 2015;

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[11] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[11] Where copyright permits.

Annex C
(informative)
Checklist for the Force Commander

SER	ITEM	REMARKS
1	What are the threats to the mission?	
2	Is there an up-to-date reconnaissance report for ammunition storage areas available?	
3	Is there sufficient ammunition technical knowledge available in the reconnaissance party concerning ammunition safety and ammunition risk management (storage, handling & maintenance)?	
4	Is there an appropriately qualified officer responsible for ammunition safety and risk management during this operation. (E.g. ATO)?	
5	Are there enough qualified soldiers for the safe handling of ammunition?	
6	Is there enough mechanical handling equipment for the different types of ammunition?	
7	Is there enough space for the safe storage, handling and maintenance of the ammunition in accordance with the recommendations of IATG 04.10? If not what are the effects and the risks for own troops and material?	
8	Are the risks known for operational use or ammunition storage that do not meet the minimum IATG requirements?	
9	Are the effects known if a storage module explodes?	
10	Is it necessary to issue a formal waiver and acceptance of residual risk for the use of smaller quantity distances (QD) than the QD recommended in IATG 04.10 or lesser safety distances if an alternative method is used?	
11	Is it necessary to store ammunition in conditioned containers / storage locations?	
12	Is there a location available for the safe storage of damaged or captured ammunition?	

SER	ITEM	REMARKS
13	Are there enough resources to provide the appropriate protection for the safe storage of the ammunition from undesired explosive events within the ammunition storage location?	
14	Are there enough resources to provide the appropriate protection for own troops and the local population from undesired explosive events within the ammunition storage location?	
15	Are there enough resources to provide the appropriate protection to mission critical equipment from undesired explosive events within the ammunition storage location?	
16	Are the storage locations marked in accordance with the UN Hazard Classification system?	
17	Are adequate firefighting arrangements in place?	

Annex D
(informative)
Example deployed unit ammunition inspection report

Deployed Unit Ammunition Inspection Report (SPECIAL / ROUTINE)[12]			
			IATG Form 12.10A
Date of Inspection:		**Other Units using Store:**	
Serial Number:		**Store Inspected (Location)**	
Unit:		**Explosive Licence(s) Serial Number:**	
Address:		**Grading of Unit Efficiency**	SATISFACTORY / UNSATISFACTORY[13]
Inspected by:			
Inspection Unit:			

1. Inspector's Comments

The following inspection report has been compiled by *(Insert Inspector's Full Name and Appointment)* under the authority of *(Insert Technical Authority)*.

The inspection has been conducted in accordance with the criteria laid down in IATG 06.70 *Inspection of explosives facilities*. The inspection covers the management and control of explosives and explosives facilities in accordance with those guidelines. The inspection has been a sample of the documentation, facilities and activities. It is to be noted that there may be documentation, facilities or activities unobserved by the inspector that remain non-compliant with the IATG provisions.

2. Previous Reports (Fire, Security etc)

3. Explosives Licensing and Safeguarding Maps

4. Ammunition Accounts

n.b. This should include any bans or constraints on any ammunition held, plus SLED.

5. Standing Operating Procedures (SOP)

[12] Delete as applicable.

[13] Delete as applicable.

6. Condition of store

n.b. Security, safety, fire measures, information displayed (emergency procedures, phone numbers, licence, A in U list etc), work services, locks, windows and so on, cleanliness, ammunition on battens/pallet bases, stack tally cards and all other important management measures.

7. Condition of Ammunition

8. Closing Remarks

Deployed Unit Ammunition Inspection Report					
					IATG Form 12.10A
Unit:				Serial Number:	
Location:		Date of Previous Inspection and Serial Number:		Inspected by:	

Item No	Designation	Batch/lot or Date	Quantity		Sentence and Quantity			Remarks and reason for sentence other than "S"	Action to be taken by Unit
			On Charge	Inspected	S[14]	R[15]	U/S[16]		

[14] Serviceable. Unit to retain for training or operations.
[15] Return. Unit to return to ammunition depot. (May be used in extremis).
[16] Unserviceable. Unit to return to ammunition depot.

