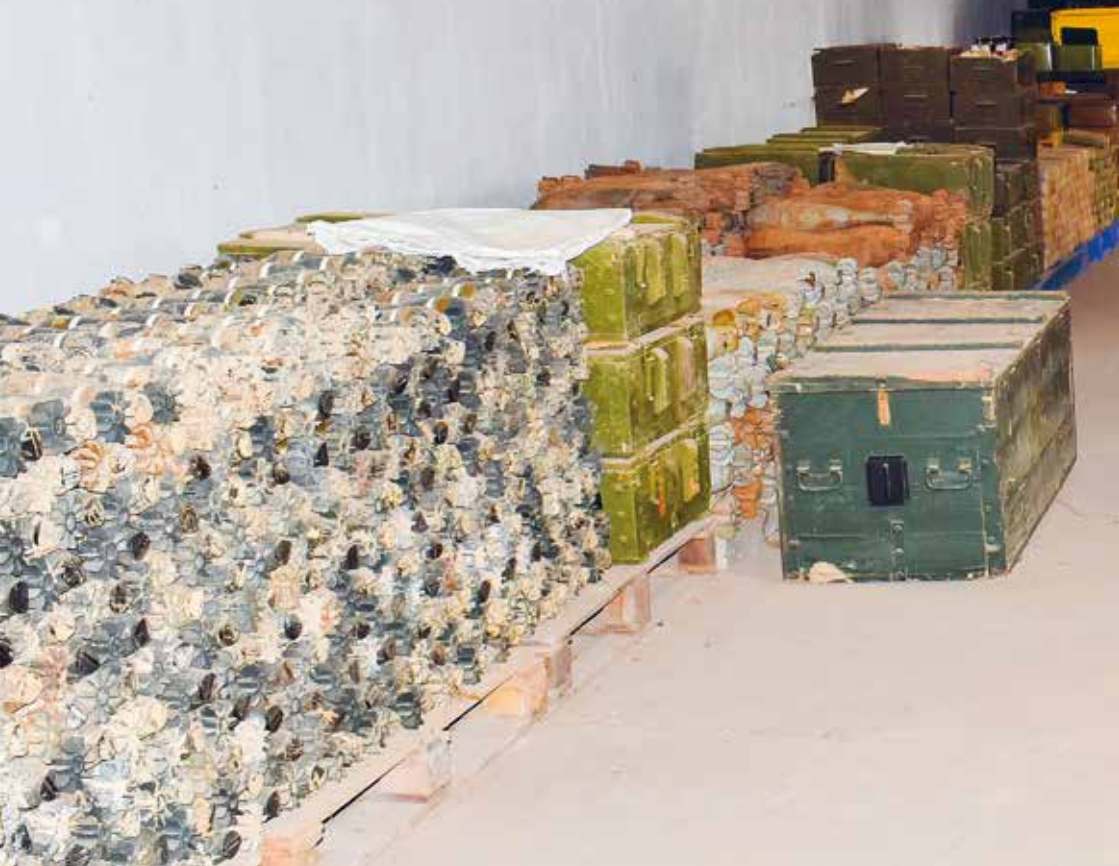


# CRITICAL PATH GUIDE TO THE INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES



**UN SaferGuard** ✓  
Securing ammunition, protecting lives

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## **ACKNOWLEDGEMENTS**

This guide is published by the UN SaferGuard Programme, managed by the United Nations Office for Disarmament Affairs (UNODA), as a practical support guide for applying the International Ammunition Technical Guidelines (IATG).

The guide was drafted with the indispensable and technical support of the Geneva International Centre for Humanitarian Demining (GICHD), a key implementing partner of the UN SaferGuard Programme. The Small Arms Survey also provided substantive support. To ensure the highest levels of readability, usability and technical quality, this document was reviewed by technical and policy specialists.

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# CRITICAL PATH GUIDE TO THE INTERNATIONAL AMMUNITION TECHNICAL GUIDELINES



**UN SaferGuard** ✓  
Securing ammunition, protecting lives

## FOREWORD

Inadequately-managed ammunition poses serious security and humanitarian risks. Potential for unintended explosion and diversion to the illicit market exponentially increases when the security of stockpile diminishes. As a corollary, effective physical security and stockpile management prevents unwanted diversion to illicit markets, including to non-State armed groups, terrorists and transnational criminal organizations. For these groups, ammunition with a high explosive quality is particularly attractive for the manufacture of improvised explosive devices. In addition to mitigating security breaches, the safe and secure management of ammunition also prevents humanitarian disasters, including death, injury and displacement that result from explosions at munitions sites.

Against this backdrop, and to support States as well as relevant implementing partners on the ground, the United Nations developed the International Ammunition Technical Guidelines (IATG) in 2008. We did this at the request of the General Assembly. The IATG contain practical, modular guidance to support States in safely and securely managing conventional ammunition stockpiles.

Under the umbrella of UN SaferGuard, our knowledge-management programme on ammunition management, the United Nations system continues to promote the IATG, supporting States and regional organizations in further mitigating the brazen risks of unwanted blasts and frequent diversion of ammunition stockpiles.

These efforts are pursued in the broader context of the Sustainable Development Goals, in particular Goal 16 on peace, justice and strong institutions and its target related to a significant reduction in illicit arms flows and Goal 11 on safe cities. States have critically recognized that there can be no development without security and safety.

Moreover, addressing poorly-managed ammunition stockpiles constitutes a key component of the Secretary-General's agenda for disarmament, *Security Our Common Future*. The Secretary-General has prioritized "disarmament that saves lives" and views attention to ammunition management as a concrete activity in realizing this pillar of his agenda.

This guide – an excellent example of synergetic cooperation between GICHD and the United Nations – is published in support of IATG users. It clarifies how the measures within the IATG are to be interpreted and applied in practice. It explains technical concepts and processes in a simple, clear, and concise manner.

The hope is that this guide will support the broadest selection of users in navigating the principles, methodology and technical content of the IATG with the ultimate goal of "saving lives".

**Izumi Nakamitsu**

*Under-Secretary-General and  
High Representative for Disarmament Affairs*

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## FREQUENTLY USED ACRONYMS

|        |   |
|--------|---|
| ACTO   | Attractive to Criminal or Terrorist Organizations   |
| ALARP  | As Low As Reasonably Practicable  |
| APB    | Ammunition Process Building   |
| ATT    | Arms Trade Treaty   |
| CAI    | Chartered Ammunition Industries   |
| DDR    | Disarmament, Demobilization and Reintegration   |
| DPKO   | Department of Peacekeeping Operations (UN)  |
| ECA    | Explosion Consequence Analysis  |
| ECOWAS | Economic Community of West African States   |
| ESH    | Explosives Storehouse   |
| ELL    | Explosives Limit Licence  |
| EOD    | Explosive Ordnance Disposal   |
| ES     | Exposed Site  |
| ESH    | Explosives Storehouse   |
| FSA    | Field Storage Area  |
| GAAP   | Generally Accepted Accounting Principles  |
| GGE    | Group of Governmental Experts   |
| GHS    | Globally Harmonized System of Classification and Labelling of Chemicals   |
| IBD    | Inhabited Building Distance   |
| IATG   | International Technical Ammunition Guidelines   |
| IDDRS  | Integrated Disarmament Demobilization and Reintegration Standards   |
| IED    | Improvised Explosive Device   |
| IMAS   | International Mine Action Standards   |
| IMD    | Inter-Magazine Distance   |
| IQD    | Inside Quantity Distances   |
| ITI    | International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons (International Tracing Instrument) |
| MINDEF | Ministry of Defence (Singapore)   |
| MOD    | Ministry of Defence (UK)  |
| MOSAIC | Modular Small-arms-control Implementation Compendium  |
| NATO   | North Atlantic Treaty Organization  |
| OB     | Open Burning  |
| OD     | Open Detonation   |
| OEWG   | Open-ended working group (established by the UNGA)  |
| OOD    | Outside Quantity Distances  |
| OSCE   | Organization for Security and Co-operation in Europe  |
| PBD    | Process Building Distance   |
| PES    | Potential Exposure Site   |
| PIDS   | Perimeter Intrusion Detection Systems   |
| PRC    | People's Republic of China  |
| PTRD   | Public Traffic Route Distance   |
| RRPL   | Risk Reduction Process Level  |
| SAF    | Singapore Armed Forces  |

|       |   |
|-------|---|
| SALW  | Small Arms and Light Weapons                  |
| SCG   | Strategic Coordination Group                  |
| SOPs  | Standing Operating Procedures                 |
| STM   | Safe to move                                  |
| TCN   | Troop Contributing Nation                     |
| TLM   | Through Life Management                       |
| TRB   | Technical Review Board                        |
| UEMS  | Unplanned Explosions at Munitions Sites       |
| UNMAS | United Nations Mine Action Service            |
| UNODA | United Nations Office for Disarmament Affairs |
| UNSC  | United Nations Security Council               |
| UOS   | Unit Of Space                                 |

# 01 INTRODUCTION



## 1.1 OVERVIEW

The International Technical Ammunition Guidelines (IATG) are an internationally-accepted global frame of reference for the development of national standards and Standing Operating Procedures (SOPs) on ammunition stockpile management. In 2011, the United Nations General Assembly (UNGA) welcomed the completion of the IATG and encouraged their use by States on a voluntary basis.<sup>1)</sup> A growing number of States and implementing partners are using the IATG to enhance the safety and security of ammunition stockpiles.

The IATG are regularly reviewed to reflect developments in the field. They are currently in their second edition (2015) and consist of 12 thematic volumes, subdivided into 45 individual modules. The 12 IATG volumes guide users in performing ammunition stockpile management at three progressive risk reduction process levels (RRPL) : 1 (basic), 2 (intermediate), and 3 (advanced). The IATG are supported by the IATG implementation support toolkit,<sup>2)</sup> which provides software applications and online tools to aid in the development and implementation of national standards and SOPs.

The UN SaferGuard Programme – supported by a Technical Review Board (TRB) and a Strategic Coordination Group (SCG) of implementing partners – is the caretaker of the IATG. It allows for holistic oversight and dissemination of the IATG and its supporting toolkit.<sup>3)</sup>

## 1.2 WHAT IS THE PURPOSE OF THIS GUIDE?

The IATG are *technical* guidelines meant to guide national authorities, on a voluntary basis, to improve stockpile management policies and practices in order to minimize the risk of Unplanned Explosions at Munitions Sites (UEMS) and diversion. Whereas some States have comprehensive ammunition management systems where planning, procurement, stockpile management and disposal is considered, this is not yet the case in many others. There can be a lack of political will, financial resources, normative and organizational frameworks, infrastructure and equipment, as well as human resources, necessary to develop holistic ammunition management regimes and systems.



### *What is ammunition?*

The IATG define ammunition as 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.<sup>4)</sup>

The IATG assist States in being aware of and understanding what comprehensive ammunition management entails, including the principles of ammunition management; risk management; ammunition accounting, storage, processing, transportation, and security; ammunition demilitarization and destruction; ammunition accidents, reporting and investigation, as well as ammunition operational support.

This guide illustrates how the IATG can be accessed and applied, towards safe and secure management of ammunition. Accordingly, the aims of the Critical Path Guide to the IATG are twofold:

1. To bring awareness and help States and other users understand how the measures within the IATG are to be interpreted and applied in practice. It explains technical concepts and processes in a simple, clear and concise manner. Examples and illustrations are plentiful, as are pointers to further resources listed at the end;
2. To inform individuals who are new to the issue of ammunition management. While it is not meant to serve as a policy tool, it includes definitions and terminology; summaries of key issues, instruments and measures; and provides an overview of the role of various institutions involved in providing international assistance for ammunition management.

---

### **1.3 WHO CAN BENEFIT FROM THIS GUIDE?**

The main intended users of this guide are States. It is designed as a resource for national authorities and has applicability for the following groups of national stakeholders:

- Representatives involved in negotiating, developing and implementing international ammunition management policy and programmes;
- Regulators involved in the development, implementation, monitoring and evaluation of national legislation, policy and regulations;
- Those involved in the supervision and management of an ammunition stockpile; and
- Those involved in the day-to-day operation of ammunition storage and processing facilities.

This guide can also be helpful for any organization (private or public) involved in the development of ammunition management capabilities at the national level.

---

## 1.4 HOW CAN THIS GUIDE BE USED?

To gain a comprehensive understanding of the IATG, users are encouraged to read the entire guide. Individuals who wish to focus on a particular aspect, volume, or module of the IATG will find it useful to consult relevant sections. Therefore, each section of the guide is self-contained.

The guide includes icons in the left margin, to alert the reader to special information in the text. The icons have the following meanings:



Points out technical terms or issues.

---



Highlights approaches or measures to improve ammunition management policies and practices.

---



Indicates important information to bear in mind when specific ammunition management techniques or measures are applied at the national level.

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Draws the reader's attention to potential challenges or pitfalls, and examples of unplanned explosions in munitions sites or diversion.

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Signals examples of good practice relating to implementation of the IATG in practice.

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Since the guide is based on the IATG, the tools, techniques and suggestions this guide offers are in accordance with the guidelines. The guide should therefore be used as a companion to the IATG, not as a substitute for it.



**02**

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**OVERVIEW  
OF THE IATG**



This section contextualizes the IATG by providing an overview of the history and background leading up to their development; the role of the UN SaferGuard Programme and the aim, scope, and structure of the IATG, as well as their application. Section 3 provides additional detail on their scope, and highlights the relation between the IATG and other international arms regulation processes and instruments. Section 4, introduces practical and technical measures for ensuring safe and secure ammunition management.

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## 2.1 BACKGROUND TO THE IATG

Many countries have suffered explosions within their own managed ammunition stockpiles. Thousands of people have died or been injured, and the livelihoods of entire communities have been disrupted. Unsecured or poorly managed national ammunition stockpiles also lead to massive diversion into illicit markets. Diverted conventional ammunition can also be used to make improvised explosive devices.



### *What constitutes a national stockpile?*

The term “national stockpile” refers to the full range of ammunition stockpiles in a country under the control of separate organizations, such as the police, military forces (both active and reserve), border guards and ammunition-producing companies. The term is applied to all ammunition types, irrespective of classification (e.g. operational, training, or awaiting disposal).<sup>5)</sup>

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The safety and security risks posed by conventional ammunition were, in the past, largely seen as the result of an accumulation of surplus ammunition, including developing States and those recovering from conflict.



### *What is surplus?*

Although there is no agreed-upon international definition of surplus, the term is usually used to refer to the quantity of arms and ammunition that exceeds the requirements of State defence and security forces. It is up to national governments to determine how to identify or calculate surplus stockpiles. IATG 1.30, section 11, outlines indicators and procedures for identifying surplus.

---

Many States suffer from inadequate stockpile management policies and practices, lacking one or more of the basic components of an effective stockpile management system.<sup>6)</sup> Ineffective policies and practices in just one area – whether planning, accounting, surveillance, security, storage or destruction – can threaten the integrity of the entire ammunition management process, increasing the possibility of surplus accumulation and risk of unplanned explosions and diversion.



#### *What is diversion?*

Diversion is defined as 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.<sup>7)</sup>

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Ammunition is classed as dangerous goods. The risks posed by conventional ammunition are twofold:

- The chemical qualities of ammunition increase the risk of explosion when improperly managed; and
  - Ammunition can also fall prey to diversion, ultimately falling into the hands of non-State armed groups or criminals, or States who are not the intended end user.
- 

## **2.2 WHAT ARE THE IATG?**

The IATG provide detailed guidance for voluntary use by States that wish to improve the safety and security of their ammunition storage sites.

### **The UN SaferGuard Programme**

Under the auspices of the United Nations Office of Disarmament Affairs (UNODA), the UN SaferGuard Programme was established as a knowledge resource management platform for conventional ammunition management issues in the United Nations. Its overall goal is to oversee the dissemination of the IATG and serves as their custodian, thus ensuring their technical quality and broadest promotion to interested stakeholders.

**Figure 1 – UN SaferGuard website**


## The aim of the IATG

The objective of conventional ammunition stockpile management is to reduce the hazard caused to local communities from unplanned explosion events and to mitigate the risks posed by the diversion of ammunition.<sup>8)</sup> Providing means to achieve this objective, the primary aim of the IATG is to assist States in improving their national stockpile management capacity, preventing the accumulation of ammunition in surplus and mitigating the safety and security risks posed by ammunition stockpiles.<sup>9)</sup>

The main users of the IATG are States aiming to improve the management of national ammunition stockpiles. The IATG are also used by other stakeholders who assist States in improving their stockpile management policies and practices, including:<sup>10)</sup>

- Various United Nations entities ;
- International and regional organizations and other groups of States ;
- Non-governmental organizations and research institutes ;
- Security Council Sanctions Committee Panel of Experts ;
- Peacekeeping training organizations and institutes ; and
- Private sector companies.

## The scope of the IATG

The IATG are not legally binding nor do they represent a blueprint that States can simply adopt. The IATG are meant to assist authorities in establishing their own national policies, standards, and safety and security programmes.

Although the IATG are primarily focused on stockpile management, they adopt a “whole-life management approach” and thus include guidance that spans and is relevant to the establishment of a Through Life Management (TLM) system (see section 3.1). Ammunition risk management is integral to the application of the IATG. The IATG identify three Risk Reduction Process Levels (RRPL), which stakeholders can use to assess their risk management situation – taking into account available material, financial, and technical resources – and to reduce their level of ammunition-related risk (see section 3.1).



#### *What is Through Life Management (TLM)?*

TLM is defined in the IATG as an integrated approach to the process, planning and costing activities across the whole service life of a specific ammunition type.<sup>11)</sup> TLM is a term developed by the United Kingdom's Ministry of Defence as an approach to the acquisition and in-service management of military capability in which every aspect of new and existing military capability is planned and managed coherently across all Defence Lines of Development, from cradle to grave.<sup>12)</sup>

## **The structure of the IATG**

The IATG are divided into 12 volumes and 45 modules. The 12 thematic volumes are:

1. Introduction and Principles of Ammunition Management
2. Risk Management
3. Ammunition Accounting
4. Explosives Facilities (Storage) (Field and Temporary Conditions)
5. Explosives Facilities (Storage) (Infrastructure and Equipment)
6. Explosives Facilities (Storage) (Operations)
7. Ammunition Processing
8. Transport of Ammunition
9. Security of Ammunition
10. Ammunition Demilitarization and Destruction
11. Ammunition Accidents, Reporting and Investigation
12. Ammunition Operational Support

Reflecting the Risk Reduction Process Level risk management approach, each module is divided into levels of ascending comprehensiveness:

- Level 1 offers the most expedient ways to apply the basic principles of safe and secure ammunition management in a particular thematic area. This will reduce risk significantly;
- Levels 2 and 3 detail progressive measures that can be taken to improve management of the stockpile in a particular thematic area once additional resources can be identified. This will reduce risk further.

This offers an incremental approach for understanding and applying the IATG with the aim of progressively reducing risk. Figure 2 provides a snapshot of the structure of module 03.10, which focuses on inventory management. Section 3.1 provides more information on the modular and RRPL approach of the IATG.

**Figure 2 – Ascending level of comprehensiveness of the IATG**

|      |  |    |
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**Risk Reduction  
Process Levels  
shown in each  
Module contents list**

## 2.3 APPLICATION OF THE IATG IN CONTEXT

While the IATG provide technical guidance for improving the safety, security and efficiency of ammunition stockpile management, they have to be contextualized to reflect the needs and realities on the ground.

To facilitate global dissemination of the IATG, the modules have also been translated into multiple languages. Additional translations are currently being sought.



### *Are the IATG available in multiple languages ?*

The IATG are currently available in Arabic, English, Portuguese, and Russian. Some modules are also available in French and German.

The latest version of each module can be found at:  
[www.un.org/disarmament/un-safeguard/guide-lines/](http://www.un.org/disarmament/un-safeguard/guide-lines/)

### **What additional guidance exists ?**

To further support IATG users and enhance their knowledge, the UN SaferGuard website also features a documents repository.



The documents repository. Relevant international and regional standards, guidelines and documents can be found at:

[www.un.org/disarmament/un-safeguard/references/](http://www.un.org/disarmament/un-safeguard/references/)

## What is the IATG implementation support toolkit?

The IATG implementation support toolkit provides software applications to support the implementation of safe, secure and effective ammunition stockpile management. The web-based tools are designed for use by ammunition experts who have the appropriate technical knowledge and competence. These tools may also be used to communicate safety and security requirements to policymakers and other stakeholders.



The IATG implementation support toolkit is available at:  
[www.un.org/disarmament/un-safeguard/toolkit/](http://www.un.org/disarmament/un-safeguard/toolkit/)

---

The main components of the toolkit include the following:

- **Risk Reduction Checklist:** designed to assess an ammunition stockpile's risk level. The goal of a conventional ammunition stockpile management organization should be to make sure that stockpile management processes are maintained at Risk Reduction Process Level 1 as a minimum (see section 3.1). The checklist provides the means for experts to do a quick assessment with a view to answer the following questions:
  - How safe is a specific Explosives Storehouse?
  - Which IATG module activities are the most urgent?
  - For the stockpile concerned, what is the Risk Reduction Process Level?

- **Quantity-Distance (QD) Map**: allows users to generate an illustrative map displaying the minimum permissible distance between a site where ammunition is stored (Potential Exposure Site) and locations that may be adversely affected by a potential explosion at an ammunition storage site (Exposed Site). The Quantity-Distance Map tool is limited to ammunition that has a mass explosion hazard (i.e. Hazard Division (HD) 1.1). More concretely, the tool provides a means for answering the following question:
  - What should be the minimum perimeter around an Explosive Storehouse in order for an unwanted explosion to only have limited effects?



#### *What is an Exposed Site?*

The IATG define Exposed Sites (ES) as 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 Exposure Site under consideration.<sup>13)</sup>

#### *What is a Potential Explosion Site?*

The IATG define a Potential Explosion Site (PES) as 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.<sup>14)</sup>

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- **Explosion Consequence Analysis (ECA)**: allows users to determine the potential hazard or risk to individuals and property from blast effects in the event of an undesirable explosion. The ECA tool does not take into account the effects from fragmentation. The ECA tool can provide insights into the following questions:
  - In the event of an explosion, what is the potential extent of infrastructure damage and casualties from blast in the region surrounding the ammunition storage site or facility?

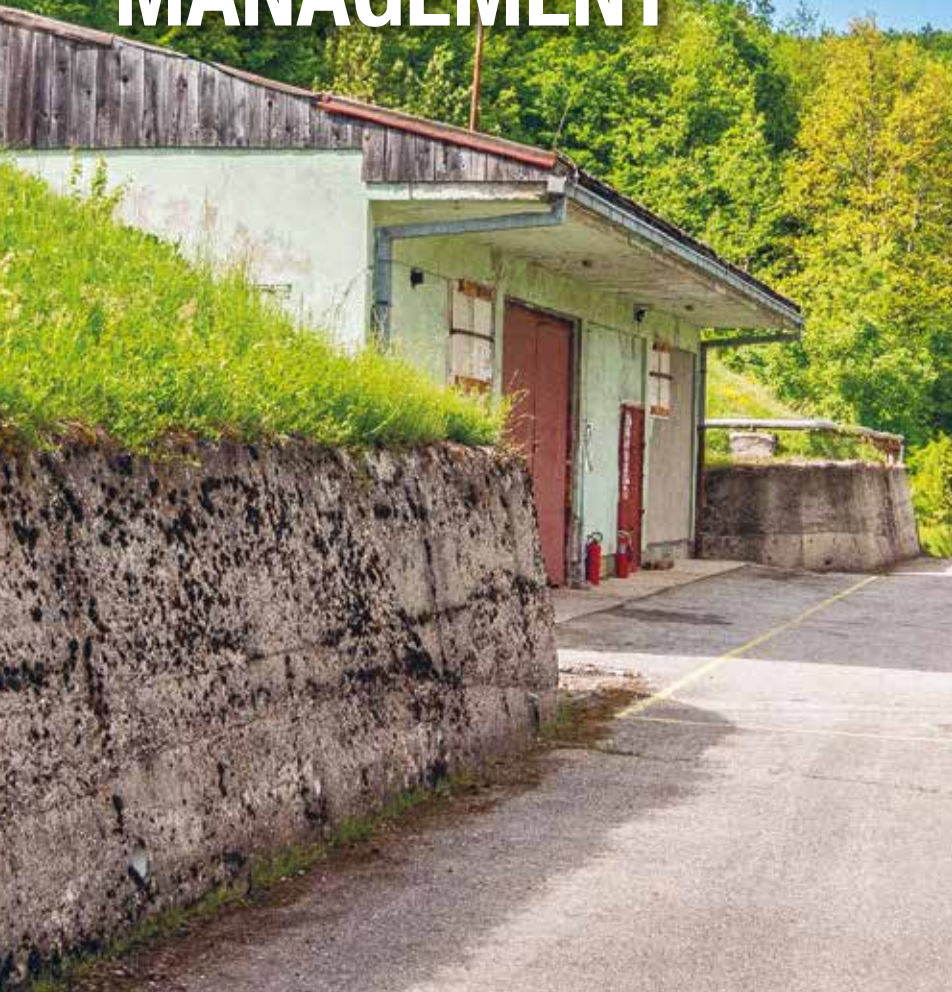


One of the most efficient means of reducing the consequences of unplanned explosions is by the use of effective separation distances. This ensures that people and facilities are always at a tolerably safe distance from explosives during storage and handling. Such distances should be appropriate, recorded and propagated in the form of an Explosives Limit Licence (ELL), for each individual explosive storehouse or facility. Section 4.4 of this guide provides an overview of quantity and separation distances. IATG module 2.20 provides detailed guidance on this issue.

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# 03

## PRINCIPLES OF AMMUNITION MANAGEMENT





The IATG are designed to assist States and other users to improve safety, security and efficiency in conventional ammunition stockpile management by providing guidance, by establishing principles and, in some cases, by referring to other related international requirements and specifications. Since their inception in 2011, the IATG have enjoyed overwhelming international support (see section 2.2). This section provides a more in-depth look at the main concepts and theoretical underpinnings of the IATG. Section 4 provides an overview of the IATG practical and technical guidance for improving the safety and security of ammunition stockpiles.

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### 3.1 WHAT ARE THE GUIDING PRINCIPLES AND INHERENT ASSUMPTIONS OF THE IATG ?

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. While there are a range of options and procedures available to ensure effective stockpile management, the IATG draw upon established explosives science to provide a common understanding of conventional ammunition management. The guidelines provide a global frame of reference for a gradual improvement in safety and security of ammunition stockpiles, within an integrated risk management process and in line with local needs and available financial, technical and human resources.<sup>15)</sup>



National governments hold the primary responsibility to ensure the safety and security of their ammunition stockpiles. This should normally be vested in an authority, which is responsible for the development and enforcement of national legislation and regulations, and which oversees the coordination and management of the State's ammunition stockpile throughout its life cycle. Some States may have limited financial and technical resources and may not be able to achieve a minimum standard of safe, efficient and effective ammunition stockpile management. In conflict-affected settings, where there is an absence of full State control and authority, it may be necessary for international organizations, such as the United Nations, to support ammunition management, in accordance with the principles enshrined in the IATG.

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The IATG are shaped by the following four guiding principles :<sup>16)</sup>

- The right of national governments to apply national standards to their national ammunition stockpile ;
- The need to protect those most at risk from undesirable explosive events, (e.g. local civilian communities and explosives workers) ;
- The requirement to build national capacity to develop, maintain and apply appropriate standards for stockpile management ; and
- The need to maintain consistency and compliance with other international norms, conventions and agreements.

