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Storage and handling

Warning

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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 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.
- 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 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;

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 (CuSO₄) 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 Sheets¹² (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 $0 - 45^\circ$ ($0 - 90^\circ$ 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°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 references¹⁸ used in this guideline and these can be found at: www.un.org/disarmament/un-safeguard/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 references²⁰ used in this guideline and these can be found at: www.un.org/disarmament/un-safeguard/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.