Item No	Designation	Batch/lot or Date	Quantity		Sentence and Quantity			Remarks and reason for sentence other than "S"	Action to be taken by Unit
			On Charge	Inspected	S[14]	R[15]	U/S[16]		

INSPECTED: Signature of Inspector: Date:	INSPECTOR'S REMARKS: Signature of Inspector: Date:	CONFIRMED: Signature of Chief Inspector: Date:

Annex E
(normative)
Certificate of safety, serviceability and adequate shelf life

Certificate of safety, serviceability and adequate shelf life			
Serial			**IATG Form 12.10C**
1	**Troop Contributing Country Details**		
1.1		Country	
1.2		Major Units Deployed	
1.3		Minor Units Deployed	
1.4		Sub-Units Deployed	
1.5		Associated Products	
2	**Ammunition Details**		
2.1		Types and Calibre (List)	
2.2		Any Proof and Surveillance Concerns or Limitations in Use	
2.3		Shelf life expiry date (SLED)	
3	**Certification**		
3.1		This form certifies that the ammunition is 'safe to deploy and store, serviceable and has sufficient shelf life remaining to last the deployment or until replenishment stocks arrive' and that any concerns about its safety in storage or use have been identified in Box 2.2 above.	
3.2		Certifying Individual	
3.3		Certifying Authority	
3.4		Signature	
4	**Distribution**		
4.1		Appropriate National Technical Authority	
4.2		UN Department of Peace Operations	
4.3		Force Commander UNXXX operation	

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.

INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES

IATG 12.20

Third edition
March 2021

Small unit ammunition storage

UN SaferGuard
Securing ammunition, protecting lives

IATG 12.20:2021

Warning

The International Ammunition Technical Guidelines (IATG) are subject to regular review and revision. This document is current with effect from the date shown on the cover page. To verify its status, users should consult www.un.org/disarmament/ammunition

United Nations Office for Disarmament Affairs (UNODA)
United Nations Headquarters, New York, NY 10017, USA

conventionalarms-unoda@un.org

Contents

Foreword

Ageing, unstable and excess conventional ammunition stockpiles pose the dual risks of **accidental explosions at munition sites** and **diversion to illicit markets**.

The humanitarian impact of ammunition-storage-area explosions, particularly in populated areas, has resulted in death, injury, environmental damage, displacement and disruption of livelihoods in over 100 countries. Accidental ammunition warehouse detonations count among the heaviest explosions ever recorded.

Diversion from ammunition stockpiles has fuelled armed conflict, terrorism, organized crime and violence, and contributes to the manufacture of improvised explosive devices. Much of the ammunition circulating among armed non-State actors has been illicitly diverted from government forces.[1] In recognition of these dual threats of explosion and diversion, the General Assembly requested the United Nations to develop **guidelines for adequate ammunition management**.[2] Finalized in 2011, the International Ammunition Technical Guidelines (IATG) provide voluntary, practical, modular guidance to support national authorities (and other stakeholders) in safely and securely managing conventional ammunition stockpiles. The UN SaferGuard Programme was simultaneously established as the corresponding knowledge-management platform to oversee and disseminate the IATG.

The IATG also ensure that the United Nations entities consistently deliver high-quality advice and support – from mine action to counter-terrorism, from child protection to disarmament, from crime reduction to development.

The IATG consist of 12 volumes that provide practical guidance for ‘through-life management’ approach to ammunition management. The IATG can be applied at the guidelines’ **basic, intermediate, or advanced levels**, making the IATG relevant for all situations by taking into account the diversity in capacities and resources available. Interested States and other stakeholders can **utilize the IATG for the development of national standards and standing operating procedures**.