## Developing national standards and policies for ammunition management

In the absence of national legislation, regulations, and standards on ammunition management, a State will not be able to achieve long-term improvements in stockpile management. The development of appropriate standards and policies is a national responsibility and is based on national needs and priorities. These can vary widely between States.

For States without developed standards and policies, the IATG offer guidance. However, the IATG do not in themselves provide a definitive set of references which can be simply duplicated to form a national set of regulations, rather they provide the underpinning principles and guidance on which national policy, regulations and technical operating procedures may be based.



The IATG are **technical guidelines**, and do not provide a template for the development of a holistic normative framework for ammunition management. Nevertheless, such guidance can be found in the *guide to Developing National Standards in Accordance with IATG*.

## Whole-life management approach

The IATG adopt a whole-life management approach to ammunition management. At the centre of this approach is risk management, with a particular focus on improving stockpile management practices as a means of reducing the probability of unplanned explosions at munitions sites and diversion. Specifically, the IATG address the following challenges by providing guidance on :

- **Categorization and accounting systems**, which increase a State's ability to assess the quality and quantity of its stockpile, distinguish between surplus stocks and ammunition necessary for operational purposes, and identify loss or theft from the ammunition stockpile ;
- Appropriate **storage and transportation systems** (including relevant infrastructure and vehicles), which protect ammunition from external, environmental influences and events as well as unauthorized access to facilities ;
- **Surveillance and technical inspection of ammunition**, to assess the stability and reliability of ammunition, to prevent accumulation of ageing, unstable and unsafe ammunition and to diminish the chances of unsafe use, handling, storage, and disposal of stocks ; and
- Proper **physical security** – ranging from effective depot and perimeter security, to lock and key systems – which mitigate theft and sabotage.

A comprehensive approach to ammunition management requires adopting a holistic approach to risk management. To reduce the risk of unplanned explosions of ammunition sites and diversion, both the technical and political aspects of ammunition management need to be addressed.



An example of such a comprehensive approach is the concept of Life-Cycle Management of Ammunition (LCMA). The LCMA model is based on the IATG and stresses the importance of the technical and political aspects:

- Technical—the functional elements necessary for the management of ammunition throughout its life cycle i.e. from planning to procurement, through stockpile management, and disposal.
- Political—the role of national ownership, the structural element necessary for effectiveness of the overall system.

For further information about the LCMA model, see Small Arms Survey's A Practical guide to Life-cycle Management of Ammunition.

### Modular and RRPL approach

In order to facilitate the reduction of ammunition-related risks, the IATG use the concept of Risk Reduction Process Levels (RRPL) to categorize the various tasks and activities associated with ammunition stockpile management. As mentioned in section 2.2, the RRPL are defined at three levels (basic, intermediate and advanced), based on the complexity of a particular activity or task and the resources required to implement them. **IATG 01.20** provides a more detailed overview of the RRPL system, an index of the different RRPL activities and where additional guidance on specific measures is located within the different IATG modules.



The IATG stress that States should aim to make sure that stockpile management processes are maintained at Risk Reduction Process Level (RRPL) 1 as a minimum, which will reduce the risk of unplanned explosions of ammunition sites and diversion 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.

Risk cannot be completely eliminated and all 3 RRPL levels carry an element of risk acceptance.

- **Level 1.** Represents the most basic compliance with the IATG and suggests that the simplest safety and security precautions have been implemented in order to prevent an accidental explosion and diversion. A minimal investment of resources has taken place in organizational development, operating procedures and storage infrastructure.
- **Level 2.** Represents an intermediate level of compliance with the IATG, reducing the risk of accidental explosion and diversion even further. A medium level investment of resources has taken place in organizational development, staff technical training, storage and processing infrastructure.
- **Level 3.** Represents advanced compliance with the IATG and indicates that a safe, secure and effective ammunition stockpile management system has been implemented in accordance with best international practice. RRPL 3 requires the greatest investment. The result is a significant reduction in the risk of unplanned explosions of ammunition sites and diversion.



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The design and implementation of an ammunition management system should be based on a thorough analysis of the circumstances in which ammunition is being stored. For example, in hot climates, where the degradation of energetic materials takes place at faster rates, it will be necessary to implement robust procedures for the disposal of propellants, which have passed their shelf-life expiry date, or implement measures for the stability testing of propellants.

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### **Building national capacity for ammunition personnel**

An inherent assumption within the IATG is that they will be used by suitably qualified and competent ammunition personnel. Yet, in many States such personnel are lacking and there is very little international guidance explaining what competencies are required for the various roles within an ammunition management system.



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#### *What is competency?*

According to the IATG, competence refers to the ability of an individual to do the job properly and the term competency refers to the related knowledge, skills, abilities, attributes and behavioural traits of an individual.<sup>17)</sup>

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A fundamental element of any safe system of work is that activities are conducted by appropriately trained and competent personnel. In developing their own national ammunition management competences, **IATG 01.90** suggests that States develop capacity in the following functional areas, as described in Table 1.

**Table 1 – Functional categories of qualified ammunition personnel** <sup>18)</sup>

| <b>Category</b>       | <b>Description of role</b>   |
|-----------------------|--|
| Ammunition operator   | Assists in the handling and movement of ammunition and explosive substances and articles during issue, receipt, storage and distribution.                              |
| Ammunition processor  | Inspects, maintains and repairs ammunition or other explosive substances and articles.   |
| Ammunition accountant | Accurately accounts for ammunition and explosive substances and articles.  |
| Ammunition supervisor | Supervises the issue, receipt, storage, distribution, maintenance and disposal of ammunition and explosive substances and articles.                                    |
| Ammunition manager    | Manages the storage, issue, receipt, distribution, maintenance and stockpile management of ammunition and explosive substances and articles.                           |
| Ammunition inspector  | Develops, implements and audits the policy and technical instructions for all aspects of the stockpile management of ammunition and explosive substances and articles. |
| Ammunition regulator  | Develops national policy and technical instructions for all aspects of the stockpile management of ammunition and explosive substances and articles.                   |



It is recommended that States take an incremental approach to developing individual competences and that the focus should be on the ammunition operator, supervisor and accountant roles. As personnel become more adept, the focus should shift to developing the higher-level competences associated with ammunition and explosives management, inspection, surveillance and national regulation.

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## 3.2 AMMUNITION MANAGEMENT WITHIN AND BEYOND THE NATIONAL STOCKPILE

The IATG are primarily designed to provide to States and other users, guidance for the safe and secure management of national ammunition stockpiles – i.e. the full range of ammunition stocks under the control of separate organizations such as the police, armed forces, border guards, and ammunition-producing companies. States may also provide ammunition for multi-national operations. The IATG provide guidance for ammunition management in such contexts.

### Ammunition management by police forces

The IATG define “small unit” ammunition stockpiles as those referring to “an 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”<sup>19)</sup>. Examples include ammunition stocks stored at police stations, isolated small military units, and border guard posts.



#### *What is an Explosives Storage Area (ESA)?*

The IATG define an Explosives Storage Area as an area used for the storage of explosives and within which authorized ammunition or missile preparation, inspection and rectification operations may also be carried out.<sup>20)</sup>

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While the types and quantities of ammunition at such locations might not be as complex and large as those stored at central Explosives Storage Areas (ESA) or facilities, they can still pose safety and security risks to local populations and the State. This is especially true when ammunition and explosives are recovered by police, or other security agencies, and not handled or stored appropriately (see Boxes 1 and 2).

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### **Box 1 – Improperly stored recovered explosives in Taiyuan, Shanxi Province, China**

On 22 June 2005, an explosion occurred in a chemical plant in Taiyuan. The incident was caused by confiscated explosives that had been stored at the facility by the local police. At the time of writing, the exact cause of the explosion and the reasons for why they were stored at the chemical plant remain unknown. However, reports suggest that it resulted in considerable damage to the infrastructure of the chemical plant and the surrounding buildings – windows were shattered within a 1.5 km radius of the location. About 336 individuals were injured as a result of the blast, including 80 pupils of a nearby primary school.

*Source: Small Arms Survey (2018).*

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**IATG 12.20** provides guidance for small unit ammunition management. Themes covered by the guidance include: small unit storage requirements, magazine infrastructure, ammunition inspections and measures to take when encountering recovered or confiscated ammunition and explosives, including how to dispose of them. Specifically, the module is designed to be used as a checklist and a basic reference guide; it points users to the more comprehensive clauses within the IATG that should be applied to small unit ammunition stores, in order to ensure that the storage complies with at least RRPL 1.

### **Ammunition management on multi-national operations**

Besides national security forces and ammunition-producing companies, ammunition may also be held by multi-national forces engaged in peace operations, including: <sup>21)</sup>

- Those mandated by the UN Security Council (UNSC);
- Those undertaken by regional organizations (e.g. African Union); and/or
- Those undertaken by coalitions of States

The various multi-national operations primarily take place in conflict-affected settings. To successfully carry out their mandate under these conditions – such as protection of civilians – those engaged must ensure operational readiness, a key component of which is maintaining the safety and security of their ammunition stockpiles. Improper stockpile management during a peace operation can endanger both uniformed and civilian persons (see Boxes 2 and 3).

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#### **Box 2 – Mortar accident in Mali: the consequences of improper ammunition management**

On 6 July 2016, a 60 mm mortar bomb exploded in the barrel during a live firing exercise conducted outside the Dutch UN Mission camp near Kidal, north-eastern Mali. Two Dutch soldiers lost their lives and another was seriously wounded. An investigation by the Dutch Safety Board concluded that military personnel had been working with ammunition that suffered from weak technical design elements and which had not been properly tested for quality or safety. The closure plate on the mortar fuze that exploded was defective and failed to prevent an explosion while in safe mode. The reliability of the ammunition had been further impaired as a result of storage and usage in unfavourable conditions: the materiel had been exposed to both high temperatures and moisture. As a result, the sensitivity of the explosive components in the fuze had increased, which, when combined with the shock from the launch of the mortar bomb, led to the explosion.

*Sources: Dutch Safety Board (2017); Reuters (2017); Carapic et al (2018), p. 34.*

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Ammunition for multi-national operations might not necessarily be directly managed by ammunition experts or qualified personnel. Guidance for managing, securing, storing and transporting weapons, ammunition and other contingent-owned equipment (COE) and as well as recovered weapons, are laid out in numerous mission-specific and UN-level documents.

**IATG 12.10** – pertaining to ammunition for multi-national operations – complements existing UN and mission-specific guidance documents by providing a reference guide for Troop Contributing Nations (TCNs) during handling, storage and transport of ammunition. The principles and procedures for safe and secure ammunition management are the same whether the ammunition is managed by national security forces and stored in an Explosives Storage Area or whether they are managed by multi-national forces and held in temporary or field storage locations. While the range of procedures during deployed operations will be substantially less than at the base or logistics level, **IATG 12.10** explains relevant measures to be implemented, by TCNs, to ensure that ammunition stockpile management during peace operations complies to a minimum of RRPL 1. <sup>22)</sup>



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The IATG recommend that TCNs develop Standing Operating Procedures (SOPs) alongside their national stockpile management SOPs, for the sound management of the ammunition stockpile available within their national contingents deployed to peace operations. These SOPs need to be harnessed within the national SOPs, UN safety requirements and local conditions of the host countries <sup>23)</sup> (see section 3.1).

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### Box 3—Ammunition management and arms embargoes

Ammunition may also be acquired by States as a result of the enforcement of international arms embargoes. A good example of this is the substantial quantity of military propellant which was intercepted by the US Navy on the MV Monchegorsk in the Red Sea, while in transit from Iran to Syria, in February 2009. A total of 98 shipping containers were seized and were kept in uncovered storage, with direct exposure to solar radiation, at the Evangelos Florakis Naval Base in Cyprus. The storage location was immediately adjacent to the principal electricity power station in Cyprus and is shown in Figure 3.

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**Figure 3**—Overhead image of propellant-filled shipping containers at the Evangelos Florakis Naval Base in Cyprus in 2011<sup>24)</sup>



During the early morning of 11 July 2011, the contents of one of the containers spontaneously ignited and subsequently the entire stockpile detonated. Later analysis by the NATO Munitions Safety Information Analysis Center (MSIAC) estimated that the net explosive content of the stockpile was approximately 480,000 kg. The incident resulted in 13 fatalities, 62 injuries and over 3 billion euros of infrastructure damage. There were consequences for those politically responsible. Figure 4 shows the ensuing devastation following the explosion.

**Figure 4**— Overhead image of the Evangelos Florakis Naval Base following the catastrophic explosion on 11 July 2011 <sup>25)</sup>



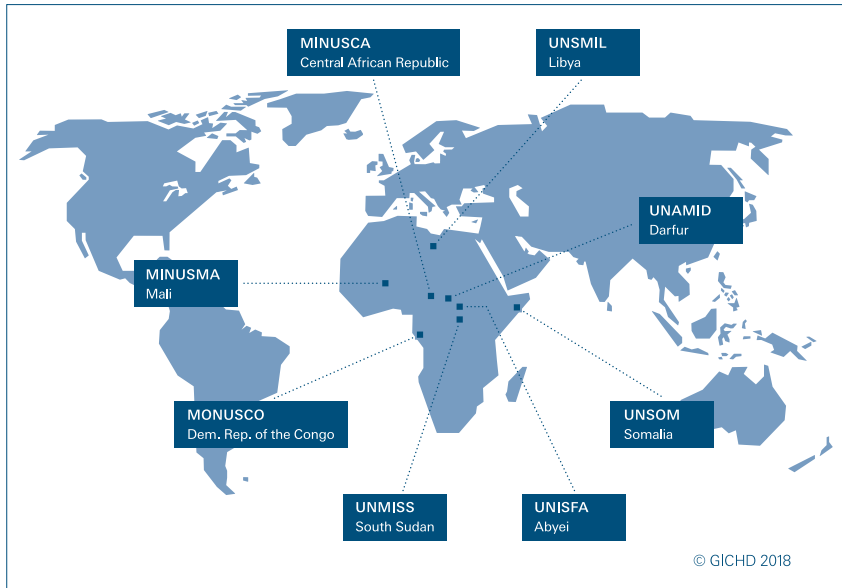
### **Ammunition management in conflict-affected and developing settings**

The risk of diversion and unplanned explosions is especially high in conflict-affected environments or in contexts where funding, technical personnel, equipment, or physical infrastructure is not available. In the absence of institutional capacity and political will, the international community often steps in to provide stockpile management support.

Addressing the risks from poorly managed and unsecured ammunition in conflict-affected and developing environments is increasingly being addressed in the mandates of UN missions. In 2013, UN Security Council resolution 2100, called on the Multidimensional Integrated Stabilization Mission in Mali (MINUSMA) to assist the transitional authorities, through training and other support, in weapons and ammunition management. <sup>26)</sup> Since then, a number of peacekeeping and special political missions have been mandated with ammunition management-relevant tasks (see Figure 5).

A comprehensive review of weapons and ammunition management-related language over the last thirty years in United Nations Security Council documents is provided in the *United Nations Aide Memoire: Options for Reflecting Weapons and Ammunition Management in Decisions of the Security Council (2018)*. <sup>27)</sup>

**Figure 5** – Major UN peacekeeping and special political missions comprising ammunition management activities (as of 2018)



The application of the IATG in conflict-affected settings has proved to be particularly challenging. However, international guidance is available. In January 2018, the United Nations published the handbook, *Effective Weapons and Ammunition Management in a Changing Disarmament, Demobilization and Reintegration Context*.<sup>28)</sup> This publication provides UN disarmament, demobilization and reintegration (DDR) officers with practical guidance regarding arms control operations at both programmatic and technical levels, enabling them to understand the technical requirements to effectively plan and implement weapons and ammunition management activities.<sup>29)</sup>

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### 3.3 HOW DO THE IATG RELATE TO OTHER UN PROCESSES ?

The IATG have been developed to be compatible with a range of other UN standards, including :

- **Modular Small-arms-control Implementation Compendium (MOSAIC):** launched in 2012, the MOSAIC framework includes 24 modules that provide practical guidance for curbing the illicit trade, uncontrolled proliferation and misuse of small arms and light weapons (SALW). MOSAIC is being used in more than 100 countries to help strengthen national capacities on SALW management.



For more information on MOSAIC, go to :  
[www.un.org/disarmament/convarms/mosaic/](http://www.un.org/disarmament/convarms/mosaic/)

- **International Mine Action Standards (IMAS).** These are the standards by which all UN mine action operations are conducted. IMAS is compatible with the IATG, particularly in the areas of stockpile reduction and the storage, transportation and handling of explosives in demining operations.



For more information on IMAS, go to :  
[www.mineactionstandards.org/](http://www.mineactionstandards.org/)

- **Integrated Disarmament Demobilization and Reintegration Standards (IDDRS).** Completed in 2006 and undergoing a substantive updating in 2019, the IDDRS provide a set of policies, guidelines and procedures to support all aspects of DDR operations in peacekeeping contexts, including disarmament. The Inter-Agency Working Group on DDR is currently revising the IDDRS to reflect the evolution of DDR practice.



For more information on the IDDRS go to :  
[www.unddr.org/iddrs.aspx](http://www.unddr.org/iddrs.aspx)

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## UN arms control process

The IATG should be situated within broader, applicable arms control process. The following section provides an overview of some of the major arms control mechanisms and instruments, highlighting their scope and the degree to which they deal with the issues of ammunition management.

## 2030 Agenda for Sustainable Development

In September 2015, UN Member States adopted the 2030 Agenda for Sustainable Development. SDG 16 dedicated to peace, justice and strong institutions is a natural entry point for national ammunition management. Improving ammunition security and safety is a key measure to curbing illicit arms flows (encapsulated in SDG 16.4) and preventing unplanned explosions.



Regulating arms and ammunition can reduce violence against women and girls in both public and private spheres.



Effective ammunition management mitigates the risk of storage depots accidentally exploding in populated areas. These explosions, when they occur, are humanitarian disasters that lead to death, injury, economic loss, displacement and destruction of infrastructure and private property.



Strengthening the institutional capacities of States to better control arms and ammunition helps prevent conflict, violence, terrorism and crime.

## The Secretary-General's Disarmament Agenda

The Secretary-General's Disarmament Agenda, *Securing Our Future*<sup>30)</sup> provides steps to be taken in order to ensure human, national and collective security in the current global climate. The issue of ammunition is covered by the agenda, especially as it relates to achieving above SDG 11 and 16. Action 22 of the implementation plan for the agenda refers directly to ammunition management.



For more information on the UN Secretary-General's disarmament agenda, visit: [www.un.org/disarmament/sg-agenda/en/index.html](http://www.un.org/disarmament/sg-agenda/en/index.html)

## Arms Trade Treaty

The Arms Trade Treaty (ATT) is a multilateral instrument that regulates the international transfer of conventional arms. The treaty establishes legally binding commitments governing international trade of conventional arms, including Small Arms and Light Weapons (SALW). Some of the ATT provisions also apply to ammunition and their parts and components.

The IATG are relevant to the ATT in terms of preventing and addressing transfer diversion.

## Firearms Protocol

The purpose of the Firearms Protocol is to “promote, facilitate and strengthen cooperation among States Parties in order to prevent, combat and eradicate the illicit manufacturing of and trafficking in firearms, their parts and components and ammunition.”<sup>31)</sup>



### *What is marking ?*

The IATG define marking as the application of marks – including colours, descriptive text and symbols – to munitions, parts and components thereof, and associated packaging, for the purpose of identifying, among other things, their role, operational features, and age; and the potential hazards posed by those munitions.<sup>32)</sup>

### *What is the purpose of marking ?*

The ammunition and packaging should be appropriately marked to provide information to enable the explosives to be stored, handled and transported correctly; packaging is a key safety measure.<sup>33)</sup>

In the context of the Firearms Protocol, if ammunition is recovered from a crime scene or in the course of illicit manufacturing or trafficking, its markings can be used by the investigating State to search its own records and as a basis for an international request for the tracing of that firearm or ammunition.<sup>34)</sup>

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## The Wassenaar Arrangement

The Wassenaar Arrangement was established to contribute to regional and international security and stability by promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies. It covers small arms and light weapons and related ammunition.

### 3.4 REGIONAL INSTRUMENTS AND ORGANIZATIONS

Table 2 provides an overview of the main international and regional regulatory agreements and frameworks relevant to ammunition management and control.

**Table 2** – International and regional regulatory frameworks relevant to ammunition management

| Framework   | Date     |                  | Legal status    |                     |
|---|----------|------------------|-----------------|---------------------|
|   | Adoption | Entry into force | Legally binding | Non-legally binding |
| <b>International</b>  |          |                  |                 |                     |
| 2030 Agenda for Sustainable Development (universal adherence)                           | 2015     |                  |                 | ✓                   |
| ATT   | 2013     | 2014             | ✓               |                     |
| CCW Protocol V  | 2003     | 2006             | ✓               |                     |
| UN Firearms Protocol  | 2000     | 2005             | ✓               |                     |
| <b>Regional</b>   |          |                  |                 |                     |
| CARICOM Crime and Security Strategy   | 2013     |                  |                 | ✓                   |
| Khartoum Declaration  | 2012     |                  |                 | ✓                   |
| CARICOM Declaration on SALW   | 2011     |                  |                 | ✓                   |
| ECCAS Convention (Kinshasa Convention)  | 2010     | 2017             | ✓               |                     |
| EU Council Common Position 2008/944/CFSP  | 2008     | 2008             | ✓               |                     |
| ECOWAS Convention   | 2006     | 2009             | ✓               |                     |
| EU Strategy to combat illicit accumulation and trafficking of SALW and their ammunition | 2005     |                  |                 | ✓                   |
| Nairobi Protocol  | 2004     | 2005             | ✓               |                     |
| OSCE Document on Stockpiles of Conventional Ammunition                                  | 2003     |                  |                 | ✓                   |
| SADC Protocol   | 2001     | 2004             | ✓               |                     |
| Nadi Framework  | 2000     |                  |                 | ✓                   |
| CIFTA   | 1997     | 1998             | ✓               |                     |

# 04

## IATG MODULES SUMMARY AND APPLICATION





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## 4.1 RISK MANAGEMENT

Ammunition presents an inherent risk, and inadequately managed ammunition stockpiles present an even greater risk by threatening public safety and the security of the respective State.



### *What is risk ?*

The IATG define risk as the combination of the probability of occurrence of harm and the severity of that harm, as represented by the following equation:  $\text{risk} = \text{likelihood} \times \text{consequence}$  <sup>35)</sup>

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Consequently, ammunition stockpile risk management is focused on the safety and security of ammunition and ammunition-related activities towards ;

- preventing unplanned explosion events and
- mitigating harm (in the event an unplanned explosion does occur) to surrounding exposures, which might be military assets, equipment, facilities, workers, the public, etc.

With safety and security in mind, the IATG lay out an integrated process for managing risks from stockpile ammunition and ammunition-related activities. This process has been configured to give a State the ability to progressively reduce risk as more resources become available to them. <sup>36)</sup> This section will explain basic IATG risk management concepts, its main components, and how these components work together in an integrated manner.

### **What is risk management ?**

The IATG state that risk management should be seen by States as a fundamental preventative measure to support safe conventional ammunition stockpile management. Additionally, they state that decisions based on more complete knowledge can be made if the likelihood of an explosives accident can be considered as well as the consequences. <sup>37)</sup>



### *What is risk management ?*

The IATG broadly define risk management as the complete risk-based decision-making process. <sup>38)</sup>

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From the above, it can be surmised that risk management is all about risk reduction, risk management and risk acceptance ; this refers to those actions taken to lessen the probability, negative consequences, or both, associated with a particular risk. Risk management strives to reduce risk to a tolerable level based on the current values of society and as determined by the appropriate national authority.



### *What is tolerable risk?*

It is risk, which is accepted in a given context based on the current values of society.<sup>39)</sup>

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Civilian casualties associated with an unplanned explosion event, and diversion of ammunition from a national stockpile, are considered highly unacceptable and represent a threshold for tolerable risk.

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Expanding further, as described in the **IATG 02.10**, risk management (accounting for both safety and security) can generally be described as a process used to:

- Identify all potential or known stockpile hazards or threats, such as unsafe ammunition, lack of or application of improper quantity distances, improper operating procedures, untrained personnel, inadequate funding, the lack of surveillance, open storage and inadequate structures, inadequate security;
- Assess and analyze these hazards to identify potential consequences, such as fatalities, injuries, or damage, potential for theft, diversion, or other illicit activities;
- Eliminate or mitigate overall risk (probability or consequences or both) to tolerable levels using techniques and engineering principles included in the IATG); and
- Identify remaining or residual risk to present to the appropriate national authority and to communicate it to affected individuals.

### **Why is risk management necessary?**

The nature of ammunition and explosives with their potential for unplanned, violent reaction makes a risk-based approach to conventional ammunition management necessary.<sup>40)</sup>



As discussed in section 2.1, the risk from ammunition stockpiles is illustrated by the number of Unplanned Explosions at Munitions Sites that have occurred in the recent past.<sup>41)</sup> These explosive events, in terms of the large numbers of casualties and lost assets and capabilities, have been the catalyst for UNGA involvement and the development of the IATG and its implementing programme – UN SaferGuard.

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Even with an effective risk management process implemented, ammunition and ammunition-related activities can never be absolutely safe. This is an inevitable fact of life, which does not mean that all efforts to ensure safety are not undertaken; it just means that absolute safety cannot be proved with 100% confidence.<sup>42)</sup> Conversely, having either a deficient or no risk management process implemented, provides for significantly less confidence in the level of safety, potentially 0% if there is no process at all. And, as detailed in a number of IATG modules, there are any number of factors that, if not monitored and managed, will actually increase the probability of an unplanned explosion event.

Consequently, an effective and integrated risk management process can help a State in:

- Keeping its ammunition stockpile safe, secure, functional and available for when it is needed;
- Assuring the best value-for-money with regards full utilization of a critical and expensive commodity; and
- Keeping ammunition-associated processes and operations safe and secure.

### What does a comprehensive risk management system look like?

Risk-based approaches take many forms, vary in degrees of complexity and are constantly evolving. For those with limited resources and capabilities, simple risk management techniques and tools can help define risks related to unplanned explosion events and prevent diversion, so that decision makers clearly understand the risks they are accepting and the consequences of their decisions.

Additionally, there is a great deal of guidance and information available to help a State establish a framework on which to develop and build its risk management processes.<sup>43)</sup>



The IATG's integrated risk management approach (applicable for both safety and security) is based on the generic risk management process given in ISO guide 51,<sup>44)</sup> with a special emphasis on activities associated with conventional ammunition storage.

A critical element of stockpile management planning and operations is the implementation of an effective and integrated risk management system. As applied within the IATG, integration means that risk management will be:

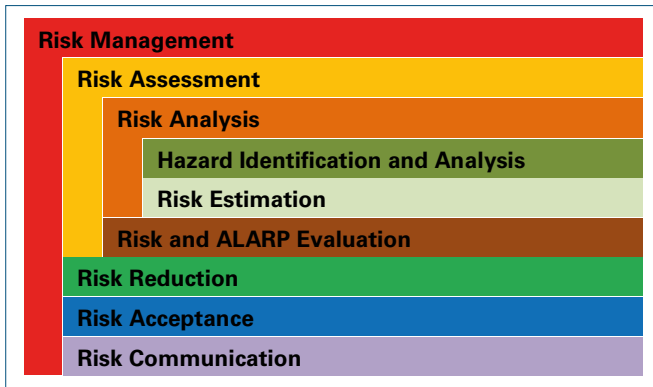
- Supported by all leadership levels, supporting organizations, and workers;
- Well defined and institutionalized in a State's risk management policy and implementation documents which include responsibilities and requirements;
- Addressed in every aspect of all stockpile management activities and related functions, such as equipment, facilities, processes, training and operating procedures.