The IATG are reviewed and updated at a minimum every five years, to reflect evolving ammunition stockpile-management norms and practices, and to incorporate changes due to changing international regulations and requirements. The review is undertaken by the UN SaferGuard Technical Review Board composed of national technical experts with the support of a corresponding Strategic Coordination Group comprised of expert organizations applying the IATG in practice.

The latest version of each IATG module can be found at www.un.org/disarmament/ammunition.

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[1] S/2008/258.

[2] See also the urgent need to address poorly-maintained stockpiles as formulated by the United Nations Secretary-General in his Agenda for Disarmament, *Securing Our Common Future* (2018).

Introduction

This IATG module is designed for the guidance of personnel within any government organisation where individuals are involved in the storage, handling and use of ammunition and explosives but are not directly managed by ammunition qualified personnel. This will usually occur in small units, (e.g. police stations or isolated military units).

The principles and procedures for the safe, effective and efficient storage, handling, transport and use of ammunition are the same whether the ammunition and explosives are in an explosive storage area or whether it is held within a small unit. However, it is recognised that the range of procedures and the level of explosives safety awareness and proficiency at the small unit level will be substantially less than at the logistic level. However, the safety and security of ammunition in their possession, regardless of how it was arrived at, and the protection of the surrounding public and other exposed sites (ES), must still be the responsibility of accountable small unit personnel, including their commanders.

This IATG module is designed to guide those responsible for the storage and handling of ammunition and explosives within small units, as well as make commanders aware of their responsibilities for the safety and security of the ammunition under their control. Many clauses in the IATG are directly applicable to safe and secure storage within small units. Where appropriate these Clauses have been included in this IATG module for ease of reference.

Small units may be placed close to the populations they support or protect, meaning the quantity and types of ammunition being held must be kept to the absolute minimum amounts necessary to support the small units' missions. Memorandum of Understandings (MOUs) may need to be established with judicial, police, military, and community leaders towards cooperatively managing and limiting the storage of confiscated explosives materials and on-site ammunition storage, with the goal of minimizing risk to ES. National policy-makers, decision-makers, and technical authorities must be made aware of storage limitations at such locations. They must understand and accept the risk that ammunition storage presents to local populations, as well as the consequences associated with possible violations of IATG 02.20 *Quantity and separation distances* (QD). The risk management process (Section 9 and IATG 02.10) shall be engaged to ensure that risks are understood, commanders are fully informed and that resulting decisions reduce or mitigate the risk to as low as possible commensurate with the operational need.

Small unit ammunition storage

1 Scope

This IATG module introduces guidance for the safe storage and handling of ammunition and explosives in small unit storage, particularly when in close contact with civilian population. Quantities and Hazard Divisions (HD) are deliberately limited, with HD 1,1, 1.21 and 1.3.1 excluded. When operational requirements dictate needs that cannot be met under the strictures of this IATG, advice must be sought from the technical authority[3]. This module is for ready use 'small unit ammunition storage' in limited quantities, not for operational stocks (see 3 Terms and Definitions).

This IATG module does not apply to unit ammunition stored within an ASA.

2 Normative references

A list of normative references is given in Annex A. These documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

A further list of informative references is given in Annex B in the form of a bibliography, which lists documents that contain additional information related to the contents of this IATG module.

3 Terms and definitions

For the purposes of this module the following terms and definitions, as well as the more comprehensive list given in IATG 01.40 *Glossary of terms, definitions and abbreviations,* shall apply.

The term 'explosive limits licence' refers to *the permitted amount of explosives at a potential explosion site*.

The term 'ammunition storage area' refers to *an area used for the storage of ammunition and explosives and within which authorised ammunition or missile preparation, inspection and rectification operations may also be carried out.*

The term "exposed site" (ES) refers to a magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route which is exposed to the effects of an explosion (or fire) at the potential explosion site under consideration.

The term 'magazine' refers to *any building, structure, or container approved for the storage of explosive materials. (c.f. explosive storehouse (ESH))*.

The term 'national technical authority' refers to *the government department(s), organisation(s) or institution(s) charged with the regulation, management, co-ordination and operation of conventional ammunition storage and handling activities.*

The term 'potential explosion site' (PES) refers to *the location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an explosion of its content*.

[3] For storage of small quantities of explosives up to about 50 kilograms, it is possible to procure commercial, portable steel or concrete magazines which either fully contain effects of an internal detonation or limit external effects to very small distances based on the controlled release of detonation by-products. A number of such containers are identified at Table AP1-4 of DDESB Technical Paper 15 (Revision 3) Approved Protective Construction. It should be noted that such constructions may pose logistical challenges in themselves and should not be seen as an easy workaround.

The term 'shelf life (service life) expiry date (SLED)' refers to the date on which the shelf life (or service life) of an ammunition item expires.

The term 'small unit ammunition storage' refers to storage that allows small quantities of 'ready use' ammunition of HD 1.22, HD 1.32 and HD 1.4 to be kept within buildings that are not specifically designed for ammunition storage (e.g. a police station, unit guardroom or training store).

The term 'small unit' refers to *any government organisation, at the tactical level, where individuals are involved in the storage, handling and use of ammunition and explosives but are not directly managed by ammunition qualified personnel*.

NOTE 1 Examples of small units would include police stations, isolated small military units, border guard posts etc.

In all modules of the IATG, the words 'shall', 'should', 'may' and 'can' are used to express provisions in accordance with their usage in ISO standards.

a) **'shall' indicates a requirement**: It is used to indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

b) **'should' indicates a recommendation**: It is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form, 'should not') a certain possibility or course of action is deprecated but not prohibited.

c) **'may' indicates permission**: It is used to indicate a course of action permissible within the limits of the document.

d) **'can' indicates possibility and capability**: It is used for statements of possibility and capability, whether material, physical or casual.

4 Background

It would be inappropriate to expect personnel not qualified in ammunition management to be aware of all the detailed technical requirements for the safe and secure storage of ammunition and explosives. However, this should not affect their responsibility to protect the health and safety of unit members or the general public.

This IATG module is designed to be used as a checklist and reference guide to the more fundamental Clauses within the IATG that should be applied to small unit ammunition stores in order to ensure a more sound safe and secure ammunition and explosives storage and that such storage complies at least with Risk Reduction Process Level 1.[4]

5 Small unit ammunition storage requirements

Small unit ammunition storage allows small quantities of 'ready use' ammunition HD 1.22, HD 1.32 and HD 1.4 to be kept within buildings that are not specifically designed for ammunition storage (e.g. a police station, unit guardroom or training store). It is recommended that a maximum limit of 10kg NEQ of HD 1.22 and/or 1.32 and any quantity of HD1.4 should usually be permitted, although up to 25kg NEQ of HD 1.22 and/or 1.32 and any quantity of HD 1.4 may be authorised if both the technical authority and operational commander agree the need.

When operational requirements necessitate the storage of larger quantities of ammunition, as well as quantities of HD 1.1, HD 1.21, and HD 1.31 ammunition for ready use, the tolerable risk the small unit is willing to accept in their respective environments shall be determined and, in consultation with

[4] See IATG 01.20 *Index of risk reduction process levels within IATG.*

the ammunition technical authority (ministerial level) these larger quantities shall be authorized based on a quantitative risk assessment[5]. See Chapter 9 for further details.