IATG 02.10 describes the IATG’s over-arching risk management approach and each of its four major components :

- Risk Assessment,
- Risk Reduction,
- Risk Acceptance, and
- Risk Communication.

As can be seen in Figure 6, Risk Assessment is then further broken out into Risk Analysis and Risk and As Low As Reasonably Practicable (ALARP) Evaluation, and Risk Analysis is yet further broken out to Hazard Identification and Analysis and Risk Estimation.

**Figure 6**– Risk management structure



Risk management has been integrated throughout the IATG’s requirements and guidance and is considered to be a complete risk-based decision-making process.



*What is ALARP?*

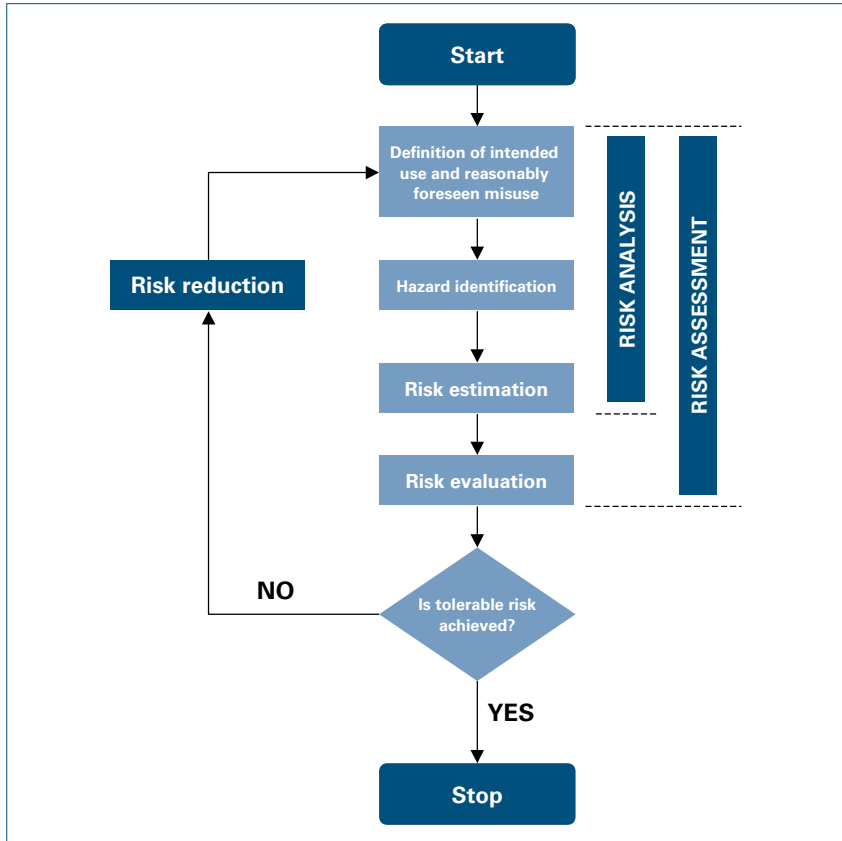
The IATG use the term “As Low As Reasonably Practicable (ALARP)” to identify the lowest amount of risk that can be accepted by a national authority. The ALARP level should be determined through a quantitative risk assessment, based on technical and explosives engineering judgement.

*What is a quantitative risk assessment?*

According to the IATG, a quantitative risk assessment is 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 principle.<sup>45)</sup>

Figure 7 shows an overview of the risk evaluation process. It shows the process for arriving at a decision or a desired result by repeating rounds of analysis or a cycle of operations. The objective is to bring the desired decision or result closer to implementation with each repetition (iteration).

**Figure 7** – The risk evaluation process



**IATG 02.10** 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.<sup>46)</sup> The following text further expands on how risk management and its implementation have been simplified, in terms of providing a State with the means to gradually and incrementally improve stockpile-related activities as their resources and capabilities allow:

- **The IATG are structured in an integrated risk management process framework.** The way this is accomplished is by identifying specific tasks and activities in each module for the particular stockpile management topic area addressed by that module and for a particular Risk Reduction Process Level (RRPL). Additionally, where there is a relationship with tasks and activities contained in other IATG modules, then reference is made to those other modules. If requirements are fully implemented, then risk management associated with that particular topic area and for a particular RRPL has been met. However, if requirements are not met, then the approach illustrated in Figure 6<sup>47)</sup> should be used to mitigate risk to As Low As Reasonably Practicable (ALARP)<sup>48)</sup> and appropriate national authority approval obtained for any remaining residual risk.



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A State should have an organization dedicated to conventional ammunition management. The basic aim of such an organization should be to make sure that stockpile management measures and processes elaborated in the IATG are maintained at RRPL1, as a minimum. This will significantly reduce the risk of diversion and explosion. Ongoing and gradual improvements should be made to the stockpile management infrastructure and processes as staff development improves and further resources become available.<sup>49)</sup>

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A State can assess the RRPL levels of its ammunition stockpile through use of the UN SaferGuard RRPL Checklist<sup>50)</sup> which poses a series of questions for specific topic areas addressed within the IATG and then, based on responses to these questions, determines a calculated weighted score. To achieve a given RRPL, a site's score must meet or exceed the appropriate score threshold, and all "critical" questions for the RRPL must be satisfactorily answered.

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Box 4 provides an extract from **IATG 01.20**<sup>51)</sup> that lists (by module clause) some of the tasks and activities associated with RRPL 1. Similar lists are available for RRPLs 2 and 3 – related tasks and activities.<sup>52)</sup>

#### Box 4 – Extract from the Index of Risk Reduction Process Level 1 within the IATG

| 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  |   |
|                |  | 7.2     | Ammunition requiring separate storage                                 |   |
| 02.10          | Introduction to Risk Management Principles and Processes | 8.2.1   | Probability estimation of an unplanned or undesirable explosive event |   |
|                |  | 10      | Risk reduction  |   |
|                |  | 11      | Risk acceptance   |   |
|                |  | 12      | Risk communication  |   |
|                |  | Annex D | Example Qualitative Risk Assessment methodology                       |   |
|                |  | Annex F | Risk management and IATG Software                                     |   |
| 02.50          | Fire Safety  | 5       | Principles  |   |
|                |  | 6.1     | Fire safety plan  |   |
|                |  | 7       | Fire alarm systems  | More technical systems would be Level 2 |
|                |  | 8       | Fire breaks and vegetation  |   |
|                |  | 8.2     | Fire practices  |   |
|                |  | 10.2    | Fire signs and symbols  |   |
|                |  | 10.3    | First aid re ghting appliances (FAFA)                                 |   |
|                |  | 11.1    | Unit immediate actions  |   |
|                |  | 11.2    | Brieng to Senior Fire Officer   |   |
|                |  | Annex C | Fire signs  |   |

- Using the baseline RRPL lists and the IATG, a State can then develop an action plan and goals for reaching its desired end state for the national stockpile and with regards to safety and security and adherence to the IATG. Using the IATG’s integrated RRPL-based approach, a State can develop, manage and monitor its own efforts towards achieving self-identified RRPL goal(s), as their domestic skills and resources become available.



Adherence to the IATG generally means that a conventional ammunition stockpile management organization is implementing many components of an integrated risk management system.<sup>53)</sup>

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## 4.2 AMMUNITION ACCOUNTING

The ability to rapidly detect inadvertent inaccuracy, loss, theft, leakage or diversion is a key control measure of effective stockpile management, particularly as ineffective stock accounting significantly increases the risk of diversion.<sup>54)</sup>



Ammunition accounting has an important role in supporting the following :

- **Security.** Accounting supports national and international efforts to eliminate ammunition-related diversion and illicit criminal activities.
- **Stockpile management.** Accounting supports processes used to manage and monitor ammunition safety (prevent unplanned explosion events), functionality (performs within required parameters), and serviceability (safe to issue).
- **Through Life Management (TLM) of ammunition.** Accounting provides important information to support TLM-related functional elements (planning, procurement, stockpile management, and disposal).

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This section will address each of these areas and will also explain what accounting is, why it is necessary, where it fits within a stockpile management organizational structure, and its role and responsibilities. Other areas, such as accounting system methodology, inventory management, importance of accuracy, stocktaking and audits, and the value of batch and lot numbers as part of accounting, will also be briefly touched on.

### What is ammunition accounting ?

Ammunition accounting is simply the process implemented for monitoring and managing the quantities, condition, locations and accuracy of ammunition stocks.



#### *What is accounting ?*

The IATG describes accounting as the information management systems and associated operating procedures that are designed to record, numerically monitor, verify, issue and receive ammunition in organizations and stockpiles.<sup>55)</sup>

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IATG volume 03 specifically addresses the topic of ammunition accounting through five modules,<sup>56)</sup> described below:

- **IATG 03.10 – Inventory management.** The importance and value of accounting and inventory management are explained in this module, as are its basic elements, such as the structure of the accounting and inventory management systems, responsibilities, assignment and monitoring of ammunition locations, issue, receipt, assignment of condition codes, planning for procurement and calculations of requirements, and associated financial accounting.
- **IATG 03.20 – Lotting and batching.** This module introduces the concept of lotting and batching; describes when lot and batch numbers should be used, how they are assigned, and what information should be derived from a lot or batch number.
- **IATG 03.30 – Import and export of ammunition.** This module discusses principles that have been internationally agreed for national controls over international ammunition transfers.
- **IATG 03.40 – End-users and end-use of internationally transferred ammunition.** This module provides guidance for the development and implementation of effective and accountable national controls over the end-users and end-uses of internationally transferred ammunition.
- **IATG 03.50 – Tracing of ammunition.** This module discusses basic principles of tracing as well as principles for tracing of illicit ammunition.

The focus of this section is primarily on accounting and inventory systems, as detailed in **IATG 03.10**, and reference will only be made to other IATG volume 03 modules as necessary.

### **Why is ammunition accounting necessary?**

Effective accounting processes and procedures provide the means for monitoring and managing ammunition condition, location, safety and security and to help identify errors, loss and theft and prevent diversion and illicit activities. They can also provide a strong deterrent and a control measure to help prevent ammunition theft, diversion and illicit activities, because the probability of being caught is increased.



Ineffective stockpile accounting systems significantly increase the risk of unplanned explosions and diversion.<sup>57)</sup>

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Additionally, accounting is important in that it supports the operational readiness of the ammunition stockpile to meet national and organizational requirements, by providing critical information to support stockpile management processes and decisions, such as policy, strategic and operational planning, budgeting, training, procurement and disposal. Table 3 illustrates how accounting supports stockpile management and can help address specific broad areas of concern.

**Table 3 – Importance of accounting in supporting stockpile management activities**

| Activity                                    | Concern  | Role of accounting process <sup>58)</sup>  |
|---|--|--|
| Matching stockpile to national requirements | <ul style="list-style-type: none"> <li>• Large quantities of improper, obsolete, surplus, unserviceable and unsafe ammunition stocks may result in misrepresented or incorrect operational capabilities</li> <li>• Valuable and limited resources being misused or mis-directed</li> <li>• Incorrect resource planning leading to incorrect procurement</li> </ul>   | <ul style="list-style-type: none"> <li>• Gives visibility over the entire stockpile in terms of status and availability</li> <li>• Provides the ability to assess if it contains the right types and quantities of ammunition to meet necessary strategic and operational requirements</li> </ul>                            |
| Security                                    | <ul style="list-style-type: none"> <li>• Diverted stocks can be used for illicit activities domestically and internationally</li> <li>• Stocks diverted from their intended purposes can impact operational readiness</li> <li>• Replacement stocks can be very costly and may require long lead times to procure</li> </ul>   | <ul style="list-style-type: none"> <li>• Provides visibility to ammunition types, quantities and locations</li> <li>• Provides ability to quickly identify lost, stolen, damaged, misused, or diverted ammunition</li> <li>• Supports investigations into illicit activities in order to take appropriate actions</li> </ul> |
| Safety and operational readiness            | <ul style="list-style-type: none"> <li>• All ammunition has a shelf life <sup>59)</sup> that is finite, and its safety and serviceability (functional and safe to issue) can be influenced by many factors               <ul style="list-style-type: none"> <li>○ Unsafe ammunition increases the possibility of an unplanned explosion event</li> <li>○ Unserviceable ammunition degrades capabilities</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Provides visibility to ammunition types, quantities and locations</li> <li>• Gives visibility to the condition and quality of ammunition stocks</li> <li>• Supports programmes aimed at monitoring and managing safety and serviceability</li> </ul>                                |

**Table 3** – continued

| Activity                             | Concern  | Role of accounting process   |
|--------------------------------------|--|--|
| Disposal                             | <ul style="list-style-type: none"> <li>• Disposal ammunition may present a greater risk for diversion or an unplanned explosion event</li> <li>• Disposal ammunition may need to be managed and monitored as it may still require safety or serviceability-related tests to be performed                             <ul style="list-style-type: none"> <li>○ Ageing propellants present greater risk of an unplanned explosion event</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Provides visibility to disposal-related ammunition types, quantities, conditions and locations</li> <li>• Disposal ammunition needs to be accounted for until removed from the stockpile as a result of a disposal action (export or demilitarization)</li> <li>• Supports programmes aimed at monitoring and managing safety (demilitarization accounts) and serviceability (export accounts)</li> </ul> |
| Forecasting and procurement planning | <ul style="list-style-type: none"> <li>• Valuable and limited resources being misused or mis-directed</li> <li>• Incorrect resource forecasting leading to incorrect planning and procurement</li> </ul>   | <ul style="list-style-type: none"> <li>• Gives visibility to the entire stockpile in terms of status and availability</li> <li>• Supports the planning and forecasting of ammunition needs, as well as any associated costs for procurement, stockpiling and storage, and disposal</li> </ul>  |

**What does a comprehensive ammunition accounting system look like ?**

Ammunition accounting and inventory are important parts of any national ammunition management system and necessary for the safety and security of the national stockpile. Having dedicated organizations, with the necessary authority and responsibility for ammunition accounting and inventory functions, within the ammunition stockpile management system, is important in terms of their effectiveness and ability to support national stockpile management efforts. To advise States in this area, the IATG have proposed an ammunition stockpile management system (with supporting component organizations),<sup>60)</sup> as shown in Table 4. Organizational structure is discussed further in section 4.2 and 4.5.

**Table 4 – Ammunition stockpile management system components** <sup>61)</sup>

| Organisations                              | Remarks   |
|--|---|
| Ammunition stockpile management department | <ul style="list-style-type: none"> <li>• Usually at Ministry of Defence/Interior or Service (Army, Navy, Air Force, Police etc) level.</li> </ul>   |
| Ammunition storage units                   | <ul style="list-style-type: none"> <li>• Subordinate to the stockpile management organisation.</li> <li>• Usually the major ammunition storage depots.</li> </ul>   |
| Ammunition technical inspection units      | <ul style="list-style-type: none"> <li>• Subordinate to the stockpile management organisation and co-located with the major ammunition storage depots.</li> </ul>   |
| Ammunition training unit                   | <ul style="list-style-type: none"> <li>• Subordinate to the stockpile management organisation.</li> <li>• Should be co-located with a major ammunition depot.</li> </ul>  |
| Ammunition inspectorate                    | <ul style="list-style-type: none"> <li>• Subordinate to, and reports directly to, the stockpile management organisation.</li> <li>• Independent of other ammunition units.</li> <li>• Consists of ammunition technical staff to ensure the safety and condition of ammunition within user units.</li> </ul> |
| User units                                 | <ul style="list-style-type: none"> <li>• User units fall under the operational chain of command.</li> </ul>   |

Within the ammunition stockpile management system structure, responsibility for accounting and inventory functions should fall directly under ammunition storage units, <sup>62)</sup> which report directly to the ammunition stockpile management organization. Independent oversight and inspections will be conducted by the ammunition inspectorate. <sup>63)</sup>

Regarding ammunition accounting methodology, **IATG 03.10** recommends that accounting principles be derived from generally accepted accounting principles (GAAP), which provide a widely accepted set of rules, conventions, standards and procedures for primarily reporting and recording financial information. However, the requirements for recording transaction activity and stock levels are equally applicable to ammunition as to any other commodity or process. <sup>64)</sup>



*What are the generally accepted accounting principles (GAAP)?*

GAAP are used by a variety of countries and are being integrated into a range of new international financial reporting standards and international accounting standards that are developed and implemented by an independent organization called the International Accounting Standards Board. <sup>65)</sup>

As indicated in Table 3, the output of accounting plays a critical role in supporting effective stockpile management. This requires that the quality of accounting-related information be: <sup>66)</sup>

- **Objective** – based on stock checks, audits, inspections and transactions.
- **Material** – relevant and complete in order to provide a true and fair view for decision-making purposes.
- **Consistent** – measured in the same manner, using consistent principles.
- **Prudent** – uses the best methods.

With regard to the accounting systems and processes themselves, either manual or computer systems would be acceptable: <sup>67)</sup>

- Manual systems are labour intensive and time consuming and the transmission of information between higher levels of hierarchy and accounting and storage units is slow, but they have proven capability and are simple to use when individuals are appropriately trained.
- Computerized systems are more efficient and capable, but are expensive to develop and usually specifically designed for a particular ammunition stockpile management organization. These systems are equally reliable as the manual systems on the accuracy of the data entered into them. An advantage is that they can be directly linked between the stockpile management organization and the ammunition accounting and storage units, thereby reducing the requirement for reporting of stock levels, as instant visibility is possible.



The accounting systems and processes selected (either manual or computerized) will be based on a State's needs and its available capabilities and resources, taking into consideration the range and complexity of the national stockpile and ammunition-related activities performed. Different types of ammunition will have different safety and security requirements, and more complex activities, such as maintenance, research, production and demilitarization will introduce other aspects that may have to be managed by accounting and inventory systems and processes.

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**Accounting system structure.** A State's ammunition accounting system should be structured to keep accurate records (by specific type, quantity, lot and/or batch number and exact location), for the following stages of an ammunition item's life cycle:<sup>68)</sup>

- On manufacture ;
- On initial testing ;
- During transportation and shipment ;
- In depot storage ;
- On transfer to user units ;
- During storage at user units ;
- In case of loss or theft ;
- When used ;
- When returned to ammunition depots ;
- When repaired or modified ;
- When subjected to surveillance or in-service proof ; and
- When destroyed or demilitarized.



**Tracking ammunition lot and batch numbers as part of inventory management makes ammunition readily identifiable and locatable and supports efforts to maintain safe and serviceable ammunition stocks.**

**Inventory management.** A fundamental component of the accounting system is its inventory management system, which 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.<sup>69)</sup> Inventory management falls naturally among the responsibilities of the ammunition storage unit. See Table 4.

Visibility of the entire ammunition inventory and associated equipment should be available to the ammunition stockpile management organization, regardless of where the ammunition is located. Table 4 identifies an ammunition inspectorate, and it is this organization that has the responsibility of assessing inventory accountability and status, conducting regular (annual) unit ammunition inspections to ensure the safety in storage at unit level, to assess the technical condition of the ammunition in unit storage, and to advise units and formation headquarters on ammunition safety and technical issues.<sup>70)</sup>

The inventory management, including specifics on related activities is addressed in **IATG 03.10.**<sup>71)</sup>

**Accuracy of ammunition accounts.** Inventory accuracy is extremely important for the reasons previously mentioned. The IATG caution that no ammunition storage organization is likely to be able to achieve 100% accuracy in its ammunition accounts.<sup>72)</sup> Organizations claiming 100% accuracy of ammunition accounts should be viewed

with suspicion, as at the very least it is an indication that they do not understand ammunition depot processes ; at worst it means that they have ineffective stockpile management processes, as errors cannot be detected down to lot or batch level, and therefore safety in storage or use may have been compromised. <sup>73)</sup>



*What is a stack ?*

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 unit of space (UOS), to a block of many pallets stored vertically over a number of particular ground level UOS. <sup>74)</sup> For planning purposes, storage space for palletized stores is calculated in UOS. <sup>75)</sup>

The use of stack tally cards supports accurate ammunition accounting, assists in stocktaking and deters theft. Each stack of ammunition should have a tally card(s) attached to it that records the following information for that particular stack :<sup>76)</sup>

- Grid locator reference ;
- Explosive storehouse number ;
- Full description of ammunition ;
- Ammunition descriptive asset code number (or similar asset code system) ;
- Lot and/or batch number (a separate card should be used for each lot and/or batch number) ;
- Ammunition condition code ; and
- A record of transactions (for that stack by quantity, lot/batch number and date ; and the issue or receipt voucher reference for each transaction).

Figure 8 gives an example of such a card using IATG Form 03.10 and identifies the type of information that should be given on it. <sup>77)</sup>

**Figure 8 – Example of a Stack Tally Card**

| Ammunition Stack Tally Card |                              |                 |        |         |           |            |                        |
|-----------------------------|------------------------------|-----------------|--------|---------|-----------|------------|------------------------|
| IATG Form 03.10             |                              |                 |        |         |           |            |                        |
| ESH                         |                              | B3              |        |         | ADAC      |            | 12201-02               |
| Ammunition Description      |                              | Round gnum Ball |        |         | Lot/Batch |            | IMI 10/09 009          |
| Condition Code              |                              | A1              |        |         | Remarks   |            |                        |
| Date                        | Issue/Receipt Voucher Number | Received        | Issued | Balance | Signature | Name       | Grid Locator Reference |
| 01.mars.12                  | XY-1011                      | 230,4           |        | 230,4   | B Smith   | Bob Smith  | C6, C7                 |
| 15 May 12                   | XY-1056                      |                 | 30,4   | 200     | J Brown   | John Brown | C6, C7                 |
| 1 June 12                   | XY-1102                      | 2               |        | 202     | B Smith   | Bob Smith  | C6, C7                 |
|                             |                              |                 |        |         |           |            |                        |

**Stocktaking and audits.** 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 are not provided with a copy of what the ammunition account shows for each storage location. It is only the reconciliation between the ammunition account and the stocktaking record for each storage location that is important.

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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.<sup>78)</sup>

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**Lotting and batching.** Ammunition and explosives may deteriorate or become damaged, with the resultant effect that they may fail to function as designed or may become dangerous, leading to an unplanned explosion event. It is therefore critical, through the accounting system, that the location of specific items of ammunition and explosives be rapidly identified in order that the appropriate remedial action can be taken.



*What is a lot?*

The IATG define a lot as 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.<sup>79)</sup> A lot number is a number allocated to a lot which uniquely identifies that lot.<sup>80)</sup>

*What is a batch?*

A batch is defined by the IATG as 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.<sup>81)</sup> Within the batch a number of sub-batches may be found. A batch number is a number allocated to a batch which uniquely identifies that batch.<sup>82)</sup>

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The assignment of lot or batch numbers is the method used to accomplish this, as the numbers distinguish and identify like items that were manufactured at the same time. Items with the same batch or lot number are generally expected to have the same properties throughout their lifetime, so having such information allows better safety and functional management of the stockpile and provides the ability to quickly identify and locate, by their lot or batch number, unsafe or suspect ammunition, to better manage risk.



IATG module 03.20 introduces the concept of lotting and batching of ammunition, and proposes a system that can be used to support the safe, effective and efficient management of ammunition.<sup>83)</sup> Lotting and batching is also important for stockpile accounting and allows for timely and reliable identification of diversions through loss or theft.<sup>84)</sup>

### 4.3 EXPLOSIVES FACILITIES: FIELD AND TEMPORARY CONDITIONS

In order to ensure the safety and security of stockpiles, ammunition should be stored in purpose-built ammunition depots. However, in certain circumstances – such as those relating to military operations or national security threats<sup>85)</sup> – there might be a need for short-term storage of ammunition under field conditions. The requirements and issues for consideration in field storage and temporary storage are covered in IATG 04.10 and IATG 04.20, respectively. This section provides an overview of measures necessary to ensure safe, secure and efficient field and temporary storage of ammunition.



Ammunition should not be stored under field conditions for more than one year, after such time it should be transferred to temporary or permanent storage facilities.<sup>86)</sup>

#### What is field storage of ammunition?



*What is field storage?*

According to the IATG, the term field storage covers measures necessary for safe, effective and efficient ammunition storage during periods when ammunition is deployed from ammunition depots to support military operations, usually abroad.<sup>87)</sup>

Field storage should be considered as a short-term measure, necessary for storing ammunition in support of deployed military operations. Once military operations have concluded, ammunition should either be returned to long-term storage or stored in accordance with the more stringent temporary storage requirements contained within [IATG 04.20](#). The requirements for field storage are not based solely on the matter of explosive safety, but include other considerations, such as stock preservation through tactical dispersal; the requirement to provide timely and effective support to ongoing military operations; and the need for logistic efficiency and flexibility.



#### *What is a Field Storage Area ?*

According to the IATG, a Field Storage Area (FSA) is a plot of land or area used for storing ammunition and explosives necessary to support military operations. Depending on the military requirements, multiple FSAs might be necessary. The number of FSA are determined by, 1) the quantity and type of ammunition required for operations, 2) the need for at least two-point dispersion to protect stocks, and 3) the need to store incompatible munitions separately. Each FSA should contain no more than 5,000 tonnes of ammunition and explosives.<sup>88)</sup>

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Ammunition necessary for military operations should be stored within a designated Field Storage Area (FSA). The quantity of ammunition and explosives held in any operational FSA shall be limited to the amount necessary to support the military mission. Similarly, the Net Explosive Quantity (NEQ) per storage site should be kept as low as practically possible, consistent with the mission and the available quantity distances.<sup>89)</sup>

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Field storage of ammunition for prolonged periods of time is not recommended, as stock will likely be exposed to the full effects of the climate. In hot regions, direct exposure of stock stored in shipping containers to solar heat will raise temperatures to levels which may cause energetic fillings based on TNT and white phosphorous to melt. Daily temperature fluctuations of ammunition will also reduce shelf life.<sup>90)</sup>

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## How to set up and operate safe and secure field storage

During field operations, ammunition has to be readily available. This implies that, when it comes to field storage, a balance has to be found between safety and security concerns and tactical requirements. For instance, field operations often require vehicles to be loaded with their full combat loads of ammunition and similar quantities to be carried on logistics vehicles. While this ensures operational flexibility, it also increases the risk that an explosive event can occur (Box 5). It is thus essential that the risk is properly analyzed and accepted for field storage of ammunition.

A formal risk assessment is the first step that should be taken to ensure the safe and secure field storage of ammunition. The risk assessment should be completed by a competent technical authority and be carried out in accordance with the principles contained within IATG 02.10. Moreover, the force commander should be informed of the risk, particularly if it involves an increased risk to the general public.<sup>91)</sup>



Where possible, steps should be taken to separate vehicles containing high explosives so that a fire in one does not result in a prompt spread to others. Stocks of ammunition stored in bulk are invariably best stored separately from personnel and vehicles and the prudent use of improvised barricades, constructed by military engineers, should be considered.