Table 1 summarises the clauses in the IATG that should be applied to small unit ammunition storage to ensure the safety of unit personnel and the general public. The requirements are listed alphabetically for ease of reference:

Requirement	Summary	IATG Reference	
		IATG #	Clause
Accounting	▪ Accounting systems. ▪ Stack tally cards. ▪ Stocktaking and audits.	03.10	14.2 14.5 14.6
Ammunition Accidents	▪ Actions by user unit. ▪ Reporting format.	11.10	8 Annex C
Bans and Constraints	▪ Ensure that ammunition that is either banned or constrained for use is identified and segregated.	01.70	6 7
Classification of Ammunition and Explosives	▪ Ammunition and explosives are classified in accordance with the UN Globally Harmonised System.	01.50	6.1 6.2
Controlled Articles and Contraband	▪ The prohibition of contraband within small magazines.	06.10	5.3
Documentation and Records (Held in Magazine)	▪ Explosive Limits Licence ▪ Humidity Record ▪ PES Log Book ▪ Temperature Record	02.30 06.70 06.70 06.70	7 Annex D Annex C Annex D
Explosives Licence	▪ Required to ensure that safe levels of storage are authorised and maintained.	02.30	7
Faults and Performance Failures during use	▪ System for the reporting of ammunition faults and performance failures when used for training or on operations.	01.60	7 8 Annex C
Fire Safety	▪ Fire alarm systems. ▪ Fire practices. ▪ Fire signs and symbols. ▪ Immediate fire fighting appliances. ▪ Unit immediate actions.	02.50	7 8.2 10.2 10.3 11.1
Inspections (External)	▪ To ensure that unit ammunition stores are appropriately inspected on a regular basis.	06.70	5.2
Inspections (Internal)	▪ To ensure that unit ammunition stores are appropriately inspected on a regular basis.	06.70	5.1
Log Books (Magazine)	▪ Log books for potential explosion sites (PES) should be kept and maintained.	06.70	5.1.1
Mixing Rules	▪ Ensures that ammunition of conflicting compatibility groups are not stored together.	01.50	7.1
Quantity and Separation Distances	▪ These should be developed by qualified ammunition personnel and will be clearly stated on the Explosive Limits Licence.	02.20	**Not for Unit Use**
Risk Analysis and Acceptance	▪ Should resources not be available to achieve the requirements of this IATG, then the residual risk SHALL be formally accepted at the appropriate level. This should normally not be below Ministerial level.	02.10	11

[5] See IATG 02.10, Chapter 5 The concept of safety

Requirement	Summary	IATG Reference	
		IATG #	Clause
Security of Magazines	▪ Access Control. ▪ Physical security infrastructure.	09.10	8.5 8.6
Transport of Ammunition	▪ In accordance with UN Model Regulations.	08.10	All
Warning Signs	▪ In accordance with the UN Globally Harmonised System.	01.50	6.1 6.1.1

Table 1: Small unit ammunition storage requirements

6 Magazine infrastructure

The unit ammunition store or magazine should comprise a single room, or several compartments separated from each other by internal walls. A Receipts and Issues (R&I) room may form an integral part of the ammunition store but should be situated at one end of the building.

Each compartment should only have one door, and this should open outwards. In certain situations, (for example where only Hazard Division (HD) 1.4 ammunition is to be stored) a purpose-built explosives store is not required.

The physical infrastructure should be in line with the guidance contained within IATG 05.20 *Types of buildings for explosives facilities.* The magazine should be unheated.

7 Unit ammunition inspections

Small units holding ammunition and explosives should be formally inspected by ammunition qualified personnel at the frequencies shown in Table 2:

Type of Explosives Licence[6]	Inspection Frequency	Remarks
Standard	Annually	▪ Small units are unlikely to hold one of these licences.
Non-Standard	6 monthly	▪
Authorised Quantity	6 monthly	▪
	Annually	▪ For those small units holding only small arms ammunition.

Table 2: Small unit ammunition inspection frequency

The efficiency of the unit in relation to its ammunition responsibilities should, on completion of each periodic inspection, be graded in terms of **Satisfactory** or **Unsatisfactory**. The grading shall be based on the standard found at the time of the inspection and give an accurate picture of the efficiency of the unit.

Small infringements may be corrected as the inspection proceeds, but a general comment observing this is to be recorded in the report. Subsequent corrective action may be taken as necessary to correct faults and bring the unit up to an acceptable standard. Accurate reporting is essential to give the chain of command a clear and unambiguous view of ammunition and explosives safety across their area. This grading shall be recorded on IATG Form 12.20A (see Annex C) (or national equivalent) by the Inspector.

[6] See IATG 02.30 *Licensing of explosive facilities*, Clause 7.

When assessing the grading of a unit's efficiency, the Inspector should base his or her judgement on the points listed in IATG 06.70 *Inspection of explosives facilities*, Annex E**.** An unsatisfactory grading should only be given if:

A) there is more than one inexcusable violation of a major point which is considered to compromise explosive safety;

B) there are four or more minor points violated and no corrective action has been taken during the inspection; or

C) recommendations to resolve a major point or two minor points specified in a previous inspection report have not been carried out.

At unit inspections, the Inspector shall report any ammunition, which, in his or her opinion, has deteriorated or has been damaged through the fault of the unit. Such ammunition is to be the subject of a Damage Report that is to be processed in the usual manner.

The Inspector shall also recommend if more specialist inspections are warranted, (e.g. electrical, lightning protection, infrastructure stability etc). These should be carried out, as a minimum, on an annual basis (National Regulations should be the ultimate arbiter).

A recommended report format for small unit ammunition inspections is at Annex C for information.

8 Unserviceable ammunition stocks and recovered ammunition and explosives

Any unserviceable ammunition in unit holdings (e.g. misfired SAA) is to be separated from serviceable stocks in ammunition containers and clearly marked to indicate that it should not be used and is unserviceable, i.e. condition D. Ammunition in HD 1.4 can be kept within the store if no other storage facility is available. Ammunition in other HD is not to be stored in the same store but is to be removed to a separate store to await removal to a theatre ammunition facility or collection by an EOD unit.

If recovered ammunition items are required as evidence in legal proceedings and hence must be retained in the custody of the legal system until required at trial, then they may be kept in the unit unserviceable store until such time as the EOD unit can collect them. They must be recorded and signed for by the EOD unit to ensure continuity of evidence. Under normal circumstances the EOD unit will be called out to deal with these items, with no involvement of the unit controlling the store.

9 Risk management

In many public security situations, the ammunition and explosives of the police or other security agencies, plus that recovered from criminals being kept for forensic or judicial requirements, will often be stored within urban areas. This may place the local population at risk unless the requirements of this IATG are strictly adhered to.

The risk management process explained in IATG 02.10 *Introduction to risk management principles and processes* shall be followed whenever IATG 02.20 Quantity Distances cannot be met. All possible efforts shall be taken to reduce or mitigate the risk to As Low as Reasonably Practicable (ALARP) levels, and once accomplished, any residual risk must be formally accepted at an appropriate level. If human life is still at risk that appropriate level should be at Ministerial level.

The risk acceptance criteria will result from three factors:

a) local perceptions of societal risk[7] and hence the detailed specification of 'tolerable risk';

b) the potential economic costs and losses due to an undesired explosive event, which may include: 1) explosive ordnance disposal remediation costs; 2) reconstruction costs (for public and civilian buildings); 3) injury compensation costs; and 4) ammunition replacement costs); and

c) environmental impact.

Where tolerable risk has been achieved, then that risk and the residual risk should be formally accepted by the appropriate authority within the ammunition users' organisation. In terms of ammunition storage this should usually take the form of issuing Explosive Limit Licences for the ammunition storage area. (See IATG 02.30 *Licensing of explosives facilities*).

Where tolerable risk has not been achieved, and where resources are not being made available to achieve tolerable risk in the short term, then the residual risk should be formally accepted in writing by the entity responsible for the allocation of resources to the stockpile management organisation. Provided measures to achieve tolerable risk have been identified, then the residual risk is now an issue of resource allocation and not one of technical knowledge.