### Box 5 – Explosion at Camp Doha, Kuwait

The accidental explosion shown in Figure 9 which occurred at Camp Doha, Kuwait, on 11 July 1991 is a good example of what can go wrong when a fire occurs in a combat vehicle loaded with ammunition. At that time, the US 11th Armored Cavalry Regiment had all of its combat vehicles loaded with ammunition and about an equal amount of ammunition was ground loaded in shipping containers. A fire was started by a defective heater in an M992 ammunition carrier which was fully loaded with 155 mm artillery ammunition. The vehicle exploded and the fire spread to consume the majority of the vehicles and ammunition stored within the compound. The result of the accident was the complete loss of 102 vehicles, and over 50 US and coalition personnel were injured. The value of the loss of the ammunition alone was placed at \$15 million.<sup>92)</sup>

**Figure 9**– Effects of the accidental explosion at Camp Doha, Kuwait, July 1991<sup>93)</sup>



The next step in setting up field storage of ammunition is determining the location of the FSA. In selecting sites for an FSA it is essential that a variety of factors are considered. **IATG 04.10**, paragraph 6.3, provides a detailed overview of the various factors and relevant considerations. However, some of the most pertinent aspects to be considered include :<sup>94)</sup>

- **Physical location.** The FSA should be sufficiently isolated so that it does not pose a hazard to other critical infrastructure such as airfields, hospitals and other logistics installations. The ground needs to be capable of withstanding the passage of substantial military vehicles and should be free from hazards such as oil and gas pipelines or storage facilities. Within the FSA sufficient space should be allocated for administrative facilities, turning circuits for large trucks and to allow one-way traffic, if possible.
- **Stock dispersion.** Sufficient space should be available for the adequate dispersal of stock such that an explosion at one does not spread to another ; two-point stock dispersal is also required for all critical ammunition types.
- **Access to transport infrastructure.** The FSA should be served by a transport infrastructure, which allows easy access to the ports, airfields and operational units it serves.
- **Security.** The requirements for security and dispersion may appear to be mutually exclusive. Where possible, ammunition should be stored with cover from view and in areas where unauthorized access can be denied.

The risk of an explosion with field storage of ammunition is significantly higher than for peacetime storage in purpose-built facilities. The explosive safety of ammunition might be undermined for a variety of reasons, including enemy action with direct, indirect and air-delivered weapons, sabotage, and increased risk of fire due to multiple movements of ammunition and proximity to military vehicles. Measures – such as quantity and separation distance and aggregation and mixing rules – can ensure higher explosive safety of field storage ammunition.

- **Quantity and separation distances.** Ammunition stored in field storage conditions is vulnerable to fire whether started deliberately or by accident. The maintenance of appropriate quantity distances between field storage sites (FSS) ensures that an accident at one FSS does not spread promptly to others. IATG 04.10, para. 7.4.1, recommends that the following simplified Inside Quantity Distances (IQD) shown as Table 5 be applied to FSS.

**Table 5 – IATG-recommended distances between field storage sites**

| Hazard Division | Factor      | Minimum IQD for Hazard Division |       |       |       |
|-----------------|-------------|---------------------------------|-------|-------|-------|
|                 |             | 1.1                             | 1.2   | 1.3   | 1.4   |
| 1.1             | Normal      | 200 m                           | 100 m | 100 m | 100 m |
| 1.1             | Barricaded  | 100 m                           | 100 m | 100 m | 100 m |
| 1.1             | Vital stock | 300 m                           | 100 m | 100 m | 100 m |
| 1.2             | Normal      | 100 m                           | 100 m | 100 m | 100 m |
| 1.3             | Normal      | 100 m                           | 100 m | 100 m | 50 m  |
| 1.3             | Propellants | 200 m                           | 100 m | 100 m | 100 m |
| 1.4             | Normal      | 100 m                           | 100 m | 50 m  | 25 m  |

- **Aggregation and mixing of stock.** The standard Compatibility Group mixing rules for the storage of ammunition should be applied to field storage.<sup>95</sup> Priority should be given to the separate storage of ammunition containing white phosphorous (Compatibility Group H) and ammunition containing hazardous liquid propellants (Compatibility Group L). It is preferable that missiles in a propulsive state are stored in a barricaded storage site, with warheads pointing away from other stocks.

One of the principal disadvantages of field storage of ammunition is that stock is more exposed to the environment and will deteriorate at a far faster rate than when stored in conventional storage facilities. A number of measures can be put in place to ensure the protection of field storage of ammunition, including :

- **Protection of stock from environmental factors.** The environment has a very significant impact on ammunition which can be damaged by exposure to extremes of temperature.<sup>96)</sup> At temperatures below 0° C rocket motors may become brittle thus more prone to cracking when handled. High temperatures may cause energetic materials to migrate into fuze wells and large rocket grains<sup>97)</sup> to become deformed.
- **Barricades.** Barricades<sup>98)</sup> serve two important functions : they prevent hazards entering the site from outside and also, when placed between individual stock holding sites, prevent a fire or explosion at one site spreading to other sites. Effective short-term barricading can be constructed using combat engineering earth-moving machinery. Longer- term solutions may be implemented using ballast-filled containers, which may be stacked to the required height. For field storage it is preferable that ground is selected that provides natural barricades and undulating terrain can be used to good effect.
- **Fire safety.** Fire safety measures are extremely important and all appropriate measures should be taken to prevent an accidental fire.<sup>99)</sup> These measures include : control of vegetation in proximity to ammunition stocks ; presence of suitable firefighting equipment to deal with vehicle fires ; and enforcement of contraband procedures, particularly the prevention of smoking within the storage locations of the FSA.
- **Security.** Suitable measures should be taken to prevent unauthorized access to ammunition. In large field storage areas this may involve the use of military patrols and dogs.<sup>100)</sup> Surveillance equipment is only an effective deterrent if it is backed up by a quick reaction force.

## What is temporary storage of ammunition ?



### *What is temporary storage ?*

According to the IATG, ammunition is deemed to be under temporary storage conditions when appropriate and safe depot storage infrastructure is not available, or when that infrastructure has deteriorated 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.<sup>101)</sup>

The IATG recognize that the most appropriate storage for ammunition is within properly planned and constructed facilities of the type described in section 4.4 of this guide. It is often necessary though, particularly in peace operations and post-conflict scenarios, for temporary ammunition storage facilities to be established, where ammunition can be stored safely and securely and a limited amount of ammunition processing may be conducted. The IATG recommend that ammunition should not remain in temporary storage facilities for more than five years.<sup>102)</sup>

### How to set up and operate a temporary storage site

Temporary ammunition storage, like field storage also requires a balance to be struck between the needs to support operations and compliance with safety requirements.<sup>103)</sup> This is the case, in particular, where full compliance with explosive quantity distances cannot be achieved. Where temporary quantity distances are implemented a formal Explosion Safety Case should be developed and it should be approved by the competent national or military authority.<sup>104)</sup>



#### *What is an Explosion Safety Case ?*

When full compliance with Outside Quantity Distances and Inside Quantity Distances is not possible, an Explosion 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.<sup>105)</sup>

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The factors which should be considered in the selection of a temporary ammunition storage area are similar to those used for a field storage area. As the temporary storage is likely to be operated for a significantly longer period than a field storage area, it is important that the road infrastructure within the storage area is capable of withstanding the passage of many vehicles and can also tolerate seasonal variations in weather. Temporary ammunition storage areas will also require additional facilities, such as a disposal site and a facility to permit the processing of ammunition.



Explosive safety also has to be ensured when setting up and operating a temporary storage site. In practice this involves putting in place effective quantity and separation distances and following aggregation and mixing rules.<sup>106)</sup>

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Ammunition stored in temporary storage areas is particularly vulnerable to fire, and an explosion in one storage location may quickly spread to others. It is recommended that the full quantity distances appropriate for permanent ammunition storage be implemented if this is feasible.<sup>107)</sup> If full compliance with quantity distances is not possible then it is recommended that each individual store shall hold no more than a 4,000 kg net explosive quantity of ammunition.<sup>108)</sup> The IATG introduce the concept of a temporary distance to distinguish between the quantity distance appropriate for a temporary ammunition storage facility and those where full compliance with IATG is achieved.<sup>109)</sup>

As with field storage, a number of measures can be implemented to improve stock protection of ammunition during temporary storage. These include:<sup>110)</sup>

- **Protection of stock from environmental factors.** The protection of ammunition from the extreme effects of climate is even more important than in field storage, as stock may be exposed for much longer periods of time. In hot climates it may be necessary to institute a policy of ammunition surveillance, and types such as tank, artillery and mortar-propelling charges will need to be subject to testing.<sup>111)</sup> In hot climates the impact of solar heat can be reduced by placing material over the stored ammunition, to create shade. If ammunition is stored in shipping containers and where local security conditions permit, doors should be opened on hot days to permit a flow of cooling air over the stock.
- **Barricades.** Barricades play an important part in preserving stock and are fundamental to ensuring that an explosion at one temporary storage location does not result in the prompt initiation of stock at an adjacent location. Use of appropriate barriers is particularly important in achieving reduced quantity or temporary storage distances, thus reducing the overall area covered by the ammunition storage facility. Effective barriers can be constructed from a variety of locally available materials, though care needs to be taken to ensure that the barricade is positioned appropriately and that the barricade materials do not contribute to a secondary fragmentation hazard.<sup>112)</sup>
- **Overhead protection.** Overhead protection is important in areas where there is a threat posed by indirect fire weapons, such as mortars and free flight rockets. Overhead protection can also prevent the propagation of an explosion event within a site if burning firebrands or ejected munitions are projected from a nearby explosives store which has exploded.
- **Fire safety.** Ammunition in temporary storage areas is more vulnerable to fire than that stored in permanent facilities. The fire prevention and control measures described for field storage areas should also be implemented for temporary storage. Particular attention should be paid to the provision of emergency water supplies to facilitate effective firefighting. Water containers should also be made available as a precautionary measure adjacent to all locations where white phosphorous ammunition items are stored.



- **Lightning protection.** Lightning protection systems should certainly be considered in areas of high lightning incidence or where temporary storage facilities are likely to be used for periods in excess of two years. The choice and installation of lightning protection systems is a specialist subject which is covered in the IATG.<sup>113)</sup> Where ammunition is stored in metal shipping containers a degree of lightning protection may be obtained from the bonding of the base of the container to earth.
- **Security.** Control of access to temporary ammunition storage facilities is extremely important in order to prevent sabotage and theft of stock. The IATG cover a full range of security features which can be implemented in temporary storage facilities.<sup>114)</sup> It is recommended that an effective perimeter fence be implemented and that all access to the site is via controlled gates. Ammunition which is assessed as being attractive to criminal or terrorist organizations (ACTO) should be stored in locked containers.<sup>115)</sup>



The rate of deterioration of ammunition propellants doubles for every 10° C rise in temperature. Thus, an artillery propelling charge which may have a safe shelf life of 20 years when stored at an ambient temperature of 20° C may only have a safe shelf life of 2.5 years when subject to prolonged storage temperatures of 60° C. This high temperature is easily reached inside shipping containers exposed directly to solar heat in many parts of Africa, the Middle East and Central Asia during the summer months.<sup>116)</sup>

Given the likely duration for which ammunition will be stored in temporary facilities, and the need to undertake some form of ammunition surveillance programme, it will be necessary to implement some form of ammunition processing facility at most temporary ammunition storage sites. Given the potential hazards associated with ammunition processing, the following factors should be considered when planning and implementing ammunition process facilities in temporary ammunition sites. The Ammunition Process Building (APB) should :

- Be located at a safe distance from other explosive holding sites i.e. at the correct Process Building Distance (PBD) ;
- Be located at a safe distance from administrative buildings or other inhabited buildings external to the site i.e. at the correct Inhabited Building Distance ;
- Preferably make use of barricades to reduce the effects of an accidental explosion within the APB ;
- Be readily accessible to ammunition storage holding locations within the site ;
- Provide suitable environmental protection for staff i.e. is weatherproof and resistant to the ingress of dust.<sup>117)</sup>

## 4.4 EXPLOSIVES FACILITIES: INFRASTRUCTURE AND EQUIPMENT

This section highlights the essential issues which must be considered by States in establishing and operating ammunition storage and processing facilities. The key considerations when storing high explosives is whether there is a sufficient separation distance from the store to people, and whether there is a sufficient separation distance between the store and other stores containing explosives. In the event of an unplanned explosion it is critical that the civilian population remains largely unaffected, and that an explosion at one site does not result in the prompt initiation of explosives at other sites.

### What are explosives facilities infrastructure and equipment ?

Explosives facilities cover the full range of physical infrastructure which are required for the safe storage and processing of ammunition. The development and construction of ammunition infrastructure is a resource-intensive activity. It is essential to plan it carefully to avoid wasting of resources. Achieving safe separation between ammunition storage and processing facilities within a site is a prerequisite for ensuring that an accidental fire or explosion at one site does not quickly spread to adjacent sites, with catastrophic results. Close attention should always be paid to inside and outside explosive quantity distances and steps taken to ensure that the maximum permitted net explosive quantity of ammunition items stored and processed at individual sites is never exceeded.

Equipment used in ammunition facilities should be specifically designed and procured for its intended activity. Careful attention should be paid to eliminating all possible sources of accidental ignition and new equipment should be introduced only after a careful process of safety evaluation.

### How to ensure the safety of explosives facilities ?

IATG 05.10 details the general criteria to be applied when selecting sites for ammunition storage and processing.<sup>118)</sup> The critical factors to be considered when evaluating a site are :

- Is there a suitable safeguarded area available to permit acceptable quantities of explosives to be stored, and the requirements for a safe Inhabited Building Distance (IBD) to be met ?
- Is the safety of the site compromised by the close proximity of another hazardous installation, such as a pipeline, industrial or petrochemical facility, or vice versa ?
- Are the individual Explosive Storehouses (ESHs) within the site separated sufficiently to achieve a safe Inter-Magazine Distance (IMD) with an acceptable ESH explosive content ?
- Does the site have facilities to permit the safe processing of ammunition ?

- Is there sufficient real estate available to construct and operate a disposal site to permit the disposal of unserviceable or unsafe munitions?
- Is the site secure or can it be secured at acceptable cost?
- Is the site in a geographically suitable location to meet future requirements for operations and training?

The storage, processing and transportation of ammunition presents inherent risks to persons and property, so achieving satisfactory separation between Potential Explosion Sites (PESs) and Exposed Sites (ESs) is a prerequisite for the safe operation of any ammunition facility.<sup>119)</sup> Quantity and separation distances are covered in **IATG 02.20**. In the event of an unplanned explosion the principle effects are air blast and fragmentation. Explosive quantity distances define the minimum permissible distance between a PES and an ES. Explosive quantity distances provide a relatively straightforward mechanism for determining the safe quantity of explosives which may be stored or processed at a particular location and take into consideration other explosive storing locations (Inside Quantity Distances) and potentially vulnerable locations external to the site (Outside Quantity Distances). Arguably, the failure to apply explosive quantity distances is the principal cause of damage to infrastructure and civilian casualties, resulting from Unplanned Explosions at Munitions Sites.



**Inside Quantity Distances (IQD).** IQD are the minimum distances that should be observed between PES and ES that contain explosives.<sup>120)</sup> There are two types of IQD:

- **Process Building Distance (PBD).** The PBD provides a high degree of protection against immediate propagation of an explosion in an Ammunition Process Building (APB). PBDs represent the minimum distances that should be observed between PES and APBs or between adjacent APBs;
- **Inter-Magazine Distance (IMD).** The IMD is the minimum distance to be observed between a PES and an ES which both store, but not process, ammunition.



**Outside Quantity Distance (OQD).**<sup>121)</sup> OQD is the minimum distance to be observed between PES and non-explosive ES. These are generally outside the explosives storage and processing area and may affect the civilian population. There are three types of OQD:

- **Inhabited Building Distance (IBD).** The IBD is the minimum distance to be observed between a PES and buildings and locations where members of the civilian population live or work.
- **Vulnerable Building Distance (VBD).** The VBD is the minimum distance to be observed between a PES and vulnerable buildings such as hospitals, schools, glass-clad buildings, and other non-hardened critical infrastructure.
- **Public Traffic Route Distance (PTRD).** The PTRD is the minimum distance to be observed between a PES and public traffic routes.

Quantity distances have been developed through a process of post-explosion assessment, and trials and evaluation over many years. It should be noted that the application of quantity distances does not guarantee safety and hazards posed by glazing, and buildings of vulnerable construction need also be considered.

Explosives licensing is the process by which the national authority responsible for the safety of ammunition storage and processing facilities defines and authorizes the maximum quantities of explosives which may be safely stored or processed at a particular location. Explosives licensing is covered in [IATG 02.30](#).

It is recommended that the following factors are considered in the development of the Explosives Limit Licence (ELL) for each Explosive Storehouse (ESH) or Ammunition Process Building (APB):<sup>122)</sup>

- Only an authorized limit of explosives, specified by Hazard Division, should be stored at a particular site. This limit should be based on a thorough analysis of quantity distance criteria, both Inside Quantity Distance (IQD) and Outside Quantity Distance (OQD), from governing Potential Exposure Sites (PESs)<sup>123)</sup> and Exposed Sites (ESs);<sup>124)</sup>
- Exposure of the civilian population to an explosive risk shall be avoided as far as is reasonably practicable;
- Any special considerations requiring management or periodic review, should be specified on the licence;
- The number of personnel exposed to a hazard should be specified and that person limits should be indicated. This is particularly important for facilities that operate with naturally higher levels of risk such as Ammunition Process Buildings (APBs) and demilitarization facilities.

Explosives storage and processing facilities pose a potential hazard to personnel and property and this hazard, as highlighted by the IBD, could extend beyond the defined boundaries of military installations. The process by which civilian development is limited in these areas is known as explosives safeguarding.<sup>125)</sup> In considering the requirements for safeguarding, States need to establish an appropriate national technical authority which will represent the government on behalf of all owners of explosives facilities nationwide. This authority should be actively involved in the implementation of an explosives safeguarding system and include:

- The development of appropriate national legislation that enables national authorities to influence future development within the explosion danger area;
- The development of a consultative (and related appeals) process between the national technical authority, local authority responsible for authorizing building permission, and the government entity which operates the explosives facility;
- The development of appropriate procedures to be followed by all parties prior to any building permission being granted for development of land within the explosion danger area.



It is very important that States control development in areas adjacent to explosives facilities in order to maintain safety. Unconstrained development in areas adjacent to explosives facilities has been a cause of significant casualties as a result of unplanned explosions at ammunition sites. This is known as Safeguarding. It is recommended that explosive safeguarding maps are established and that sites of specific relevance to explosive quantity distance calculations which exist outside of the safeguarded perimeter are identified.<sup>126)</sup>

### Examples of effective infrastructure at ammunition storage facilities

The quality and physical location of the explosive storage infrastructure has a significant influence on the safety and security of ammunition. Security fences, intrusion detection systems and locked doors make unauthorized access to ammunition more difficult to achieve. The protection of ammunition from environmental influences such as large daytime temperature fluctuations, direct solar heat, humidity, wind and rain, is important as these elements can have a direct impact on the physical and chemical properties of the ammunition being stored. In short, good quality explosive storage infrastructure provides both physical protection from explosions at adjacent stores and helps maintain the condition and shelf life of the ammunition for longer periods. A variety of types of building are available for the storage of ammunition.<sup>127)</sup>

**(a) Shipping containers and open stacks** of ammunition are the least desirable form of explosives storage since little to no protection is afforded from direct exposure to sun and resulting fluctuations in store temperature and humidity.<sup>128)</sup> Open stacks are also critically vulnerable to prompt detonation caused by an accidental explosion at a nearby site. Open stacked ammunition, especially if the stacks are located close together, could have catastrophic mass explosion implications in the event of an accident or attack. Figure 10 shows one example of Kub (SA6 Gainful) surface-to-air missiles stored in an open stack. It can be seen that there is no protection from the elements or method of preventing the missiles becoming propulsive in the event of fire or explosion. A number of light-walled buildings are also visible in the background.

**Figure 10** – Surface-to-air missiles stored in open stacks <sup>129)</sup>



**(b) Light-structured buildings** are constructed of light frangible materials that should not produce a great number of dangerous projections when used as a Potential Exposure Site (PES).<sup>130)</sup> As an Exposed Site (ES), this structure could collapse but the debris produced should not initiate explosions. Light-structured buildings are preferable to open stacks as they provide environmental protection to ammunition stocks and, when protected by a suitable receptor barricade, offer some protection to stock from low angle, high- velocity fragments.



Earth barricades are extremely effective at screening both Exposed Sites (ES) and Potential Exposure Sites (PES) from high-velocity fragment attack. Barricades need to be built to a sufficient height to protect the structure being protected and, in the case of interceptor traverses (i.e. those that screen PES), should not contain large debris which could pose an additional fragmentation hazard to nearby ES.

**(c) A medium-walled building** is one constructed of a minimum thickness of 215mm solid or 280 mm cavity masonry walls or 150 mm of reinforced concrete and a 15 mm reinforced concrete roof.<sup>131)</sup> Figure 11 shows a medium-walled building featuring individual compartments to facilitate segregation of ammunition.

**Figure 11 – Medium-walled Explosives Storehouse (ESH) <sup>132)</sup>**



**(d) A heavy-walled structure** is one with a minimum of 680 mm thick masonry or 450 mm thick concrete walls, and a minimum 150 mm reinforced concrete roof. <sup>133)</sup> A receptor barricade is not generally required because the heavy walls fulfil this function.

**(e) An earth-covered building** is any structure, except an “igloo” type magazine, which has a minimum thickness of 600 mm of earth on the roof and earth cover to the sides and rear walls. <sup>134)</sup> Barricades should be provided to shield doors and walls that are not earth covered and face a PES.

**(f) An earth-covered magazine or “igloo” type Explosives Storehouse (ESH)** is an explosive storehouse with earth cover and a structure and doors designed to resist blast and high-velocity fragments, so that the contents will not be initiated or seriously damaged at the required Inter-Magazine Distance (IMD). <sup>135)</sup> The supporting structure for the earth cover may be constructed of corrugated steel and reinforced concrete but is normally a reinforced box structure. As an ES, this type of building behaves similarly to an earth-covered building 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.

Figure 12 shows an example of an earth-covered igloo type ESH. Igloo ESHs represent a considerable investment in physical infrastructure but they are the safest and most cost-effective type of ammunition store where constraints on available real estate exist.

**Figure 12** – Earth-covered magazine “igloo” type Explosives Storehouse<sup>136)</sup>



In order for ammunition stocks to be inspected and repaired, appropriate processing facilities are required. It is recognized that many States do not have the resources to develop new ammunition storage and processing facilities from scratch. Where existing facilities are to be adapted or enhanced, then priority should be given to those aspects which affect safety and security. It is essential that only specific equipment authorized for use within explosive facilities is used within ESHs and APBs. Any item which is capable of acting as a source of ignition should only be introduced after careful consideration. The safety standard for electrical installations is particularly important and specific technical requirements are covered in the **IATG 05.40**.<sup>137)</sup>



*What is an Ammunition Process Building (APB) ?*

The IATG define an APB as 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.<sup>138)</sup> This includes facilities such as missile test rooms, preparation buildings, explosives workshops and all facilities used for ammunition maintenance and preparation. APBs may be considered as both Potential Exposure Sites and Exposed Sites, for the purposes of explosive quantity distance assessments and are normally surrounded by barricades to reduce the hazard.



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## 4.5 OPERATIONAL ASPECTS OF AMMUNITION STORAGE

Potential hazardous effects are inherent with ammunition and explosives (and their constituent energetic components), within the facilities that contain them or process them, as well as within every ammunition-related activity and process.



Depending on the material and activity or process involved, inadvertent initiation or functioning of ammunition, explosives, or one of their energetic components could result, due to any number of stimuli or threats, such as incorrect handling, drop, impact, friction, spark, heat, cold, electrostatic discharge, radio frequency-induced currents, incompatibility between materials or substances, or due to chemical instability e.g. propellant stabilizer depletion.

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The inadvertent initiation of even small quantities of explosives can lead to death or serious injury and may lead to a major catastrophe.<sup>139)</sup> Consequently, awareness, understanding and constant management and control of ammunition and explosives-related risk should always be foremost in the minds of those who manage and work with ammunition and explosives.<sup>140)</sup>

Because of the very broad range of topics associated with the operational aspects of ammunition storage, this subsection focuses primarily on basic organizational and programmatic elements that should be implemented to help assure the safety of ammunition-related process and activities associated with ammunition storage. This subsection explains why these operational aspects are important and what they entail. It will then discuss further some of the guidance and requirements given in the IATG for addressing specific operational aspects associated with storage operations.



Though the focus of this section is on ammunition storage, it's important to be aware that most of the programmatic elements discussed herein are very much applicable across the full range of explosives and ammunition-related activities and operations.

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### What do operational aspects entail ?

The IATG do not provide a definition of “operational” as it pertains to ammunition storage, nor do they describe what operational aspects of ammunition storage are entailed. However, it does dedicate IATG module 06 – Explosives Facilities (Storage) (Operations)] – to this particular topic.<sup>141)</sup> The collective focus of the series is on :

- Awareness of risks and hazards associated with ammunition and explosives (not only inherent with ammunition and explosives, but also posed by external threats) ;

- The need for management, controls, and oversight of ammunition and explosives, as well as associated components (facilities, equipment, processes, personnel, etc.) and operational-related activities performed on ammunition and explosives, or to one of these components (such as maintenance and repairs to facilities and equipment); and
- Providing guidance and programmatic element requirements (with reference given to other applicable IATG modules as necessary) related to the above for:
  - IATG 06.10: Control of explosives facilities.
  - IATG 06.20: Storage space requirements.
  - IATG 06.30: Storage and handling.
  - IATG 06.40: Ammunition packaging and marking.
  - IATG 06.50: Specific safety precautions (storage and operations).
  - IATG 06.60: Works services (construction and repair).
  - IATG 06.70: Inspection of explosives facilities.
  - IATG 06.80: Inspection of ammunition.



The titles of IATG 06.10 to 06.80 make it apparent that all aspects of facilities and operations associated with ammunition and explosives should be assessed, managed and monitored, in order to address risks associated with ammunition and explosives and related activities.

### **Why are operational aspects of ammunition storage important?**

The national ammunition stockpile and associated infrastructure, equipment and personnel represent a significant financial and strategic investment for a State. Consequently, constant vigilance and careful consideration of the operational aspects of ammunition and explosives are necessary for the safety, security and functionality of the national stockpile and the mitigation of risk relating to diversion and unplanned explosion events. These risks call for the management of ammunition and all related activities. This should be considered as essential, and not doing so significantly increases the likelihood of an unplanned explosion event or of having a stockpile that cannot support national requirements.

### **What does an effective operational structure look like?**

The titles of the eight modules listed above give a clue as to what subject areas the IATG associate with an effective ammunition storage operational structure. However, a crucial first step is necessary before these subject areas can be addressed properly - the development of a national organizational structure that has the responsibility to manage, monitor, control, maintain and provide oversight of ammunition and explosives, the facilities that house and process them, and all other related processes and activities.



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To help accomplish effective and comprehensive operational storage and manage the “operational aspects” associated with such storage, an organizational structure needs to be developed with well-defined roles and responsibilities.

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The IATG advise on the establishment of an ammunition stockpile management system with a clear chain of command and responsibilities. The organizational structure for national stockpile management proposed in the IATG consists of an ammunition storage unit, a technical inspection unit, a training unit and an ammunition inspectorate. **IATG 03.10** gives an example of a management structure as in Table 4, found in section 4.2. The operational structure entails the following : <sup>142)</sup>

- **Ammunition stockpile management department.** The role of this national-level organization with a defined safety-oriented programme (preferably designated by national policy) would be to identify major programmatic roles and responsibilities and provide over-arching governing directives for assessing and managing risks associated with ammunition and explosives and related activities.
- **Stockpile management organization.** The stockpile management organization would be the intermediate-level organization, subordinate to the ammunition stockpile management department. It would have a number of management system sub-organizations subordinate to it, and its primary role would be to provide direct management and oversight of all ammunition and explosives-related work activities. It would have the following broad responsibilities :
  - Incorporate governing directives issued by the ammunition stockpile management department into guidance documents, standards, processes and operating procedures for use at all intermediate and user levels ;
  - Develop necessary training courses and provide training for staff ;
  - Manage and assure the availability of appropriate facilities, tools, equipment and other requirements as necessary ; and
  - Conduct the required testing to ensure the safety and functionality of stockpile ammunition.