Should the resource allocation entity refuse to formally accept the risk in writing, then the issue should be referred to the next level of government for reconciliation of the issue. If this stage is reached it is then a political responsibility to free up the required resources, or the risk should be formally accepted in writing at that level of government. Formal acceptance of risk means taking individual and personal responsibility should there be future consequences associated with an explosive event involving stored ammunition and explosives; hence it is likely that the issue of risk acceptance may reach quite high levels of government and the political level. This assures accountability should there be an explosive event in the future, as politicians should have accepted the consequences of a decision not to allocate sufficient resources to achieve tolerable risk. This process should take place annually during the budget development process for the stockpile management organisation.

Given that most, if not all, Small Unit Ammunition Stores will be within a working facility and likely to be in close proximity to the general public, and that there is often an emergency or operational need for the users of the store to hold ammunition of HD1.1, 1.2 or 1.3, planners and designers should consider the application of QDs and if these QDs cannot be achieved in a particular situation, the advice of an explosives safety expert should be sought, to conduct an explosives safety case using Qualitative Risk Assessment techniques and commercially-available software.

9.1 Risk communication (LEVEL 1)

Risk communication is an interactive process of exchange of information and opinion on risk among the owners and managers of small unit ammunition, small unit commanders, risk assessors, risk managers, and other stakeholders, which may include representatives from the local civilian community that may be impacted by the risk. Risk communication is an integral and ongoing part of the risk management process, and ideally all stakeholder groups should be involved from the start. Risk communication makes stakeholders aware of the results of the risk assessment, the logic behind the risk analysis process and the remedial measures taken to ensure a level of tolerable risk.

The identification of particular interest groups and their representatives should comprise a part of an overall risk communication strategy. This risk communication strategy should be discussed and agreed upon between risk managers early in the process to ensure two-way communication. This strategy should also cover who should present information to the public, and the way it should be done. The risk communication strategy should aim to improve the perceptions of safety for the personnel within the ammunition depot and the local community.

[7] Risk perception or aversion may vary in different population groups, especially between men and women. A proper assessment of perceived societal risk and therefore of risk tolerance should endeavour to gather information from men and women, representative of diverse socioeconomic groups.

Ammunition and situational risk shall also be communicated up the chain of command.

10 Useful forms and report format templates

The IATG implementation support toolkit [8] contains a range of templates for the necessary forms and report formats to support the safe, effective and efficient management of ammunition at the small unit level.

[8] IATG implementation support toolkit available at www.un.org/disarmament/ ammunition

Annex A
(normative)
References

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

a) IATG 01.20 *Index of risk reduction process levels within IATG*. UNODA;

b) IATG 01.40 *Glossary of terms, definitions and abbreviations*. UNODA;

c) IATG 01.50 *UN Explosive hazard classification system and codes*. UNODA;

d) IATG 02.10 *Introduction to risk management principles and processes*. UNODA;

e) IATG 02.20 *Quantity and separation distances.* UNODA;

f) IATG 02.30 *Licensing of explosives facilities*. UNODA;

g) IATG 08.10 *Transport of ammunition*. UNODA.

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[9] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[9] Where copyright permits.

Annex B
(informative)
References

The following informative documents contain provisions, which should also be consulted to provide further background information to the contents of this module:[10]

A) AASTP-1, Edition B, Version 1, *NATO Guidelines for the Storage of Military Ammunition and Explosives*. NATO Standardization Office (NSO). December 2015. http://nso.nato.int/nso/nsdd/listpromulg.html;

B) AASTP-5, Edition 1, Version 3, *NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations*. NATO Standardization Organization (NSO). June 2016;

C) Technical Paper 15, Revision 3. *Approved Protective Constructions*. US Department of Defense Explosive Safety Board (DDESB). May 2010. www.wbdg.org/building-types/ammunition-explosive-magazines

D) NATO (AC/326 SG/C)D(2010)0001 Revision 3, *Nationally Approved Structures*. 5 January 2010

The latest version/edition of these references should be used. The UN Office for Disarmament Affairs (UNODA) holds copies of all references[11] used in this guideline and these can be found at: www.un.org/disarmament/un-saferguard/references. A register of the latest version/edition of the International Ammunition Technical Guidelines is maintained by UNODA, and can be read on the IATG website: www.un.org/disarmament/ammunition. National authorities, employers and other interested bodies and organisations should obtain copies before commencing conventional ammunition stockpile management programmes.