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The stockpile management organization has a critical role in the success of and proper implementation of national policy and directives and with this comes considerable responsibility. **IATG 03.10** provides a list of specific responsibilities that should be assigned to the stockpile management organization. <sup>143)</sup>

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## Programmatic elements

Now that an organizational structure has been identified, the programmatic elements that should be established and managed by this organizational structure can be addressed. These elements are defined within the eight IATG modules listed on

previous page and will help manage risk associated with ammunition-related processes and activities. The purpose and programmatic elements addressed within each module are summarized below.

- **Control of explosives facilities (IATG 06.10).** 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 who work in them. This module outlines the control regime that should be implemented and managed for explosives facilities. Table 6 lists the main areas of consideration addressed by **IATG 06.10** and associated with this control regime.

**Table 6 – Controls pertaining to explosives facilities as described in IATG 06.10**

| Theme                                       | IATG 06.10 Paragraph | Relevant controls   |
|---|----------------------|---|
| Personnel employed in explosives facilities | 4                    | <ul style="list-style-type: none"> <li>• Training and supervision</li> <li>• Special conditions of employment</li> <li>• Specific employment conditions</li> </ul>  |
| Security                                    | 5                    | <ul style="list-style-type: none"> <li>• Patrolling and guarding</li> <li>• Control of entry</li> <li>• Contraband</li> <li>• Searching of personnel</li> <li>• Magnetic therapy products</li> <li>• Spark, flame or heat- producing items</li> <li>• Lighting of fires</li> <li>• Vehicle tracker items</li> <li>• Other controlled items</li> </ul>                           |
| Estate management                           | 6                    | <ul style="list-style-type: none"> <li>• Site plans</li> <li>• Works services</li> <li>• Surplus facilities</li> <li>• Roads and drainage</li> <li>• Railway lines</li> <li>• Vermin control</li> <li>• Vegetation and crops</li> <li>• Control of trees and shrubs</li> <li>• Cut vegetation</li> <li>• Agriculture and agricultural chemicals</li> <li>• Livestock</li> </ul> |
| Fire and first aid                          | 7                    | <ul style="list-style-type: none"> <li>• First aid equipment</li> <li>• Firefighting equipment</li> </ul>   |

|                                |    |   |
|--------------------------------|----|---|
| Aircraft overflight            | 8  | <ul style="list-style-type: none"> <li>• Helicopters</li> </ul>   |
| Potential Explosion Site (PES) | 9  | <ul style="list-style-type: none"> <li>• Cleanliness</li> <li>• Action on vacating a PES</li> <li>• Emergency evacuation</li> <li>• Thunderstorms</li> <li>• Tools, materials, and equipment permitted in a PES</li> </ul>  |
| Operations in a PES            | 10 | <ul style="list-style-type: none"> <li>• Explosive storehouse and open bay storage</li> <li>• Ready-to-use ammunition</li> <li>• Captured enemy ammunition and foreign explosives</li> <li>• Process buildings</li> <li>• Receipt and issue bays</li> <li>• Handling and testing of electro-explosive devices</li> </ul>  |
| Storage                        | 11 | <ul style="list-style-type: none"> <li>• Covered storage</li> <li>• Open storage</li> <li>• Explosive items</li> <li>• Non-explosive items</li> <li>• Dangerous goods and explosive stores filled with dangerous goods</li> <li>• Ammunition and ammunition packaging</li> <li>• Commercial explosives and fireworks</li> <li>• Experimental explosives</li> <li>• Special stores</li> <li>• Isolation and segregation of stocks</li> <li>• Rail and vehicle and staging facilities</li> <li>• Storage conditions</li> <li>• Ventilation and relative humidity</li> </ul> |
| Issuing of ammunition          | 12 | <ul style="list-style-type: none"> <li>• Stock turnover</li> <li>• Prevention of deterioration of explosives</li> </ul>   |
| Underground storage (tunnels)  | 13 | <ul style="list-style-type: none"> <li>• General</li> <li>• Stacking</li> <li>• Repair and maintenance</li> <li>• Records</li> <li>• Prohibited storage</li> <li>• Limitations in storage</li> <li>• Mechanical handling equipment</li> <li>• Humidity</li> <li>• Non-explosive dangerous goods</li> </ul>  |

- Storage space requirements (IATG 06.20).** Storage of ammunition and explosives is expensive and must be efficient to be cost effective. However, efficient storage requires effective storage space vplanning, and that is the primary focus area of this module, which provides guidance on the general practical considerations (and recommended spacing) for storage space planning. Figure 13 gives an example from IATG 06.20 of a methodology<sup>144)</sup> that can be used for determining the theoretical maximum unit of space (UOS) available for storage within an ESH:

**Figure 13** – Example methodology for theoretical UOS maximum

| ESH DETAILS                    | FIGURES             | COMMENT   |
|--------------------------------|---------------------|---|
| ESH width                      | 6m                  |   |
| ESH length                     | 8m                  |   |
| ESH height                     | 3.7m                |   |
| ESH volume                     | 177.6m <sup>3</sup> |   |
| Height of dunnage              | 0.1m                | From the floor                                    |
| MHE gangway                    | 2m                  | Up the middle                                     |
| Gap from walls                 | 0.5m                | From each face                                    |
| Gap from ceiling               | 0.5m                | From top package                                  |
| Available ESH width            | 3m                  | 6-(2x0.5)-2                                       |
| Available ESH length           | 7m                  | 7-(2x0.5)   |
| Available ESH height           | 3m                  | 3.7-0.1-0.5. Rounded down to nearest meter/pallet |
| <b>Maximum theoretical UOS</b> | <b>63 UOS</b>       | <b>3x7x3</b>                                      |

The diagram illustrates a 3D perspective of a storage area. It shows a 3x7x3 arrangement of brown rectangular packages. The storage area is bounded by yellow lines representing the walls, ceiling, and floor. Labels indicate the following dimensions and clearances: 50cm Wall to Packages (on all four sides), 50cm Ceiling to Packages (top), 50cm Wall to Packages (bottom), 2m MHE Gangway (middle), 10cm Dunnage (bottom), and 50cm Wall to Packages (bottom).

- Storage and handling (IATG 06.30).** The safe storage and handling of ammunition and explosives is a basic requirement of explosives safety. Improper storage and handling can result in an unplanned explosion event that can lead to loss of stocks and facilities and cause deaths and injuries. Even if an explosion event does not occur, damaged ammunition has to be either repaired or destroyed and then replaced at potentially considerable expense. Both scenarios are unacceptable, and this module provides guidance on general, practical considerations for safe storage and handling of ammunition and explosives. Table 7 lists the main safe storage and handling aspects and areas of consideration addressed by **IATG 06.30**.

**Table 7 – Safe storage and handling considerations as described in IATG 06.30**

| Theme  | IATG 06.30 Paragraph | Relevant controls   |
|--|----------------------|---|
| Handling of ammunition                       | 4                    | <ul style="list-style-type: none"><li>• Safety</li><li>• Classification of ammunition</li><li>• Approval to store</li><li>• Physical handling of ammunition</li><li>• Damaged packaging</li></ul> |
| Stacking of ammunition                       | 5                    | <ul style="list-style-type: none"><li>• General criteria</li><li>• Loose packaged ammunition</li><li>• Unpackaged ammunition</li><li>• Specific stacking requirements</li></ul>                   |
| Use of racking                               | 6                    | <ul style="list-style-type: none"><li>• General criteria</li><li>• White phosphorus ammunition</li></ul>  |
| Stack tally cards and pallet contents sheets | 7                    | <ul style="list-style-type: none"><li>• Location of tally cards</li><li>• Required information</li><li>• Accuracy</li></ul>   |
| Use of lifting equipment and slings          | 8                    | <ul style="list-style-type: none"><li>• Ferrous slings</li><li>• Multi-legged slings</li><li>• Slings of loads</li></ul>  |
| Storage temperature                          | 9                    | <ul style="list-style-type: none"><li>• Temperature restrictions</li><li>• Temperature recording</li></ul>  |

- **Ammunition packaging and marking (IATG 06.40).** Ammunition and explosives should be placed in packaging that is designed to protect the contents from all foreseeable hazards regarding physical damage and environmental deterioration, throughout the expected life of the item, up to and including final disposal of the item. The packaging should be marked to provide information to enable the explosives to be stored, handled and transported correctly. The UN Model Regulations (see section 4.7) provide internationally accepted best practices for packaging and marking of dangerous goods (including ammunition and explosives). The general practical ammunition packaging and marking information given in IATG 06.40 is based on the UN Model Regulations.<sup>145)</sup> Table 8 lists the main packaging and marking aspects and areas of consideration addressed by **IATG 06.40**.

**Table 8**—Packaging and handling areas of consideration as described in IATG 06.40

| Theme                           | IATG 06.40 Paragraph | Relevant controls  |
|---------------------------------|----------------------|--|
| Ammunition packaging            | 4                    | <ul style="list-style-type: none"><li>• Packaging requirements</li><li>• Design and safety of explosives packaging</li><li>• Change of Hazard Division</li><li>• Physical handling of ammunition packages</li><li>• Temporary packaging</li><li>• Special packaging</li><li>• Marking of ammunition and its associated packaging</li><li>• Colour coding of ammunition and its associated packaging</li><li>• Fraction packages</li><li>• Empty ammunition packaging</li></ul> |
| Palletization                   | 5                    | <ul style="list-style-type: none"><li>• Reasons for palletization</li><li>• Palletization system requirements</li><li>• Ammunition palletization restrictions</li><li>• Damaged pallets/banding material</li><li>• Identification of palletized ammunition</li><li>• Movement of palletized ammunition</li></ul>   |
| Sealing of ammunition packaging | 6                    | <ul style="list-style-type: none"><li>• Types of ammunition seals<ul style="list-style-type: none"><li>○ Authenticity sealing</li><li>○ Technical staff sealing</li><li>○ Broken seals</li><li>○ Qualification and authorization to carry out authenticity sealing</li><li>○ Sealing procedures and authorized tools</li><li>○ Packing notes</li></ul></li></ul>   |
| Ammunition in transit           | 7                    | <ul style="list-style-type: none"><li>• Staging posts</li><li>• Inspection requirements</li></ul>  |

- **Specific safety precautions (storage and operations) (IATG 06.50).** The most obvious hazard from explosives during storage is an accidental explosion or deflagration.<sup>146)</sup> This module highlights specific areas of special risk (including health hazards) associated with certain chemicals and materials used in the manufacture of ammunition as well as certain ammunition itself and describes mitigating factors. It also highlights other specific areas of management concern, such as :



- Certifying packages, articles, equipment, buildings and land, as free from explosives.
  - Explosive ordnance disposal, range clearance and demilitarization.
  - Use of munitions in museums or displays or as souvenirs.
  - Emergency planning and arrangements.
  - Assuring explosives are “safe-to-move”/certificate of safety.
  - Storage temperature/humidity monitoring and management.
- **Work services (construction and repair) (IATG 06.60).** Personnel involved in construction and repair activities within an explosives facility or area should be tightly controlled for their own safety and the safety of others. Adequate risk control measures and procedures should be put in place in order to identify and minimize any risk from their activities and to them from surrounding activities. This module provides guidance on control measures and procedures for the control of personnel involved in the construction, repair and maintenance of explosives facilities.<sup>147)</sup> Table 9 lists the main work services aspects and areas of consideration addressed by **IATG 06.60**.

**Table 9 – Work service areas of consideration as described in IATG 06.60**

| <b>Theme</b>                   | <b>IATG 06.60 Paragraph</b> | <b>Relevant controls</b>   |
|--------------------------------|-----------------------------|--|
| Specific responsibilities      | 4                           | <ul style="list-style-type: none"> <li>● Contractor</li> <li>● Explosives area support workers</li> <li>● Head of the establishment and post holder duties               <ul style="list-style-type: none"> <li>○ Site plan</li> <li>○ Explosives licence</li> <li>○ Safety briefing and permits work</li> <li>○ Other duties</li> <li>○ Role of the safety monitor</li> </ul> </li> </ul> |
| Major works                    | 5                           | <ul style="list-style-type: none"> <li>● Risk assessment               <ul style="list-style-type: none"> <li>○ Outside the IBD</li> <li>○ Between the IBD and the PTRD</li> <li>○ Within the PTRD</li> </ul> </li> </ul>  |
| Minor works                    | 6                           | <ul style="list-style-type: none"> <li>● One-off tasks</li> <li>● Staff numbers and length of task</li> </ul>  |
| Additional safety requirements | 7                           | <ul style="list-style-type: none"> <li>● Working on or in a PES</li> <li>● Working in an explosive storage area</li> </ul>   |

- **Inspection of explosives facilities (IATG 06.70).** Inspections of explosives facilities are conducted to assess if explosive safety requirements pertaining to each facility, its support equipment, and its operations are being followed and are consistent with national regulations and issued licences. Deterioration of an explosives facility or support equipment, violations of licence limitations and conditions, or failure to follow requirements can all potentially create a hazard for personnel and property. It is imperative that all aspects of the explosives licence and the national authority explosives regulatory regime are being complied with and that explosives facilities are fit for purpose.<sup>148)</sup>

There are two types of inspection carried out on explosives facilities:<sup>149)</sup>

- **Internal** – using staff from the explosives facility. Informal internal inspections should be carried out as a routine daily task by all staff working in the explosives facility. Additionally, a formal internal inspection should be carried out by the person in charge of the explosives facility (or a nominated and qualified representative).
- **External** – using staff from other facilities or as required by the national technical authority. 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.



The national technical authority should have requirements for documents, procedures and checklists established for the carrying out of inspections. The national authority should also set a required inspection frequency. It is generally accepted that for internal inspections once a month is sufficient, coupled with some non-routine inspections. For external inspections, frequency will quite often be annual, but should be influenced by staffing and operational tempo.

Inspections should be carried out by qualified personnel using checklists, with the results of inspections recorded on an inspection record sheet and in a log book established for each PES. Figure 14 gives an example PES log book extracted from Annex C of **IATG 06.70**.<sup>150)</sup> It includes a checklist of inspection points for the PES and can be used to record the status of checks and tests conducted.

**Figure 14** – Extract from sample PES Log Book

| PES Log Book (Record of Checks and Tests)   |  |       |   |   |   |      |   |   |   |   | IATG Form 06.70A |   |   |  |
|---|--|-------|---|---|---|------|---|---|---|---|------------------|---|---|--|
| Items 1 to 18 & 21 to 25 insert <input type="checkbox"/> if correct or <input type="checkbox"/> if incorrect.<br>Items 19 to 20 insert <input type="checkbox"/> 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 traverses                             |       |   |   |   |      |   |   |   |   |                  |   |   |  |
| 8   | Locks, key labelling                               |       |   |   |   |      |   |   |   |   |                  |   |   |  |
| 9   | Explosives stored (ELL 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 <sup>9</sup> |       |   |   |   |      |   |   |   |   |                  |   |   |  |

Additionally, **IATG 06.70** provides detailed information about what to inspect, how to document inspections, grading of inspection results, and actions to take where inspections detect deficiencies and violations of licences. The appendices provide a sample PES log book, national authority inspection guidelines, and a sample explosive storehouse (ESH) inspection checklist. Figure 15 provides an extract of the ESH inspection checklist.<sup>151)</sup>

**Figure 15** – Extract from sample ESH Inspection Checklist<sup>152)</sup>

| 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 <sup>21</sup> 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                          |   |                            |

- **Inspection of ammunition (IATG 06.80).** Inspection of ammunition may be required for the following ;
  - Where ammunition has been damaged ;
  - Where faults and defects in the ammunition type are suspected ;
  - As part of a routine inspection or surveillance programme ; and
  - As a “safe to move” inspection.



**IATG 06.80 should be consulted in parallel with IATG 07.20 - 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.**<sup>153)</sup>

Recommended procedures for inspection of generic types of ammunition are provided in **IATG 06.80**. Table 10 summarizes the main ammunition inspection aspects and areas of consideration addressed by **IATG 06.80**, which also provides a number of annexes devoted to inspection points for generic weapon types, such as burning fuses,<sup>154)</sup> demolition charges,<sup>155)</sup> mines,<sup>156)</sup> mortar bombs,<sup>157)</sup> and small arms ammunition.<sup>158)</sup>

**Table 10** – Ammunition inspection areas of consideration as described in IATG 06.80

| <b>Theme</b>                           | <b>IATG 06.80 Paragraph</b> | <b>Relevant controls</b>   |
|--|-----------------------------|--|
| Types of inspections                   | 4                           | <ul style="list-style-type: none"><li>• General criteria</li></ul>   |
| Safety during processing               | 5                           | <ul style="list-style-type: none"><li>• Risk assessments</li><li>• Visual inspection</li><li>• Documentation</li></ul>   |
| Condition classification of ammunition | 6                           | <ul style="list-style-type: none"><li>• Ammunition classification</li><li>• Ammunition condition groups and codes</li></ul>  |
| Markings                               | 7                           | <ul style="list-style-type: none"><li>• General criteria</li></ul>   |
| Seals                                  | 8                           | <ul style="list-style-type: none"><li>• General criteria</li></ul>   |
| Common inspection points               | 9                           | <ul style="list-style-type: none"><li>• Lot/batch numbers</li><li>• Rust identification</li><li>• Fuze covers</li><li>• Fuze plugs</li><li>• Gauging</li><li>• Luting</li><li>• Torque</li></ul> |
| Specific to type inspection points     | 10                          | <ul style="list-style-type: none"><li>• General criteria</li><li>• Generic ammunition types inspection points and associated annexes</li></ul>   |
| “Safe to move” inspections             | 11                          | <ul style="list-style-type: none"><li>• General criteria</li><li>• STM inspection / certification</li><li>• STM – post explosion hazards</li></ul>   |
| Documentation                          | 12                          | <ul style="list-style-type: none"><li>• Documentation system</li></ul>   |

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## 4.6 AMMUNITION PROCESSING

Ammunition processing is a term which covers all tasks involving the repair, testing, modification, disassembly or breakdown of ammunition and explosives.<sup>159)</sup> Any such task 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. **IATG 07.10** covers ammunition processing,<sup>160)</sup> while **IATG 07.20** pertains to ammunition surveillance.<sup>161)</sup> This section provides an overview of these modules and related measures.

### What is ammunition processing ?



#### *What is ammunition processing ?*

Ammunition 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.<sup>162)</sup>

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Ammunition processing has to be conducted safely and effectively, requiring careful planning and management of risk. The IATG identify the following elements which are critical to the establishment of a safe system of work to undertake ammunition processing :<sup>163)</sup>

- Trained and competent staff.
- Appropriate levels of supervision and management.
- Written instructions for ammunition processing.
- Appropriate equipment.
- Appropriate facilities.

A risk evaluation should be conducted as part of the planning process for all ammunition processing activities. This subject is covered in detail in **IATG 02.10**. Risk analysis is the systematic use of information to identify hazards and estimate risk. Risk evaluation determines whether a tolerable risk has been achieved for the ammunition processing task being analyzed.

Hazard identification is extremely important as ammunition processing may create hazards not associated with any other ammunition life-cycle activity. Careful consideration should be given to the hazards associated with the breakdown of ammunition and also the exposure of energetic fillings which create an enhanced accidental explosion risk.



Prevention is better than cure and all efforts should be taken to avoid an accident. Should an accident occur, then the immediate priority is to make the scene safe in order for first aid to be provided to any injured personnel. It is essential that all processing operations are stopped and actions taken to secure any ammunition which may be present. If the accident involves a fire then site-wide contingency plans should be enacted.<sup>164)</sup>

Unsafe ammunition may be encountered during the course of ammunition processing and the procedures to be adopted in this event should be defined in the munitions repair instructions. It may be necessary for the item to be moved to a disposal site where appropriate action using explosive ordnance disposal procedures may take place.<sup>165)</sup>

Thunderstorms are prevalent in tropical and other hot climatic zones and pose a particular hazard to munitions containing electro-explosive devices (EEDs). It is essential that ammunition processing is not conducted on munitions containing EEDs when a thunderstorm is in the vicinity. It is strongly recommended that all ammunition processing and movement ceases at facilities during thunderstorms.<sup>166)</sup>

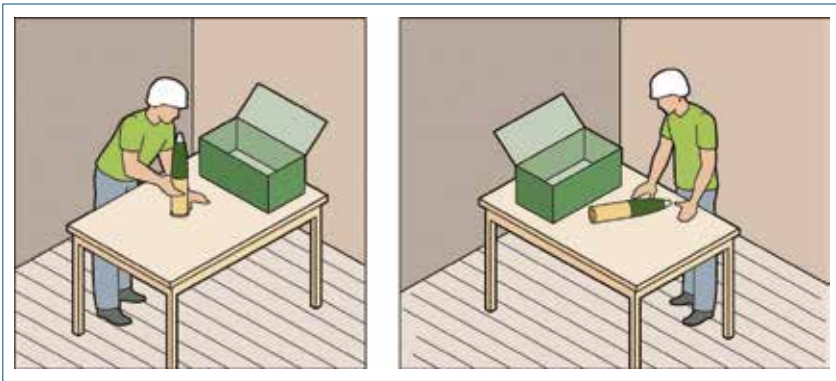
## How is ammunition processing conducted?

The most effective way of reducing the maximum credible event which could occur in an accident scenario during ammunition processing is by limiting the explosive content of the ammunition permitted in the Ammunition Process Building (APB) at one time.<sup>167)</sup> In judging the explosive limit for a particular task, due attention must be paid to the maximum explosive quantity specified in the Explosives Limit Licence<sup>168)</sup> as well as the quantity of ammunition required for process efficiency. Care should be taken to ensure that high levels of stocks do not accumulate during ammunition processing operations. Other measures can be implemented to limit the risk of accidents during ammunition processing, including the following:

- There should be a limit to the number of individuals<sup>169)</sup> within an ammunition processing facility as a condition of the explosives licence, or a limit to the number of individuals responsible for carrying out specific ammunition processing tasks.
- Only personnel that have received appropriate training and are adequately supervised should be used in the processing of ammunition.<sup>170)</sup>
- Ammunition processing should never take place in ammunition storage facilities. Ideally, processing should be conducted in purpose-built and licensed APBs. Where APBs are not available, effective use may be made of transportable or temporary ammunition processing facilities.<sup>171)</sup>
- The use of correct equipment for ammunition processing, to be considered during the risk evaluation and planning process.<sup>172)</sup>
- All electrical equipment must be tested and confirmed suitable for use with explosives.<sup>173)</sup>
- Staff must be positively encouraged to use the right tool for the job and to ensure that the tool is used in the correct fashion. To limit the potential for improvisation, only the specific tools required to carry out the task in hand are to be present.

Figure 16 shows illustrations of a simple inspection process being undertaken.

**Figure 16 – Ammunition inspection process**<sup>174)</sup>



Relatively few countries have specific facilities to safely process ammunition and it may be necessary to implement temporary measures for the on-site processing and inspection of ammunition. These facilities may take the form of temporary shelters; however, all safety requirements shall be implemented. Such facilities will need to be provided with barricades and be located at safe separation distances from other sites storing or processing ammunition, and also from other inhabited buildings.

### Examples of ammunition processing

There are various types of ammunition processing. This section provides an overview of the different ammunition processing types.

**(a) Inspection of ammunition:** Inspection of ammunition is one of the most straightforward ammunition processing tasks and typically may involve the following:

- Confirmation of the physical condition and quantity of ammunition within an ammunition package and confirmation that the items are stored in approved service packaging;
- A visual examination to confirm whether ammunition which has been issued for training or operations and where the package has been opened is still fit for use;
- Visual detection of signs of corrosion or other deterioration which may indicate the requirement of future ammunition repair tasks;
- The use of diagnostic equipment, such as gauges, to confirm the serviceability of items.



**(b) Break down of ammunition :** It may be necessary to break down ammunition items as part of a broader demilitarization task, or to provide samples for ammunition surveillance and testing.<sup>175)</sup> The breaking down of ammunition is inherently more hazardous than ammunition inspection, as explosive fillings are often exposed during the process. There may also be particular hazards associated with the removal of items such as fixed fuzes which require the use of remotely operated equipment.

**(c) Ammunition repair :** Ammunition repair includes all activities necessary to return an ammunition item to a serviceable condition. It may include, for example, the replacement of desiccants in ammunition packaging, the removal of corrosion and the repainting of shells and aircraft bombs. At the more complex end of the spectrum, it may involve the removal and replacement of individual components within ammunition items such as fuzes, igniters and propelling charges. Ammunition repair tasks may originate as a result of a planned activity, such as a life extension programme, or may originate as a result of information gathered during in-service surveillance or proof of ammunition.

**(d) Ammunition packaging :** Ammunition packaging forms an important part of an effective ammunition safety management system.<sup>176)</sup> It is recommended that States classify ammunition in accordance with United Nations guidelines and best international practice.<sup>177)</sup> It is suggested that all ammunition packages be marked with the following information :

- Hazard Classification Code, i.e. the combination of Hazard Division and Compatibility Group ;
- Nature or designation of ammunition item ;
- Quantity contained within the package ; and
- UN serial number and proper shipping name.

The condition of ammunition packaging has an important role to play in maintaining the safety and integrity of the ammunition type. To ease handling, boxes should ideally be palletized and not stacked to more than a safely designated height.

**(e) Ammunition surveillance :** The primary purpose of ammunition surveillance is to ensure that the ammunition type meets defined quality standards.<sup>178)</sup> It involves the systematic method of evaluating the properties, characteristics and performance capabilities of the ammunition type throughout its life cycle (manufacturer to disposal) in order to assess the reliability, safety and operational effectiveness of in-service stocks and to provide data to support decisions on disposal or shelf-life extension. A related activity to ammunition surveillance is proof,<sup>179)</sup> which includes the functional testing or firing of the ammunition.

For most munitions, the following degradation mechanisms will impact on the technical condition of the munition :<sup>180)</sup>

- For energetic materials :
  - Stabilizer depletion within propellants containing nitrocellulose and nitroglycerine
  - De-bonding between energetic materials and inert surfaces
  - Chemical migration within energetic materials
  - Cracking of brittle materials or other mechanical defects brought about by daily temperature fluctuations
- For electronic components :
  - Component ageing and deterioration
  - Component shock damage through poor handling
- Structural integrity :
  - Mechanical and vibration damage
  - Corrosion
  - Deterioration of seals, O-rings and gaskets



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It is important to note that from the moment an ammunition item is manufactured it begins to degrade. Ammunition surveillance may detect the deterioration of a particular component in an ammunition item and ammunition repair may address that particular issue. Careful storage, transport and handling may cause the rate of degradation to reduce, but all ammunition will eventually reach the end of its safe shelf life and require disposal.

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**(f) Assessing propellant stability:** One of the most significant factors determining the safety of a State's ammunition stockpile is the chemical stability of the propellants found in tank, artillery and mortar-propelling cartridges, as well as the propellant grains in large solid rocket motors. These items are most often manufactured with a mixture of nitrocellulose and nitroglycerine and contain stabilizers to remove the chemical products of decomposition. Over time, particularly when munitions are stored at elevated temperatures, these stabilizers become depleted. The rate of chemical deterioration of a propellant is approximately doubled for every 10° C rise in temperature above 30° C. Over time the stabilizer is depleted and in the absence of this stabilizer, the rate at which the propellant decomposes accelerates until it spontaneously ignites. Prolonged storage at elevated temperatures has a definite detrimental effect on propellant shelf life.<sup>181)</sup>

Figure 17 shows an ammunition technician from the Canadian Army conducting a propellant stabilizer test using high performance liquid chromatography equipment.

**Figure 17** – Ammunition technician conducting propellant stabilizer assessment on ammunition<sup>182)</sup>



**(g) Ammunition in-service proof:** In-service proof is an activity which is undertaken during the in-service phase of the ammunition life cycle. The purpose of in-service proof is to ensure that the ammunition item meets the required operational quality levels and is safe and suitable for continued service use.<sup>183)</sup> Ammunition in-service proof fulfils the following objectives :

- It ensures that the ammunition remains safe and suitable for use and has not deteriorated in storage ;
- It provides a quantitative means of ensuring that the ammunition remains fit for operational use ;
- It allows future performance to be predicted and decisions taken on service life and any operational or training constraints which may be applied to the ammunition.

In-service proof of ammunition may be conducted in either a quantitative or qualitative fashion. For quantitative assessment the ammunition must be fired under strictly controlled conditions and appropriate data such as muzzle velocity, chamber pressure, range and target effect, need to be collected. This quantitative data should then be compared to manufacturers' baseline technical performance data, or other data collected during the munition's qualification testing prior to entry into service to determine whether performance is satisfactory. Qualitative data may be collected through monitoring or ammunition fired during training. Appropriate observations by ammunition technical personnel may provide a reliable early indication of problems which are developing in the ammunition stockpile through degradation and deterioration.

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## 4.7 TRANSPORT OF AMMUNITION

The transport of ammunition and explosives is an essential life-cycle related activity associated with a State's national stockpile and is explained in **IATG 08.10**. It is an important step towards meeting operational and strategic objectives. If a State owns ammunition, then it will need to be transported at some point. However, ammunition presents an inherent risk wherever it is located and even more so during transport, where it could be exposed to hazards, such as a fuel oil fire due to a transport-related accident, or external threats, such as a bullet attack, which can impact its safety and security.

These risks point to the need for the transport of dangerous goods (which includes ammunition and explosives) to 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.<sup>184)</sup>

This section describes what ammunition transport is, what it involves, why it is important, as well as the international system for dangerous goods transportation. Information is also provided to describe what an effective national transport system might look like in terms of how a State can minimize risk for safe and secure transport of its ammunition.

### What is transport of ammunition ?

Ammunition is specifically developed, procured, manufactured, stored, maintained and disposed of in support of national operational and strategic objectives, which means that during its life cycle it will need to be moved and transported for any number of purposes, as listed in Table 11. This transport could be in a variety of different transport modes, such as truck, railcar, fixed-wing and rotary-wing aircraft, ship, or barge and could be domestic or international.

**Table 11 – Purposes for ammunition transport**

| <b>Import (new or used)</b>  | <b>Export (new, used, donation)</b>  |
|--|--|
| <ul style="list-style-type: none"> <li>• Manufacturer to depot (new production)</li> </ul> | <ul style="list-style-type: none"> <li>• Trials and experiments</li> </ul>                               |
| <ul style="list-style-type: none"> <li>• Ammunition maintenance or upgrade</li> </ul>      | <ul style="list-style-type: none"> <li>• Disposal/demilitarization</li> </ul>                            |
| <ul style="list-style-type: none"> <li>• Hazard classification testing</li> </ul>          | <ul style="list-style-type: none"> <li>• Surveillance/propellant stability</li> </ul>                    |
| <ul style="list-style-type: none"> <li>• Proof testing</li> </ul>                          | <ul style="list-style-type: none"> <li>• Relocation – depot to unit (training and operations)</li> </ul> |
| <ul style="list-style-type: none"> <li>• Research</li> </ul>                               | <ul style="list-style-type: none"> <li>• Safety testing</li> </ul>                                       |

A significant transportation consideration for any state is the multitude of different regulations (national, regional, international) that could apply to its ammunition transport needs. For domestic movements, these operations need to be conducted safely. For international movements, these operations must also be conducted safely, but they also need to comply with other States' requirements and international agreements. 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.<sup>185)</sup>

Additionally, 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.<sup>186)</sup>

The foundation of international dangerous goods transportation regulations is the United Nations (UN) hazard classification system contained in **IATG 01.50**, which does not take into account the probability of an incident, but assumes that if it can happen it will, and when it does, it identifies the extent of the hazard. This system (discussed further in next section) consists of the following:<sup>187)</sup>

- Nine dangerous goods classes, of which class 1 comprises 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. The Hazard Division will be assigned, based on the items' behaviour and test results, according to the Manual of Tests and Criteria of the UN Recommendations on the Transport of Dangerous Goods ;<sup>188)</sup>
- Class 1 ammunition is further divided into Compatibility Groups designed to minimize 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 ;
- The UN Hazard Classification Code (HCC) for an explosive or type of ammunition is the combination of the Hazard Division and the Compatibility Group.



---

#### *What is a Hazard Classification Code (HCC)?*

The HCC is an alphanumeric symbol that denotes the complete HCC for a particular type of ammunition. 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.<sup>189)</sup>

#### *What is the Hazard Division (HD)?*

The UN classification system that identifies hazardous substances.<sup>190)</sup>

#### *What is a Compatibility Group (CG)?*

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 types of ammunition may be safely stored together.<sup>191)</sup>

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## **Why is transport of ammunition important?**

Transport safety is approached differently to ammunition storage. The storage requirements given in the IATG focus on mitigating the consequences of an explosion event by ensuring that the ammunition stockpile is kept away from the general population and public infrastructure. Ammunition transport, however, brings ammunition in close proximity to the public, major infrastructure and potentially many other exposures, such as ports and other transport distribution networks, cities and other explosives locations. Consequently, it is important to effectively assess, manage and regulate the transport of ammunition in order to prevent accidents, as far as possible.<sup>192)</sup>

To address these aspects, the United Nations has developed mechanisms for the harmonization of hazard classification criteria during transport and safe transport conditions. These are accepted by other international agreements governing the transport of ammunition and explosives by road, rail, air or sea, and help ensure consistency between various regulatory systems.<sup>193)</sup> States should adopt, support and follow, to the greatest extent possible, international agreements for domestic and international transport of ammunition and other dangerous goods.



Responsibility for the transport of dangerous goods issued within the United Nations system lies with the UN Economic Commission for Europe (UNECE) whose mandate includes the establishment of norms, standards and conventions to facilitate international cooperation on transportation within and outside the European region.<sup>194)</sup> For more information on the UNECE, visit: [www.unece.org/trans/welcome.html](http://www.unece.org/trans/welcome.html)

Dangerous goods documents developed by the UNECE, which all other international dangerous goods regulations complement, include:

- The Globally Harmonized System of Classification and Labelling of Chemicals (GHS); a single, globally harmonized system to address the classification of chemicals, labels, and safety data sheets during transportation; this includes explosives for military and civil use;<sup>195)</sup>
  - UN Recommendations on the Transport of Dangerous Goods (also called the UN Model Regulations), that aim to present a basic scheme of provisions that will allow uniform development of national and international regulations governing the various modes of transport;<sup>196)</sup> and
  - The UN Manual of Tests and Criteria, which is a UNECE-developed document, that stipulates the range of tests that should be used to determine the Hazard Division applicable to a certain type of ammunition.<sup>197)</sup>
-

Table 12 provides a listing of the primary international agreements and their applicability as they relate to the transport of dangerous goods (which includes ammunition and explosives) by road, rail, air, waterway, and sea :

**Table 12** – International regulations governing the transport of dangerous goods <sup>198)</sup>

| International Agreements  | Responsible Organization   | Applicability  |
|---|--|--|
| Globally Harmonized System of Classification and Labelling of Chemicals (GHS)                         | UN Economic Commission for Europe (UNECE) <a href="http://www.unece.org/trans/danger/danger.html">www.unece.org/trans/danger/danger.html</a>   | <ul style="list-style-type: none"> <li>• Classification of chemicals, labels and safety data sheets during transportation - includes explosives for military and civilian use</li> </ul>                 |
| UN Recommendations on the Transport of Dangerous Goods (UN Model Regulations)                         | UN Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods <a href="http://www.unece.org/trans/danger/publi/unrec/rev13/13nature_e.html">www.unece.org/trans/danger/publi/unrec/rev13/13nature_e.html</a> | <ul style="list-style-type: none"> <li>• Complementary to GHS</li> <li>• Designed to be generic of transport mode</li> <li>• Dangerous goods hazard classification and transport requirements</li> </ul> |
| UN Manual of Tests and Criteria   | UN Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods <a href="http://www.unece.org/trans/danger/publi/unrec/rev13/13nature_e.html">www.unece.org/trans/danger/publi/unrec/rev13/13nature_e.html</a> | <ul style="list-style-type: none"> <li>• Complementary to UN Model Regulations</li> <li>• Contains criteria, test methods and procedures for the hazard classification of dangerous goods</li> </ul>     |
| European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)             | UNECE <a href="http://www.unece.org/trans/danger/danger.html">www.unece.org/trans/danger/danger.html</a>   | <ul style="list-style-type: none"> <li>• Safe transport of dangerous goods by road</li> </ul>  |
| European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) | UNECE <a href="http://www.unece.org/trans/danger/danger.html">www.unece.org/trans/danger/danger.html</a>   | <ul style="list-style-type: none"> <li>• Safe transport of dangerous goods by inland waterways</li> </ul>  |



**Table 12 – Continued**

| <b>International Agreements</b>   | <b>Responsible Organization</b>  | <b>Applicability</b>  |
|---|--|---|
| International Ordinance on the Transport of Dangerous Goods by Rail (RID)                                 | Intergovernmental Organisation for International Carriage by Rail (OTIF)<br><a href="http://www.otif.org/en/">www.otif.org/en/</a>   | <ul style="list-style-type: none"> <li>• Safe transport of dangerous goods by rail</li> </ul>   |
| Annex 18, The Safe Transport of Dangerous Goods by Air, to the Convention on International Civil Aviation | International Civil Aviation Organization (ICAO)<br><a href="http://www.icao.int/safety/DangerousGoods/Pages/annex-18.aspx">www.icao.int/safety/DangerousGoods/Pages/annex-18.aspx</a>                             | <ul style="list-style-type: none"> <li>• Addresses broad principles governing the international transport of dangerous goods by air</li> </ul>  |
| International Civil Aviation Organization Technical Instructions (ICAO-TI) (DOC 9284)                     | International Civil Aviation Organization (ICAO)<br><a href="http://www.icao.int/safety/DangerousGoods/Pages/technical-instructions.aspx">www.icao.int/safety/DangerousGoods/Pages/technical-instructions.aspx</a> | <ul style="list-style-type: none"> <li>• Amplifies basic provisions of Annex 18; contains detailed instructions necessary for the safe international transport of dangerous goods by air</li> </ul>           |
| International Air Transport Association Dangerous Goods Regulations (IATA DGR)                            | International Air Transport Association (IATA)<br><a href="http://www.iata.org/Pages/default.aspx">www.iata.org/Pages/default.aspx</a>   | <ul style="list-style-type: none"> <li>• Safe transport of dangerous goods by air</li> <li>• Provides a “field manual” version of the ICAO Technical Instructions.</li> </ul>                                 |
| International Convention for the Safety of Life at Sea (SOLAS)  | International Maritime Organization<br><a href="http://www.imo.org">www.imo.org</a>  | <ul style="list-style-type: none"> <li>• Safe transport of dangerous goods at sea</li> <li>• Chapter VII covers carriage of dangerous goods</li> </ul>  |
| International Maritime Dangerous Goods Code (IMDG Code)   | International Maritime Organization<br><a href="http://www.imo.org">www.imo.org</a>  | <ul style="list-style-type: none"> <li>• Advice on classification, stowage, segregation, packing, labelling, terminology and emergency response action of dangerous goods related to sea transport</li> </ul> |

## What does effective transport of ammunition look like?

Transport of ammunition is an integral activity associated with stockpile management.<sup>199)</sup> International requirements and agreements for the classification and transport of ammunition, all having the purpose of mitigating risk and increasing safety during the transportation of ammunition and explosives, have been identified and discussed in this section. **IATG 08.10** state that ammunition and explosives should be transported in accordance with these international requirements and agreements, specifically:

- The requirements of the UN Model Regulations, which contain details of the symbols and hazard classifications required for the safe transport of ammunition and explosives;<sup>200)</sup> and,
- International regulations and agreements (see Table 12) that govern the transport of dangerous goods and state that ammunition and explosives should be transported in accordance with the requirements of these international regulations.<sup>201)</sup>

The UN Model Regulations have been integrated into all international modal transport regulations. Users, therefore, – including carriers, consignors and inspecting authorities of dangerous goods – benefit from simplified transport, handling and control and a reduction in time-consuming formalities. Whilst initially produced for the transport of dangerous goods, the principles have been applied by many States as the basis for a simplified consequential hazard and risk assessment for the storage of ammunition.<sup>202)</sup> The combination of the Hazard Division and 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.<sup>203)</sup>

Consequently, the first steps for effective transport is the development of national policy and regulations that are based on the UN Model Regulations for the hazard classification of ammunition and explosives as discussed in this section, and that require the application of international transport regulations and agreements.

The next important step for effective transport is the development of an organizational structure, to include the assignment of a national competent authority, to serve as the technical authority that ensures compliance with national policy and regulations, the UN Model Regulations and international transport regulations and agreements. This organization and national competent authority should have the responsibility and oversight of the implementation of the adopted agreements and any related activities. **IATG 03.10** suggests an ammunition stockpile management system<sup>204)</sup> with its component organizations that would have the responsibility to manage, monitor, control, maintain and provide oversight of ammunition and explosives-related facilities, processes and other activities. Ammunition transport and its related activities are included as part of this system.



#### *What is a competent authority?*

A competent authority is a body, organization, or otherwise-recognized entity as such, for any purpose in connection with (dangerous goods) regulations.<sup>205)</sup>

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The IATG do not specifically describe what effective ammunition transport should look like. However, throughout the IATG modules, transportation-related topics are addressed and integrated into stockpile management activities, while associated requirements and guidance are provided. Some examples include :

- Transportation classifications, labelling and marking ;<sup>206)</sup>
- The impact of an ammunition fault or performance failure on transportation ;<sup>207)</sup>
- The impact of bans and constraints on transportation ;<sup>208)</sup>
- Transportation aspects associated with ammunition management personnel competencies ;<sup>209)</sup>
- Transportation-related operations as part of quantity and separation distance requirements ;<sup>210)</sup>
- General ammunition packaging and marking information ;<sup>211)</sup>
- Security during transport of ammunition.<sup>212)</sup>

Consequently, adherence to IATG guidance already brings a State closer to an effective ammunition transport process.

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#### *What is a ban ?*

The term “ban” refers to a moratorium placed on the issue and use of ammunition, usually pending technical investigation.<sup>213)</sup>

#### *What is a constraint ?*

The term “constraint” refers to the imposition of a limitation or restriction in the use, transportation, carriage, issue, storage or inspection of munitions.<sup>214)</sup>

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Ammunition transport has many distinct elements associated with it, and each plays an important role in ensuring ammunition is both safe to transport, as well as safe during transport. Some of these elements include ammunition design and associated operational testing as part of safety and suitability for service, hazard classification (including Compatibility Group) assignment and associated testing, packaging, marking and labelling, Compatibility Group mixing (for the transport mode involved), implementation of appropriate regulations and requirements, securing ammunition for transport, security of ammunition during transport, and documentation. A State should bear in mind that all these elements include transporting dangerous goods in one form or other. Through Life Management<sup>215)</sup> approach to ammunition is particularly useful in order for a State to encompass and prepare for transports in all stages – from planning to procurement, to stockpile management and final disposal.

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## 4.8 SECURITY OF AMMUNITION STORAGE AREAS

The loss, theft, leakage and proliferation (collectively these are generally known as diversion) of stockpile ammunition can threaten a State's ability to meet its national and strategic objectives. Additionally, ammunition diverted from national stockpiles can find its way into civil wars, insurgencies, terrorism, crime and other forms of armed violence, thus fuelling national and regional instability and threatening the security of States.



Security of ammunition stockpiles can make a major contribution towards reducing the risks of diversion of ammunition to illicit markets.<sup>216)</sup> Effective and efficient security should be considered an essential element of any conventional ammunition stockpile management programme as it reduces the risk of theft and diversion.<sup>217)</sup>

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This subsection explains what ammunition storage area security is, what it involves, why it is important, as well as what the major components of effective ammunition storage area security should include.

### What is ammunition storage area security ?



*What is stockpile security ?*

Stockpile security is defined by the IATG as 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.<sup>218)</sup>

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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 cost with system and process improvements.<sup>219)</sup> There is a range of activities to improve storage area security explained in detail in **IATG 09.10** and throughout the IATG modules.

### Why is ammunition storage area security important ?

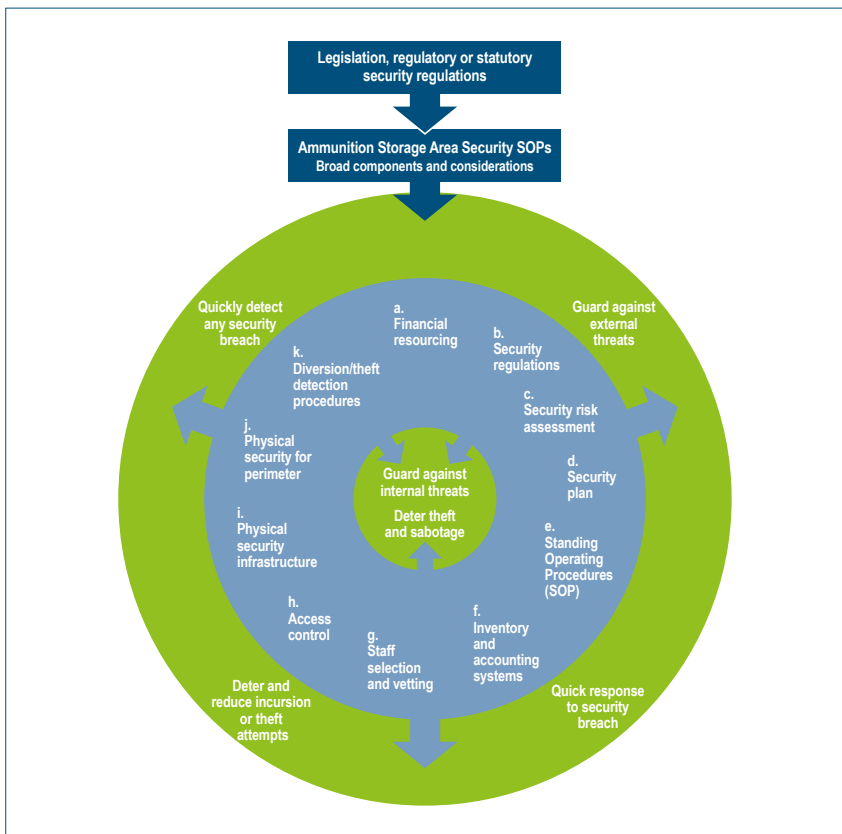
Storage area security protects the national stockpile from diversion of ammunition to illicit markets that could threaten the security of a State, impacting its ability to meet national and strategic objectives or fuel national and regional instability. Stockpile management in accordance with good practices is an important component in ensuring that a national authority fulfils its "duty of care" in ensuring that an ammunition stockpile is correctly looked after.<sup>220)</sup> The systematic control of ammunition stockpiles is in keeping with the philosophy of "due care" and States should therefore

take a proactive, rather than reactive, stance in ensuring that ammunition is accounted for and secured to the highest standards.<sup>221)</sup>

### What does effective ammunition storage area security look like ?

Effective security of an ammunition area and its ammunition stockpile is “the collective result of implemented measures” based on national legislation and regulatory requirements, taking into consideration the results of a comprehensive security risk assessment that fully considers all potential threats involved and the protection which must be afforded. Figure 18 illustrates the primary aims (the outer and inner part of the circle) of stockpile security and the main components and considerations (inside the circle) associated with a comprehensive physical security system for stockpile security. These are all factors that may need to be addressed when conducting a stockpile security risk assessment, as further discussed below.

**Figure 18** – Components and aims of effective Ammunition Storage Area security



**a. Financial resourcing.** Ammunition storage area security and stockpile security are expensive ; however, costs are minimal when compared to the overall potential value of the ammunition stockpile. These are important functions worth resourcing, considering that the purpose of security is to :

- Prevent diversion which can fuel domestic or regional conflicts, or criminal activities ; and
- Protect a State’s investment to meet national and strategic objectives.

For these reasons, financial accounting systems should consider the cost of stockpile security, which should include infrastructure, depreciation of infrastructure, and operating and staff costs over the anticipated life of the ammunition.<sup>222)</sup>

**b. Security regulations.** From an institutional perspective, comprehensive security regulations such as legislation, regulatory or statutory instruments, should exist as a legal authority on which to structure the security of the national stockpile and associated storage and process areas. Requirements should be clear and consistent, applicable to the entire stockpile and should be reviewed regularly.<sup>223)</sup>

**c. Security risk assessment.** The importance of stockpile security risk assessment as a foundation on which to build security requirements has been mentioned several times. Assessment results identify threats that must be guarded against and provide the basis as to what security components are necessary to be implemented for effective ammunition storage area security.

Using assessment results, the responsible authority will be able to establish management priorities to address expected threats in the most cost-effective and secure manner, thereby helping to ensure that the residual risk of loss, theft or diversion is kept to a minimum. Table 13 provides a general listing of areas that should be examined as part of a security risk assessment.<sup>224)</sup>

**Table 13 – Stockpile security risk assessment focus areas**

|  |
|--|
| <ul style="list-style-type: none"><li>• Financial value of facilities and contents within them</li></ul>   |
| <ul style="list-style-type: none"><li>• Active hazards to conventional ammunition security and their frequency<ul style="list-style-type: none"><li>○ probability of stockpile leakages through espionage, theft or diversion.</li><li>○ stockpile damage/destruction due to sabotage or other forms of attack.</li></ul></li></ul>  |
| <ul style="list-style-type: none"><li>• Passive hazards and their frequency<ul style="list-style-type: none"><li>○ natural catastrophes such as floods, earthquakes, fires, etc.</li></ul></li></ul>   |
| <ul style="list-style-type: none"><li>• Identification of materiel attractive to criminals and terrorist organizations (ACTO). Examples of such items include:<sup>225)</sup><ul style="list-style-type: none"><li>○ Man-portable air defence systems (MANPADS)</li><li>○ Detonators</li><li>○ Bulk explosives</li><li>○ Man-portable anti-tank missiles</li><li>○ Hand grenades</li><li>○ Small arms ammunition</li></ul></li></ul> |

The following paragraphs will explain how to deal with security threats and identify what role they play as part of comprehensive and effective ammunition storage area security.

**d. Security plan.** The security plan is an essential component of stockpile security and should be consistent with security regulations. It should be based on the results of a security risk assessment that should be carried out before any security plan is drawn up. A security plan should be written for each specific stockpile location and adapted, as necessary, for local conditions and requirements that can vary between locations.<sup>226)</sup> IATG 09.10 provides a security plan format that can be used as a model for a State's own plans. Figure 19 gives an extract from that model and shows the type of information that might be included in the security plan.

**Figure 19** – Snapshot of security plan model<sup>227)</sup>

| <b>Model for a security plan<sup>17</sup> (LEVEL 1)</b> |   |
|---|---|
| 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;   |

**e. Standing Operating Procedures (SOPs).** Security-related SOPs are implementing documents and should be prepared as complementary to security regulations, security risk assessment, and security plans. SOPs should lay down clear operational activities, requirements and responsibilities for day-to-day and emergency response actions to be taken.<sup>228)</sup>

Table 14 lists the minimum content that should be included in a SOP.

**Table 14** – SOP minimum content<sup>229)</sup>

|  |
|--|
| • Scope and terms of references  |
| • Individual in charge   |
| • Generic and known security threats                                       |
| • Responsible individuals and organizations                                |
| • Access control and key control rules and requirements                    |
| • Inventory and accounting procedures                                      |
| • Any detailed security procedures for specific ammunition types and areas |
| • Actions upon discovery of incursion or diversion (as well as surpluses)  |
| • Actions in response to alarms  |



**f. Inventory and accounting systems.** Important aspects of a security system are ammunition accounting and inventory management systems (discussed in subsection 4.2). These systems, if effective, can provide timely and reliable detection of inadvertent inaccuracy, loss, theft, leakage or diversion. The ability to detect such losses is not only a key control measure of effective stockpile management, but also of stockpile security, particularly as ineffective stock accounting significantly increases the risks of proliferation.<sup>230)</sup> Without the ability to detect illicit losses of ammunition stocks through an effective and accurate accounting and inventory management system, the security of ammunition stockpiles becomes immediately ineffective, regardless of how well that security system has been designed.

**g. Staff selection and vetting.**<sup>231)</sup> Physical security and inventory management systems become vulnerable if they are compromised through the actions of staff members. Organizations should only fill staff positions with individuals without a criminal record, criminal connections or tendencies, who are likely to remain loyal, are well motivated, and appropriately rewarded. Stockpile management organizations should ensure that appropriate procedures are developed and followed for the security vetting of staff, prior to employment in ammunition storage areas, and that they are security-verified at regular intervals throughout their employment. It should also be a condition of their contracts that they shall report any relevant changes in personal circumstances to security vetting staff.<sup>232)</sup>

**h. Access control.** Access control is a broad area which involves many security components and considerations. Access control relates to personnel and vehicle entry into ammunition areas, personnel entry into facilities, as well as key and combination lock management and controls.<sup>233)</sup>

**i. Physical security infrastructure.** This component deals with the physical elements that are used to control and monitor entry into facilities, such as security requirements for doors, gates, windows, locks and padlocks; intrusion detection systems or alarms, associated record keeping, and testing.<sup>234)</sup>

Windows should 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.<sup>235)</sup>

**j. Physical security for the perimeter.** This component deals with the physical elements that are used to delineate the boundary of a protected or restricted area; it details perimeter control, entry/exit points, perimeter intrusion detection systems (PIDS), security lighting and closed-circuit television (CCTV) systems.<sup>236)</sup> These are designed to resist or discourage external threats that might exist and are the result of a security risk assessment. Fencing is the most obvious first step that can be taken with regards to perimeter protection; Table 15 provides information about the four types of fencing available and the threats they deter. Physical security for temporary sites is harder to achieve due mainly to the large ground area that they cover. Perimeter security

of temporary sites should be the highest priority, and this may be achieved by using a combination of armed guards, patrols, guard dogs and temporary fencing.<sup>237)</sup>

**Table 15 – Types of perimeter fence** <sup>238)</sup>

- Class 1
- Minimum 1.5 m high
  - Primarily to delineate a boundary
  - No particular security requirements/ provides no deterrence



- Class 2
- Anti-intruder fence that offers some resistance
  - Should be supported by other perimeter security systems



- Class 3
- Intermediate security barrier
  - Designed to deter or delay
  - Offers resistance to attempts at climbing and breaching
  - Should be supported by other perimeter security systems
  - Welded mesh resists climbing and cutting
  - Offers a good balance between resistance versus cost



- Class 4
- High security barrier designed for maximum deterrence
  - High degree of resistance to climbing or breaching
  - Must be supported by other perimeter security systems
  - Should always be used in conjunction with CCTV and an intruder detection system
  - Expensive to construct



Other aspects of perimeter security that should be considered include :

- Clear zones free of vegetation both within (4 m) and outside (10 m) of the security fence to provide good visibility of the fence line by security staff and perimeter security systems (if used).<sup>239)</sup>
- Penetration of land under fences for drainage, etc. should also be addressed for security reasons. Drainage openings or passages should have bars and grilles preventing access at each end.<sup>240)</sup>
- Perimeter lighting both inside the perimeter fence and outside the fence should provide sufficient light to allow detection of unauthorized activity. Access points to the storage area should have direct illumination above the entry points, Lighting should be installed in accordance with the requirements of **IATG 05.40**.
- A perimeter intrusion detection system (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.
- Visual surveillance systems can be used to increase the effective range and area of ground covered by individual members of the security staff, thereby minimizing staff requirements. Technology is available that can provide day, low-light, and night coverage.
- Roving patrols and trained working dogs can be used to complement an existing guard and response force, by conducting security and building checks during non-duty hours.<sup>241)</sup>

**k. Diversion/theft detection procedures.** Any diversion should be immediately and expediently investigated to determine the nature of the diversion, identify any deficiencies in the security system, and enable corrective action. The goal of this investigation (different from a criminal investigation to determine culpability) is to assess the security system, identify and close gaps in the security system and to prevent a similar event from occurring. Depending on the results of the investigation and the scale of the loss, counter-diversion activities may need to be carried out. Principles of counter-diversion are detailed in table 2 of **IATG 09.10** and these principles should be used as a guide for policymakers, law enforcement, customs, arms export, transportation and traffic control agencies to counter diversion of ammunition and explosives once their loss from the stockpile has been detected.