[10] Data from many of these publications has been used to develop this IATG.

[11] Where copyright permits.

Annex C
(informative)
Example Small Unit Ammunition Inspection Report

Small Unit Ammunition Inspection Report (SPECIAL / ROUTINE)[12]			
			IATG Form 12.20A
Date of Inspection:		**Other Units using Store:**	
Serial Number:		**Store Inspected (Location)**	
Unit:		**Explosive Licence(s) Serial Number:**	
Address:		**Grading of Unit Efficiency**	SATISFACTORY / UNSATISFACTORY[13]
Inspected by:			
Inspection Unit:			

1. Inspector's Comments

The following inspection report has been compiled by *(Insert Inspector's Full Name and Appointment)* under the authority of *(Insert Technical Authority)*.

The inspection has been conducted in accordance with the criteria laid down in IATG 06.70 *Inspection of explosives facilities*. The inspection covers the management and control of explosives and explosives facilities in accordance with those guidelines. The inspection has been a sample of the documentation, facilities and activities. It is to be noted that there may be documentation, facilities or activities unobserved by the inspector that remain non-compliant with the IATG Guidelines.

2. Previous Reports (Fire, Security etc)

3. Explosives Licensing and Safeguarding Maps

4. Ammunition Accounts

n.b. This should include any bans or constraints on any ammunition held, plus SLED.

5. Standing Operating Procedures (SOP)

6. Condition of store

n.b. Security, safety, fire measures, information displayed (emergency procedures, phone numbers, licence, A in U list etc), work services, locks, windows and so on, cleanliness, ammunition on battens/pallet bases, stack tally cards and all other important management measures.

[12] Delete as applicable.

[13] Delete as applicable.

7. Condition of Ammunition

8. Closing Remarks

Small Unit Ammunition Inspection Report					
					IATG Form 12.20A
Unit:				Serial Number:	
Location:		Date of Previous Inspection and Serial Number:		Inspected by:	

Item No	Designation	Batch/lot or Date	Quantity		Sentence and Quantity			Remarks and reason for sentence other than "S"	Action to be taken by Unit
			On Charge	Inspected	S[14]	R[15]	U/S[16]		

[14] Serviceable. Unit to retain for training or operations.
[15] Return. Unit to return to ammunition depot. (May be used in extremis).
[16] Unserviceable. Unit to return to ammunition depot.

Item No	Designation	Batch/lot or Date	Quantity		Sentence and Quantity			Remarks and reason for sentence other than "S"	Action to be taken by Unit
			On Charge	Inspected	S[14]	R[15]	U/S[16]		
INSPECTED: Signature of Inspector: Date:			INSPECTOR'S REMARKS: Signature of Inspector: Date:						CONFIRMED: Signature of Chief Inspector: Date:

Amendment record

Management of IATG amendments

The IATG are subject to formal review on a five-yearly basis. This does not preclude amendments being made within these five-year periods for reasons of operational safety, efficacy and efficiency or for editorial purposes.

As amendments are made to this IATG module they will be given a number, and the date and general details of the amendment will be shown in the table below. The amendment will also be shown on the cover page of the IATG by the inclusion of the amendment number and date.

As the formal reviews of each the IATG module is completed, new editions will be issued. Amendments will be incorporated into the new edition and the amendment record table cleared. Recording of amendments will then start again until a further review is carried out.

The most recently amended, and thus extant, IATG module is posted on
www.un.org/disarmament/ammunition

Number	Date	Amendment Details
0	01 Feb 15	Release of Edition 2 of IATG.
1	31 March 21	Release of Edition 3 of IATG.