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## 4.9 AMMUNITION DEMILITARIZATION AND DESTRUCTION

Disposal of ammunition refers to the removal of ammunition and explosives from a stockpile by utilizing a variety of methods (that may not necessarily involve destruction). Demilitarization and destruction of ammunition are covered in **IATG 10.10**. Disposal of ammunition using these methods is an important subject, as the excess accumulation of ammunition in conventional ammunition state stockpiles has long been identified as a problem and the implementation of effective measures to address unserviceable and shelf-life expired munitions is an essential precursor to

reducing the probability and consequences of unplanned explosions at munitions sites.<sup>242)</sup> This section provides an overview of demilitarization and destruction processes and activities as described in the IATG.



#### *What is disposal ?*

The IATG define disposal as the removal of ammunition and explosives from a stockpile by utilizing a variety of methods, (that may not necessarily involve destruction). Logistical disposal may or may not require the use of render safe procedures.

There are six traditional methods of disposal used by armed forces around the world : sale ; gift/donation ; use for training ; deep sea dumping ; landfill ; and destruction or demilitarization.<sup>243)</sup> Of these, destruction and demilitarization are the preferred modes of disposal.<sup>244)</sup>

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### **What is the ammunition demilitarization and destruction cycle ?**

IATG 10.10 provides an overview of the various disposal options.<sup>245)</sup> However, the module stresses that the most acceptable and practical methods of disposal are destruction or demilitarization.<sup>246)</sup> Demilitarization of ammunition tends to suggest the industrial processing of ammunition and it implies the use of complex machinery to break down and gain access to explosive components. An essential ingredient of all ammunition demilitarization activities is the ability to carry out the processing of ammunition, discussed in section 4.6. Figure 20 provides an overview of the ammunition demilitarization and destruction cycle as described by the IATG.<sup>247)</sup>



#### *What is demilitarization ?*

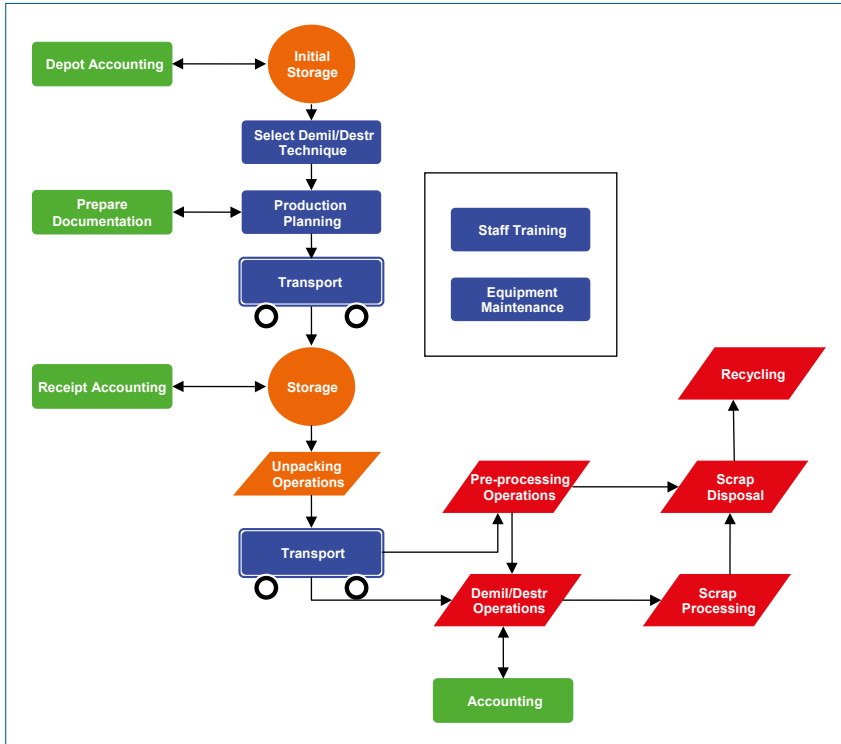
According to the IATG, demilitarization refers to the complete range of processes that render weapons, ammunition and explosives unfit for their originally intended purpose. Demilitarization not only involves the final destruction process, but also includes all other transport, storage, accounting and pre-processing operations that are equally critical to achieving the final result.<sup>248)</sup>

#### *What is destruction ?*

The IATG define destruction as the process of final conversion of weapons, ammunition and explosives into an inert state so that the item can no longer function as designed.<sup>249)</sup>

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**Figure 20 – Ammunition demilitarization and destruction cycle**



It is essential that ammunition disposal is not considered as a stand-alone activity and is instead viewed as a fundamental part of the effective through life management of ammunition. Even in well-resourced States, ammunition demilitarization and disposal are sometimes seen as an unwanted expense and prioritized accordingly. If not afforded a sufficiently high priority, unserviceable ammunition stocks awaiting disposal can fill up available ammunition storage space and prevent the effective storage and management of operational ammunition. Ammunition which has passed its shelf life may also degrade to the extent that the energetic contents pose a severe spontaneous fire and explosion risk.

### What are the principal demilitarization and destruction techniques?

Various technologies and techniques are available for demilitarizing and destroying ammunition.<sup>250</sup> The IATG suggest that open burning (OB) and open detonation (OD) are the easiest ways for States with limited capabilities to undertake the disposal of ammunition, and both techniques are particularly appropriate for the destruction of non-complex weapons in relatively small quantities. While OB and OD are relatively simple processes and are easy to implement, some complex weapons require a

degree of pre-processing, often to separate propulsive components, such as booster and second stage rocket motors from high explosive warheads. For this reason, OB and OD may still be applicable as part of a broader approach to ammunition destruction featuring demilitarization.<sup>251)</sup>



**Open burning (OB):** A technique often used for the disposal of military propellants and pyrotechnical compositions. The disposal of the latter, in particular, has potential environmental implications due to the presence of heavy metals in some pyrotechnical compositions and the release of volatile and semi-volatile toxic substances during the low-temperature burning process. In selecting a suitable site for burning, great care must be taken to prevent accidental fires from spreading, particularly in hot climates. Open burning is particularly effective for the disposal of bulk propellant charges associated with artillery and tank ammunition.

**Open detonation (OD):** A technique where a small quantity of serviceable explosive (the donor charge) is used to initiate the explosive filling in the ammunition being disposed of. While OD is an effective technique to be conducted safely, it requires suitably qualified and experienced personnel to plan, supervise and conduct OD operations.

**NOTE;** only suitably qualified and experienced personnel should conduct demilitarization and destruction techniques.



Although not described by the IATG in detail, explosive harvesting systems are a useful mode of demilitarization and destruction. Explosive harvesting systems are described in generic terms in IATG 10.10, para. 9.2.4 and para. 9.2.7. It is considered a RRPL 3 activity.

Explosive harvesting is a technique used in some parts of the world to repurpose the high explosive found in military munitions, for example, for use as quarrying charges. A number of commercial explosive harvesting systems have been implemented.

## Technical considerations for ammunition demilitarization and disposal

In order to determine the most suitable method of ammunition disposal, States should consider the following factors:<sup>252)</sup>

- **Safety.** Safety is paramount when considering a method of ammunition disposal. If the ammunition has deteriorated to such a condition where it is unsafe to move and process then local disposal by open burning (OB) or open detonation (OD) may be the only feasible solution.
- **Feasibility.** The quantity of ammunition to be disposed of is an important factor in determining the most economic method of disposal. If many thousands of identical items are to be processed and the process may yield recoverable materials such as metals, then there may be a sound economic case for initiating

a disposal programme based on demilitarization. If the quantity of ammunition to be disposed of is relatively small or is made up of a diverse range of items, then OB/OD will probably be a more economically feasible solution.

- **National legislation.** National legislation, particularly environmental legislation and regulations, may dictate the most appropriate method of disposal. Generally, open detonation of large quantities of ammunition is not usually viable in areas of high population density. Some States and international organizations will only support large-scale ammunition disposal projects based on demilitarization, with appropriate reuse of recovered materials.
- **Technical capabilities of the conducting State.** OB/OD generally requires a lower level of technical capability than industrial demilitarization. In austere environments, consideration should also be given to the level of local equipment and logistical support capabilities which are present.
- **Complexity of the ammunition type.** The complexity of the ammunition type is critical in determining the most appropriate technical means of disposal. Complex weapons, such as liquid-fuelled missiles and other large guided weapons for air and maritime platforms, invariably require complex processing prior to disposal. OB/OD of the complete item shall only be carried out when all other options have been investigated and eliminated.
- **Availability of technology and supporting infrastructure.** The availability of infrastructure to permit the safe processing of ammunition will determine the extent to which industrial demilitarization techniques may be employed. Temporary or mobile ammunition inspection or processing facilities are particularly useful if fixed ammunition process buildings are not available.
- **Security.** Security and the risk of stock diversion is an important factor in determining how quickly ammunition should be disposed of. For bulk explosives and detonators, of which both are highly desirable to terrorist groups, OB/OD may be the fastest and most appropriate means by which these simple IED precursors may be rendered unusable.

### Non-technical considerations

The IATG strongly recommend that only environmentally-sound methods of demilitarization and destruction be adopted. Two methods of disposal previously used - disposal by landfill (burial) and deep-sea dumping - are now strongly discouraged. Disposal by landfill was commonly used in the early 20th century for the disposal of chemical-filled munitions and resulted in long-term pollution of ground water. Deep-sea dumping was widely used up to the late 20th century and is now prohibited by treaty. Disposal by landfill or deep-sea dumping will not be supported by UN programmes.<sup>253)</sup>

Treaty obligations such as the Anti-Personnel Mine Ban Convention and the Convention on Cluster Munitions may affect ammunition disposal options.

## **Ammunition control and stockpile management during demilitarization and disposal operations**

An effective strategy covering disposal, destruction and demilitarization is a fundamental element of good life-cycle management of ammunition. Ammunition managers and logistics staff must consider the complete through life management of ammunition and not just focus on the acquisition and in-service phases. An effective ammunition disposal strategy helps ensure that ammunition is disposed of promptly and that scarce licenced storage space in ammunition storage areas is not “wasted” through the requirement to store unserviceable or surplus ammunition stock for long periods while it awaits disposal.

The IATG suggest that ammunition is destroyed in accordance with the following priorities: <sup>254)</sup>

- **Priority 1.**
  - Ammunition that poses the greatest risks to the civilian community in terms of explosive safety;
  - Ammunition that is Attractive to Criminal and Terrorist Organisations (ACTO).
- **Priority 2.**
  - Ammunition that must be destroyed in order to meet treaty obligations;
  - Small Arms Ammunition.
- **Priority 3.**
  - Ammunition that needs to be destroyed to release storage space;
  - Remaining ammunition types.

It is the decision of each State to assess its disposal and destruction priorities taking into account security, safety and financial considerations as well as the capability of conducting the demilitarization process.

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### **4.10 AMMUNITION ACCIDENTS, REPORTING AND INVESTIGATION**

The reporting and investigation of accidents involving ammunition is a fundamental element of an effective ammunition safety management system. Ammunition accidents may indicate areas which need to be addressed in training, particularly when the ammunition accident is determined to be caused by an error in the weapons system drill, or by poor or unsafe weapons system handling.

More importantly, the investigation of ammunition accidents may indicate a significant problem with a particular manufactured batch of ammunition. It may also demonstrate that ammunition is deteriorating while in storage and the operational effectiveness of the munitions in the stockpile can no longer be relied upon or that the ammunition item may no longer be safe for use. Recommended procedures for ammunition accident reporting and investigation <sup>255)</sup> and a suggested investigation methodology <sup>256)</sup> are described in the IATG. This section provides an overview of these aspects by drawing on material from [IATG 11.10](#) and [IATG 11.20](#).



## What are ammunition accidents and why should they be investigated?



### *What are ammunition accidents?*

The IATG define ammunition accidents as 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 whether military or civilian.<sup>257)</sup>

### *What is an incident?*

According to the IATG, the term incident refers generically to all accidents, performance failures and faults involving ammunition or where ammunition is present.<sup>258)</sup>

The principal reasons why ammunition accidents should be investigated are to :<sup>259)</sup>

- Improve safety and to prevent a reoccurrence of the accident ;
- Identify faults in the manufacture of particular batches of ammunition ;
- Identify underlying faults in the design of ammunition. This is particularly relevant for types of ammunition which are only used occasionally during training ;
- Identify ammunition that is deteriorating in an unsafe mode during storage ;
- Identify common errors in the weapons system drill and issues that need to be addressed in training ;
- Provide information to support legal or other judicial proceedings ;
- Conform with national legislation on health and safety ;
- Provide information to improve future weapon and ammunition design.

The national authority should specify how ammunition accidents are to be reported and how the follow-up investigation should be conducted.

The following actions should be taken by the Unit and personnel using the ammunition in the event of an accident :<sup>260)</sup>

- Cease firing ;
- Immediate medical support and casualty evacuation to injured parties ;
- Secure the scene ;
- Report the accident to the investigating authority ;
- Ensure witness details are recorded and that witnesses are made available for the subsequent accident investigation ;
- Ensure that any related weapons system is made safe and secure and is not operated.

The investigating authority is the entity nominated by the national authority with responsibility to conduct ammunition accident investigations.<sup>261)</sup> The investigating authority should:

- Maintain a team of competent accident investigators ;
- Assign one or more accident investigators to each ammunition accident ;
- Examine the technical reports submitted by ammunition accident investigators on each accident ;
- Direct further testing and investigation of the munitions stockpile, if required ;
- Consult with other entities involved in the Life-Cycle Management of Ammunition such as the ammunition procurement organization, the manufacturer and the military organization responsible for training on the related weapons system ;
- Make a technical judgment on the cause of the accident and inform all interested parties ;
- Provide support to judicial and legal proceedings as determined by national regulations and legislation ;
- Initiate remedial action in order to prevent a reoccurrence of the incident.

The ammunition accident investigator is the person assigned by the investigating authority to conduct the accident investigation. The ammunition accident investigator should:<sup>262)</sup>

- Examine the scene of the accident ;
- Ensure that the scene is safe ;
- Examine any ammunition or weapons system involved in the accident ;
- Identify the type and lot of ammunition involved and advise the investigating authority to initiate a ban or constraint on the ammunition involved ;<sup>263)</sup>
- Conduct an ammunition accident investigation ;
- Make an initial assessment as to the likely cause of the accident ;
- Submit an ammunition accident investigation report to the investigating authority.

## What is ammunition accident investigation methodology ?



The first priority of the accident investigator is to ensure that the scene is safe and that any explosive or non-explosive hazards are addressed before the accident investigation commences. At the scene of explosion or ammunition accident involving combat vehicles, where multiple items of ammunition may have been involved, the investigator should be aware of the particular hazards posed by ammunition items which have been subject to fire or explosion and have not functioned. Where necessary, these items should be recorded and photographed in situ before they are dealt with using explosive ordnance procedures.

It is essential that the scene of the accident is undisturbed in order for evidence to be collected, and the true cause of the accident determined.<sup>264)</sup> As a rule, only those actions required to preserve life should be taken at the scene and the remains of those certified dead by a doctor should stay in place until the initial phase of the accident investigation has been concluded. To preserve the integrity of the scene and material collected, the following factors should be considered :

- Forensic gloves, boots and suits should be worn, if appropriate ;
- If possible, the investigator should establish a common approach path to the scene of the accident, to minimize the disruption of small items of evidence ;
- Collection of evidence should involve a minimum number of personnel. If the civil or military police are involved in the accident investigation then it may be appropriate for a crime scene investigator to log, collect and present any items of evidence which are recovered ;
- Evidence, once collected and packaged, should not be left unattended or unsecured.



Ammunition investigators should adhere to the following guidelines when dealing with human remains :

- The bodies of any victims must always be treated with respect ;
- The investigator should be aware of the hazard posed by contact with contaminated body fluids. Gloves and other protective clothing should be worn to reduce this hazard ;
- If it is possible that victims' bodies may contain fragments of ammunition items, this should be indicated to the forensic collection agencies and steps taken later to recover evidence during post mortem examination.

There are several types of evidence which may be collected at an accident scene :<sup>265)</sup>

- **Witness evidence.** Witness evidence is extremely important in determining the sequence of events in the run up to the accident taking place. Witnesses should be questioned separately, and all evidence obtained should be presented in a signed witness statement. Accident investigators should be aware that witnesses may present false testimony in order to cover up their perceived culpability in an accident.
- **Physical (or forensic) evidence.** Physical evidence includes all evidence recovered at the scene which may later assist in determining the actual cause of the accident.
- **Photographic evidence.** Photography is an invaluable aid to documenting an ammunition accident and maximum use should be made of high-resolution digital imagery.

It is important that the accident investigator considers all available evidence. The IATG provide comprehensive guidance to accident investigators in determining the actual cause of an accident.<sup>266)</sup> The accident investigator should submit a comprehensive report and all of the collected evidence to the investigating authority on completion of the investigation.<sup>267)</sup>

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### **Box 6 – An example of an ammunition accident and investigation**

On 9 March 1997, a 155 mm artillery projectile exploded prematurely in the barrel of an FH2000 howitzer during a live firing exercise conducted by the Singapore Armed Forces (SAF) in New Zealand.<sup>268)</sup> The accident resulted in the deaths of two SAF servicemen and injuries to a further twelve. The post-incident investigation and committee of enquiry concluded that the incident was probably caused by a defective fuze fitted to the artillery projectile. Figure 22 shows a photograph of the howitzer taken during the course of the ammunition accident investigation.

The Singapore Ministry of Defence (MINDEF) convened a committee of inquiry and released a report on 28 June 1997.<sup>269)</sup> The committee found after the incident that 1.3% of the fuzes from the same lot which was involved in the accident were defective. This defective lot of fuzes was supplied by Chartered Ammunition Industries (CAI) to MINDEF under an agreement in 1992. CAI was to supply fuzes manufactured according to internationally accepted military specifications. These military specifications require thorough inspections and other quality control measures during and after the manufacturing process to eliminate all defects in the fuzes. CAI, in turn, had contracted a US company, Island Ordnance Systems (IOS), for the supply of these fuzes.

Without the knowledge of CAI, IOS obtained the fuzes from Xian Dong Fang Machinery Factory in the People's Republic of China (PRC). In October 1994, CAI discovered that the fuzes had been manufactured at a factory in the PRC rather than in the USA. However, CAI did not notify MINDEF of this fact. MINDEF only became aware that these fuzes had been manufactured in the PRC during the committee of inquiry proceedings. Furthermore, the committee found that no breach of SAF training safety regulations was applicable in this incident.<sup>270)</sup>

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**Figure 21** – Effects of a premature bore explosion on a Singapore Armed Forces 155 mm howitzer<sup>271)</sup>



#### 4.11 AMMUNITION OPERATIONAL SUPPORT

National operations associated with deployment or small tactical units will likely require the use and storage of ammunition. However, due to distance or an isolated location, national support for such operations may be substantially less, compared to that provided at a base or logistics level.<sup>272)</sup> Compounding the issue is that such operations could be faced with a need to store unique, non-stockpile type ammunition or explosives, such as captured enemy ammunition, seized contraband, or criminal evidence. Despite these limitations and challenges, safe and secure management practices are still vitally necessary to protect the mission ; national or multi-national (where supporting a multi-national operation) personnel and assets; the public; and possibly other important assets, such as criminal evidence, from the risks associated with an unplanned explosion event or diversion.



National operations associated with deployment may include,  
1) those mandated by the UN Security Council (UNSC),  
2) those undertaken by regional organizations (e.g. African Union), or  
3) those undertaken by coalitions.<sup>273)</sup>



#### *What is a small unit?*

A small unit is defined as 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. Examples include police stations, isolated small military units and border guard posts.<sup>274)</sup>

Prior to the start of operations, it is important for a State to perform proper planning to address expected challenges and consider operational support needs. Important stockpile management tasks should be identified, prioritized and resourced, and proper guidance should be provided as well for accomplishing required tasks. These activities should be accomplished from the perspective of maintaining effective risk management, towards keeping risk at an acceptable level. Operational support needs can change over time as a function of the phase of the operation, so the review and assessment of operations is a continuous process. This subsection outlines what operational support consists of, why it is important, what guidance is available, and what the basic components of an effective operational support system should look like.

### **What is operational support?**

Both deployed forces and small units operate in unique environments where there might be difficulty in obtaining ammunition-qualified personnel, the necessary supporting infrastructure, and the ability to implement and use typical national processes and systems. On this basis, operational support is the fulfilment of State actions necessary to give operational units the minimum capabilities and resources needed for proper and effective management of ammunition and explosives under their control, in order to mitigate risk from an unplanned explosion event or diversion, and ensure the functionality of stockpile ammunition.

### **Why is operational support important?**

The principles and procedures for the safe, effective and efficient storage, handling, transport and use of ammunition and explosives are the same whether these materials are in an explosive storage area, a temporary or field storage location, or within a small unit.<sup>275)</sup> However, the potential risk and probability of an unplanned explosion event or diversion can differ significantly for each of these based on availability of qualified personnel, available resources, and the care, maintenance, and management of the ammunition and explosives being stored. The fact remains that regardless of any difficulties and challenges associated with deployment and small unit isolation, the responsibility to protect the health and safety of unit, national and multi-national members, the general public and the natural environment remains with the State, via the force commander.<sup>276)</sup> To help ensure that protection, a State should provide operational support, guidance and resources to help meet minimum national safety and security requirements.

## What does effective operational support look like?

For the reasons previously discussed, a State should treat ammunition and explosives under its care in the same manner, regardless of where it is located or the conditions under which it is stored. It can also be argued that deployed ammunition and unique ammunition and explosives should receive additional attention due to the environment and conditions they may operate in and because these areas can influence safety, functionality and shelf life.

To help States address operational risks associated with ammunition and explosives, **IATG 12.10** was developed to assist deployed forces, and **IATG 12.20** was developed to assist small units. These two modules are intended to help ensure that storage practices can meet the minimum requirements relating to RRPL 1, which will often reduce risk significantly. Ongoing and gradual improvements can then be made to the stockpile management infrastructure and processes as staff development improves and further resources become available.<sup>277)</sup>

**Operational planning.** Effective operational support begins with comprehensive operational planning (at national and multi-national levels, as appropriate) conducted prior to a mission or an operation commencing. Annex C of IATG 12.10 provides a checklist of important considerations pertaining to operational planning. The content of Table 16 is an extract from this Annex and gives an indication of the type of operational support information that should be collected.

**Table 16 – Planning considerations for the operational force commander**<sup>278)</sup>

| SER | ITEM  |
|-----|---|
| 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? |

As part of operational planning, other important aspects related to storage and explosives safety matters may need to be considered and addressed, such as the chain of command and roles and responsibilities<sup>279)</sup> for participating States, the mission commander, force commander/base commander, Force Explosives Safety Officer (FESO), commander of Troop Contributing Nations (TCNs) and base commander support elements. Other aspects include the development of agreements, approval of authorities for deviations from explosives safety requirements, licensing of explosives locations, real-estate and construction management, etc.

On an operational base there may, by necessity, be more reliance on risk management and the carrying out of explosion consequence analyses. The force commander is responsible for striking a balance between safety and operational requirements and therefore should:<sup>280)</sup>

- Be informed when minimum standards cannot be met ; and
- Understand the possible consequences of any reduction in safety criteria.

Consequently, risk parameters (such as what is an acceptable risk) and approval levels should be well defined in national and mission documents.

**Operational support.** Effective operational support should be accomplished through national train-as-you-fight courses, procedures and exercises, meaning that operational aspects are based on established and implemented national processes and procedures that would also apply to deployments and small units. This approach provides for a consistent national basis for risk management. Operational environments will always present challenges, but these can often be overcome with proper training, planning, support, and adequate resources. Methods and techniques that can help offset such challenges include :

- Having a national explosives safety standard and procedures for stockpile management and safety ; the availability of basic and clear procedures for the conduct of ammunition and explosives safety-related processes. The IATG can be used to support national efforts to develop such documents ;
- Availability of call-back support capabilities for deployed or small unit personnel ;
- National command oversight, as well as periodic technical assistance visits from national experts (such as surveillance, disposal, inspections, etc.) ;
- Awareness of techniques and methodologies available to help reduce the risk and consequences of any explosion incident and for preventing diversion ;
- Appropriate training and high reliance on risk management methodologies and decision making, and acceptance of residual risk at the appropriate authority level, whenever minimum recommendations cannot be met ;
- For deployment operations : managing the specific activities and operations listed in Table 17, which summarizes minimum recommendations (given in IATG 12.10) for the safety and security management of ammunition-related storage and transport.



**Table 17 – Ammunition storage on operations – IATG requirements<sup>281)</sup>**

| <b>Requirement</b>                           | <b>Summary</b>   | <b>IATG Reference</b>            |  |
|--|--|----------------------------------|--|
| Accounting                                   | <ul style="list-style-type: none"> <li>Accounting systems</li> <li>Stack tally cards</li> <li>Stocktaking and audits</li> </ul>  | 03.10                            | 14.2<br>14.5<br>14.6                   |
| Ammunition accidents                         | <ul style="list-style-type: none"> <li>Actions by user unit</li> <li>Reporting format</li> </ul>   | 11.10                            | 8<br>Annex C                           |
| Classification of ammunition and explosives  | <ul style="list-style-type: none"> <li>Ammunition and explosives are classified in accordance with the UN Globally Harmonized System</li> </ul>  | 01.50                            | 6.1<br>6.2                             |
| Controlled articles and contraband           | <ul style="list-style-type: none"> <li>The prohibition of contraband within temporary or field storage</li> </ul>  | 06.10                            | 5.3                                    |
| Documentation and records (held in magazine) | <ul style="list-style-type: none"> <li>Explosives Limit Licence</li> <li>Humidity record</li> <li>PES log book</li> <li>Temperature record</li> </ul>  | 02.30<br>06.70<br>06.70<br>06.70 | 7<br>Annex D<br>Annex C<br>Annex D     |
| Explosives licence                           | <ul style="list-style-type: none"> <li>Required to ensure that safe levels of storage are authorized and maintained</li> </ul>   | 02.30                            | 7                                      |
| Faults and performance failures during use   | <ul style="list-style-type: none"> <li>System for the reporting of ammunition faults and performance failures when used for training or on operations</li> </ul>   | 01.60                            | 7<br>8<br>Annex C                      |
| Fire safety                                  | <ul style="list-style-type: none"> <li>Fire alarm systems</li> <li>Fire practices</li> <li>Fire signs and symbols</li> <li>Immediate firefighting appliances</li> <li>Unit immediate actions</li> <li>Supplementary</li> </ul> | 02.50<br><br>04.10               | 7<br>8.2<br>10.2<br>10.3<br>11.1<br>11 |
| Mixing rules                                 | <ul style="list-style-type: none"> <li>Ensuring that ammunition of conflicting Compatibility Groups are not stored together</li> </ul>   | 04.10                            | 8.1                                    |
| Quantity and separation distances            | <ul style="list-style-type: none"> <li>These should be developed by qualified ammunition personnel and will be clearly stated on the Explosives Limit Licence</li> </ul>   | 04.10                            | 6.0<br>8.4<br>8.5                      |
| Transport of ammunition                      | <ul style="list-style-type: none"> <li>In accordance with UN Model Regulations</li> </ul>  | 08.10                            | All                                    |
| Warning signs                                | <ul style="list-style-type: none"> <li>In accordance with the UN Globally Harmonized System</li> </ul>   | 01.50                            | 6.1<br>6.1.1                           |

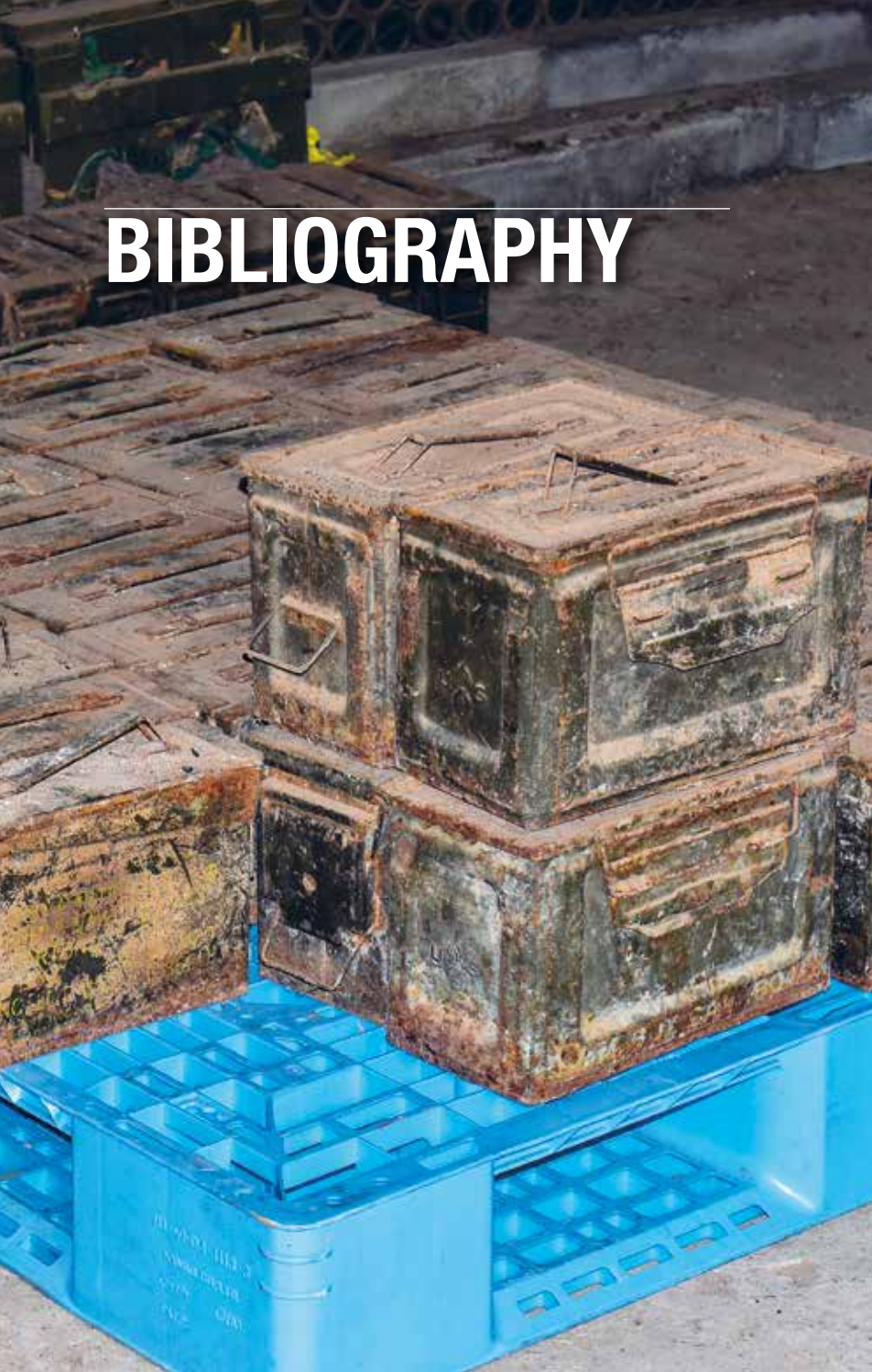
- For small unit operations - managing operations listed in Table 18, which summarizes minimum recommendations (given in IATG 12.20) for the safety and security management of ammunition-related storage and transport.

**Table 18 – Small unit ammunition storage – IATG requirements<sup>282)</sup>**

| <b>Requirement</b>                           | <b>Summary</b>   | <b>IATG Reference</b>            |                                    |
|--|--|----------------------------------|------------------------------------|
| Accounting                                   | Accounting systems<br>Stack tally cards<br>Stocktaking and audits  | 03.10                            | 14.2<br>14.5<br>14.6               |
| Ammunition accidents                         | Actions by user unit<br>Reporting format   | 11.10                            | 8<br>Annex C                       |
| Bans and constraints                         | To ensure that ammunition that is either banned or constrained for use is identified and segregated                              | 01.70                            | 6<br>7                             |
| Classification of ammunition and explosives  | Ammunition and explosives are classified in accordance with the UN Globally Harmonized System                                    | 01.50                            | 6.1<br>6.2                         |
| Controlled articles and contraband           | The prohibition of contraband within small magazines   | 06.10                            | 5.3                                |
| Documentation and records (held in magazine) | Explosives Limit Licence<br>Humidity record<br>PES log book<br>Temperature record  | 02.30<br>06.70<br>06.70<br>06.70 | 7<br>Annex D<br>Annex C<br>Annex D |
| Explosives licence                           | Required to ensure that safe levels of storage are authorized 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<br>8<br>Annex C                  |
| Fire safety                                  | Fire alarm systems<br>Fire practices<br>Fire signs and symbols<br>Immediate firefighting appliances<br>Immediate actions of unit | 02.50                            | 7<br>8.2<br>10.2<br>10.3<br>11.1   |
| Inspections (external)                       | To ensure that unit ammunition stores are appropriately inspected on a regular basis   | 06.70                            | 5.2                                |

| <b>Requirement</b>                | <b>Summary</b>  | <b>IATG Reference</b> |                  |
|-----------------------------------|---|-----------------------|------------------|
| 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 Exposition Sites (PES) should be kept and maintained  | 06.70                 | 5.1.1            |
| Mixing rules                      | To ensure 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 Explosives Limit Licence  | 02.20                 | Not for unit use |
| Risk analysis and acceptance 283) | 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               |
| Security of magazines             | Access control<br>Physical security infrastructure  | 09.10                 | 8.5<br>8.6       |
| Transport of ammunition           | In accordance with UN Model Regulations   | 08.10                 | All              |
| Warning signs                     | In accordance with the UN Globally Harmonized System  | 01.50                 | 6.1<br>6.1.1     |

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## FURTHER RESOURCES

### UN resources

Most recent UN General Assembly resolution on 'Problems arising from the accumulation of conventional ammunition stockpiles in surplus' :

[www.un.org/disarmament/convarms/ammunition/](http://www.un.org/disarmament/convarms/ammunition/)

Most recent UN General Assembly resolution on 'Countering the threat posed by improvised explosive devices' :

[www.un.org/disarmament/convarms/ieds/](http://www.un.org/disarmament/convarms/ieds/)

IATG modules, Implementation Support Toolkit, and Documents Repository :

[www.un.org/disarmament/un-safeguard/](http://www.un.org/disarmament/un-safeguard/)

The UN SaferGuard Toolkit is particularly useful for evaluating the safety of ammunition storage and processing facilities.

The quantity-distance map uses open source geographical imagery and allows key OQDs, based on an input net explosive quantity (NEQ) to be stored.

To graphically display quantity-distances :

[www.un.org/disarmament/un-safeguard/map/](http://www.un.org/disarmament/un-safeguard/map/)

Explosive consequence analysis :

[www.un.org/disarmament/un-safeguard/explosion-consequence-analysis/](http://www.un.org/disarmament/un-safeguard/explosion-consequence-analysis/)

UN Model Regulations :

[www.unece.org/trans/danger/publi/unrec/rev13/13nature\\_e.html](http://www.unece.org/trans/danger/publi/unrec/rev13/13nature_e.html)



## Other resources

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Link to the IMAS support tools which provide assistance in the calculation of safety distances for OB and OD :

[www.mineactionstandards.org/about/imas-support-tools/](http://www.mineactionstandards.org/about/imas-support-tools/)

Technical note on the estimation of explosion danger areas :

[www.mineactionstandards.org/fileadmin/MAS/documents/technical-notes/TN\\_10.20\\_01\\_2001\\_Explosion\\_Danger\\_Areas\\_V\\_2.0\\_Amd\\_1\\_2.pdf](http://www.mineactionstandards.org/fileadmin/MAS/documents/technical-notes/TN_10.20_01_2001_Explosion_Danger_Areas_V_2.0_Amd_1_2.pdf)

OSCE handbook on best practices on conventional ammunition (Sect V page 143 onwards covers ammunition destruction) :

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# NOTES

- 1) UNGA (2012), para. 1.
- 2) For access to the IATG implementation support toolkit please see :[www.un.org/disarmament/un-safeguard/toolkit/](http://www.un.org/disarmament/un-safeguard/toolkit/)
- 3) UNGA (2011), para. 7.
- 4) UNODA (2015), IATG 01.4, para. 3.8.
- 5) UNODA (2015), IATG 1.40, para. 3.180.
- 6) UNGA (2008c), paras. 19-45.
- 7) UNODA (2015), IATG 01.40, para. 3.86.
- 8) UNODA (2015), IATG 01.10, para. 4.
- 9) UNGA (2012), para. 7.
- 10) UN SaferGuard (2016).
- 11) UNODA (2015), IATG 01.40, para. 3.287.
- 12) Tetlay (2010), p. 4; see also UNODA (2015), IATG 03.10, para. 6.
- 13) UNODA (2015), IATG 01.40, para. 3.115.
- 14) UNODA (2015), IATG 01.40, para. 3.195.
- 15) UNODA (2015), IATG 01.10, para. 5.
- 16) UNODA (2015), IATG 01.10, para. 6.
- 17) UNODA (2015), IATG 01.90.
- 18) UNODA (2015), IATG 01.90, para 6.
- 19) UNODA (2015), IATG 01.40, para. 3.262.
- 20) UNODA (2015), IATG 01.40, para. 3.113.
- 21) UNODA (2015), IATG 12.10, para. 1.
- 22) UNODA (2015), IATG 12.10, para. 4.
- 23) UNODA (2015), IATG 01.10, para. 6.1.
- 24) Sharp et al (2013).
- 25) Sharp et al (2013).
- 26) UNSC (2013), paras. 16 (iv), 28.
- 27) [www.un.org/disarmament/publications/aide-memoire](http://www.un.org/disarmament/publications/aide-memoire)
- 28) [www.un.org/disarmament/publications/more/ddr-handbook/](http://www.un.org/disarmament/publications/more/ddr-handbook/)
- 29) UNODA (2018b).
- 30) UNODA (2018a).
- 31) UNGA (2001), art. 2.
- 32) UNODA (2015), IATG 01.40, para. 3.166.
- 33) UNODA (2015), IATG 06.40, Introduction.
- 34) Parker and Wilson (2016), p. 33.
- 35) UNODA (2015), IATG 02.10, para. 4.
- 36) UNODA (2015), IATG 01.10, para. 6.2.
- 37) UNODA (2015), IATG 02.10, p. iii.
- 38) UNODA (2015), IATG 01.40, definition 3.233.
- 39) UNODA (2015), IATG 01.40, definition 3.289. UNODA (2015), IATG 02.10, para. 6.3.
- 40) UNODA (2015), IATG 01.80, p. iii.
- 41) Small Arms Survey (n.d.).
- 42) UNODA (2015), IATG 02.10, para. 5.
- 43) UNODA (2015), IATG 02.10, Annexes A and B.
- 44) ISO/IEC (2014).
- 45) UNODA (2015), IATG 01.14, definition 3.221.
- 46) UNODA (2015), IATG 02.10, para. 1.

- 47) UNODA (2015), IATG 02.10, Table 2 and paras. 7-12.
- 48) As Low As Reasonably Practicable (ALARP). Technical and explosives engineering judgement is required to determine whether the level achieved is as low as reasonably practicable. (UNODA, 2015, IATG 02.10, para. 7 endnote 17)).
- 49) UNODA (2015), IATG 01.10, para 6.5.
- 50) [www.un.org/disarmament/un-safeguard/risk-reduction-process-levels/](http://www.un.org/disarmament/un-safeguard/risk-reduction-process-levels/)
- 51) UNODA (2015), IATG 01.20, para. 5.
- 52) UNODA (2015), IATG 01.20, paras. 6 and 7.
- 53) UNODA (2015), IATG 02.10, p. iii.
- 54) UNODA (2015), IATG 03.10, p. iii.
- 55) UNODA (2015), IATG 01.40, definition 3.6.
- 56) With regard to IATG modules 03.30, 03.40 and 03.50, they provide guidance to assist international efforts to eliminate ammunition-related diversion and criminal activities.
- 57) UNODA (2015), IATG 03.10, Introduction.
- 58) Roles and requirements for ammunition accounting (and inventory) are detailed in UNODA (2015), IATG 03.10.
- 59) Shelf life refers to the length of time an item of ammunition may be stored before its performance degrades. However, shelf life is not a sufficient indicator of the stability of energetic materials contained within ammunition, which can be impacted by many factors. A comprehensive surveillance system can monitor and test safety and functional characteristics of a stockpile's ammunition.
- 60) UNODA (2015), IATG 03.10, para. 8.
- 61) UNODA (2015), IATG 03.10, Table 3.
- 62) UNODA (2015), IATG 03.10, para. 10.
- 63) UNODA (2015), IATG 03.10, paras. 4, 5, 10 and 13.
- 64) UNODA (2015), IATG 03.10, para. 14.3.
- 65) UNODA (2015), IATG 03.10, footnote 13, p. 11.
- 66) UNODA (2015), IATG 03.10, paras. 14.3 and 14.4.
- 67) UNODA (2015), IATG 03.10, para. 14.2.
- 68) UNODA (2015), IATG 03.10, para. 14.1.
- 69) UNODA (2015), IATG 03.10, para. 7.
- 70) UNODA (2015), IATG 03.10, para. 13.
- 71) UNODA (2015), IATG 03.10, paras. 15-20.
- 72) UNODA (2015), IATG 03.10, para. 14.4.
- 73) UNODA (2015), IATG 03.10, para. 14.4.
- 74) UNODA (2015), IATG 03.10, footnote 14, p. 12.
- 75) UNODA (2015), IATG 01.40, definition 3.296, p. 33.
- 76) UNODA (2015), IATG 03.10, para. 14.5.
- 77) UNODA (2015), IATG 03.10, Table 4, p. 12.
- 78) UNODA (2015), IATG 03.10, para. 14.6.
- 79) UNODA (2015), IATG 01.40, para. 3.160.
- 80) UNODA (2015), IATG 01.40, para. 3.161.
- 81) UNODA (2015), IATG 01.40, para. 3.20.
- 82) UNODA (2015), IATG 01.40, para. 3.210.
- 83) UNODA (2015), IATG 03.20, para. 1.
- 84) UNODA (2015), IATG 03.20, p. ii.
- 85) UNODA (2015), IATG 04.10, p. v.

- 86) UNODA (2015), IATG 03.20, p. ii.
- 87) UNODA (2015), IATG 04.10, para. 1.
- 88) UNODA (2015), IATG 04.10, paras. 6.2 and 6.2.4.
- 89) UNODA (2015), IATG 04.10, para. 4.
- 90) UNODA (2015), IATG 04.10, paras. 8.1 and 8.2.
- 91) UNODA (2015), IATG 04.10, para. 5.
- 92) The New York Times (1991).
- 93) Photo credit :  
[www.insensitivemunitions.org/wp-content/uploads/2011/06/army-air\\_force.jpg](http://www.insensitivemunitions.org/wp-content/uploads/2011/06/army-air_force.jpg)
- 94) Based on UNODA (2015), IATG 04.10, para. 6.3.
- 95) UNODA (2015), IATG 01.50.
- 96) UNODA (2015), IATG 07.20, para 7.3; UNODA (2015), IATG 04.20, para 8.
- 97) Non-elastomeric rocket motors become brittle at low temperatures. At high temperatures “slump” can occur in the grains of larger rocket motors, altering the burn rate characteristics of the motor.
- 98) UNODA (2015), IATG 05.30.
- 99) UNODA (2015), IATG 02.50.
- 100) UNODA (2015), IATG 09.10.
- 101) UNODA (2015), IATG 04.20, para. 6.
- 102) UNODA (2015), IATG 04.20.
- 103) UNODA (2015), IATG 04.20, para. 5.
- 104) UNODA (2015), IATG 02.10, para. 13.4 & Annex G.
- 105) Ibid
- 106) UNODA (2015), IATG 04.20, paras. 7.3 and 7.4.
- 107) UNODA (2015), IATG 02.20.
- 108) UNODA (2015), IATG 04.20, para. 7.4.
- 109) UNODA (2015), IATG 04.20, para. 7.4.1.
- 110) UNODA (2015), IATG 04.20, para. 8.
- 111) UNODA (2015), IATG 07.20.
- 112) UNODA (2015), IATG 05.30, paras. 6 and 7.
- 113) UNODA (2015), IATG 05.40.
- 114) UNODA (2015), IATG 09.10.
- 115) UNODA (2015), IATG 09,10, paras. 6 and 7.
- 116) UNODA (2015), IATG 02.20, para. 7.3.
- 117) UNODA (2015), IATG 05.20, para. 8.7.
- 118) UNODA (2015), IATG 05.10.
- 119) UNODA (2015), IATG 02.20, para. 6.
- 120) UNODA (2015), IATG 05.20, para, 6.1.
- 121) UNODA (2015), IATG 05.20, para, 6.2.
- 122) UNODA (2015), IATG 02.30.
- 123) The proximity of nearby PESs will affect IQDs, such as the IMD and PBD.
- 124) The proximity of nearby ESs will affect OQDs, such as IBD, VBD and PTRD.
- 125) UNODA (2015), IATG 02.40.
- 126) UNODA (2015), IATG 02.40, Introduction.
- 127) UNODA (2015), IATG 05.20, para. 8.
- 128) UNODA (2015), IATG 05.20, para. 8.8.
- 129) Photo : Arms and Ammunition Advisory Section, UNMAS Libya, 2014.
- 130) UNODA (2015), IATG 05.20, para 8.1.

- 131) UNODA (2015), IATG 05.20, para 8.2.
- 132) Photo : Arms and Ammunition Advisory Section, UNMAS Libya, 2014.
- 133) UNODA (2015), IATG 05.20, para. 8.3.
- 134) UNODA (2015), IATG 05.20, para. 8.4.
- 135) UNODA (2015), IATG 05.20, para. 8.5.
- 136) Photo : US National Archive : [www.catalog.archives.gov/id/6365533](http://www.catalog.archives.gov/id/6365533)
- 137) UNODA (2015), IATG 05.40.
- 138) UNODA (2015), IATG 01.10, para. 3.12.
- 139) UNODA (2015), IATG 06.50, p. ii.
- 140) UNODA (2015), IATG 06.10, p. iv.
- 141) UNODA (2015), IATG 01.10, Annex D, pp. 19-20.
- 142) UNODA (2015), IATG 03.10, para. 8.
- 143) UNODA (2015), IATG 03.10, para. 9.
- 144) UNODA (2015), IATG 06.20, Table 1.
- 145) UNODA (2015), IATG 06.40, p. ii.
- 146) UNODA (2015), IATG 06.50, p. ii.
- 147) UNODA (2015), IATG 06.60, para. 1.
- 148) UNODA (2015), IATG 06.70, p. ii.
- 149) UNODA (2015), IATG 06.70, para. 5.
- 150) UNODA (2015), IATG 06.70, Annex C, p. 7.
- 151) UNODA (2015), IATG 06.70, Annex F.
- 152) UNODA (2015), IATG 06.70, Annex F.
- 153) UNODA (2015), IATG 06.80, p. iii.
- 154) UNODA (2015), IATG 06.80, Annex C.
- 155) UNODA (2015), IATG 06.80, Annex J.
- 156) UNODA (2015), IATG 06.80, Annex R.
- 157) UNODA (2015), IATG 06.80, Annexes S-V.
- 158) UNODA (2015), IATG 06.80, Annex A-D.
- 159) UNODA (2015), IATG 07.10.
- 160) UNODA (2015), IATG 07.10.
- 161) UNODA (2015), IATG 07.20.
- 162) UNODA (2015), IATG 01.40, para. 3.200.
- 163) UNODA (2015), IATG 07.10, para. 5.
- 164) UNODA (2015), IATG 07.10, para. 8.1.
- 165) UNODA (2015), IATG 07.10, para. 8.3.
- 166) UNODA (2015), IATG 07.10, para. 8.2.
- 167) UNODA (2015), IATG 07.10, para. 6.1.
- 168) UNODA (2015), IATG 02.50. The explosive quantity distance between a processing building or facility and Potential Exposure Site holding ammunition is known as the Process Building Distance (PBD).
- 169) UNODA (2015), IATG 07.10, para. 6.2.
- 170) UNODA (2015), IATG 07.10, para. 6.4.
- 171) UNODA (2015), IATG 07.10, para. 7.1.
- 172) UNODA (2015), IATG 07.10, para. 7.5.
- 173) UNODA (2015), IATG 05.40, para 6.
- 174) Illustration ; [www.gichd.org/asm](http://www.gichd.org/asm)
- 175) UNODA (2015), IATG 07.10, para. 10.
- 176) UNODA (2015), IATG 06.40.

- 177) UNODA (2015), IATG 01.50.
- 178) UNODA (2015), IATG 07.20, para. 8.
- 179) UNODA (2015), IATG 07.20, para. 9.
- 180) UNODA (2015), IATG 07.20, para. 7.
- 181) UNODA (2015), IATG 07.20, para. 13.
- 182) 2011, The Canadian approach, ammunition reconstitution from Afghanistan, Australian Defence Force Explosive Ordnance Safety Symposium (Parari), Brisbane, Australia.
- 183) UNODA (2015), IATG 07.20, para. 9.
- 184) UNODA (2015), IATG 08.10, p. ii.
- 185) UNODA (2015), IATG 08.10, p. ii.
- 186) UNODA (2015), IATG 08.10, p. ii.
- 187) UNODA (2015), IATG 01.50, para. 6.
- 188) UNODA (2015), IATG 01.50, para. 6.1.
- 189) UNODA (2015), IATG 01.40, definition 3.129.
- 190) UNODA (2015), IATG 01.40, definition 3.130.
- 191) UNODA (2015), IATG 01.40, definition 3.51.
- 192) UNODA (2015), IATG 08.10, p. ii.
- 193) UNODA (2015), IATG 08.10, p. ii.
- 194) UNODA (2015), IATG 08.10, para. 4.
- 195) UNODA (2015), IATG 08.10, para. 4.
- 196) UNODA (2015), IATG 08.10, para. 4.1.
- 197) UNODA (2015), IATG 05.10, para. 8.1.
- 198) UNODA (2015), IATG 01.50 and 08.10;  
Table 12 was developed based on narrative given in these two modules.
- 199) UNODA (2015), IATG 01.10, para. 4.
- 200) UNODA (2015), IATG 08.10, para. 4.1.
- 201) UNODA (2015), IATG 08.10, paras. 4 - 8.
- 202) UNODA (2015), IATG 01.50, para. 6.
- 203) UNODA (2015), IATG 01.50, p. ii.
- 204) UNODA (2015), IATG 03.10, Table 3.
- 205) UN (2017), para. 1.2.1.
- 206) UNODA (2015), IATG 01.50.
- 207) UNODA (2015), IATG 01.60, p. ii.
- 208) UNODA (2015), IATG 01.70, p. ii.
- 209) UNODA (2015), IATG 01.90, p. ii.
- 210) UNODA (2015), IATG 02.20, p. ii.
- 211) UNODA (2015), IATG 06.40, p. ii.
- 212) UNODA (2015), IATG 08.10, para. 9.
- 213) UNODA (2015), IATG 01.40, definition 3.17.
- 214) UNODA (2015), IATG 01.40, definition 3.55.
- 215) UNODA (2015), IATG 03.10.
- 216) UNODA (2015), IATG 01.30, p. v.
- 217) UNODA (2015), IATG 09.10, p. v.
- 218) UNODA (2015), IATG 01.40, paras. 3.248 and 3.277.
- 219) UNODA (2015), IATG 01.30, p. v.
- 220) UNODA (2015), IATG 01.30, p. v.
- 221) UNODA (2015), IATG 09.10, p. v.
- 222) UNODA (2015), IATG 01.30, para. 9.4.

- 223) UNODA (2015), IATG 09.10, para. 8.2.
- 224) UNODA (2015), IATG 09.10, para. 7.
- 225) UNODA (2015), IATG 09.10, Table 1.
- 226) UNODA (2015), IATG 09.10, para. 8.3.
- 227) UNODA (2015), IATG 09.10, Annex C.
- 228) UNODA (2015), IATG 09.10, para. 8.2.
- 229) UNODA (2015), IATG 09.10, para. 8.2; Table 14 based on narrative in para. 8.2.
- 230) UNODA (2015), IATG 03.10, p. iii.
- 231) 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.
- 232) UNODA (2015), IATG 09.10, para. 8.4.
- 233) UNODA (2015), IATG 09.10, paras. 8.5.1, 8.5.2 and 8.5.3.
- 234) UNODA (2015), IATG 09.10, para. 8.6.
- 235) UNODA (2015), IATG 05.20, para. 11.11.
- 236) UNODA (2015), IATG 09.10, para. 8.7.
- 237) UNODA (2015), IATG 04.20, para. 11.
- 238) UNODA (2015), IATG 09.10, paras. 8.7.1.2 to 8.7.1.5.
- 239) UNODA (2015), IATG 09.10, para. 8.7.1.6.
- 240) UNODA (2015), IATG 09.10, para. 8.7.1.7.
- 241) UNODA (2015), IATG 09.10, para. 8.7.5.
- 242) UNODA (2015), IATG 10.10, introduction and Berman and Reina (2014), part 1.
- 243) UNODA (2015), IATG 01.40, para. 3.84.
- 244) UNODA (2015), IATG 10.10, p. v.
- 245) UNODA (2015), IATG 10.10, pp. 2-3.
- 246) UNODA (2015), IATG 10.10, para. 4.
- 247) UNODA (2015), IATG 10.10, para. 6.
- 248) UNODA (2015), IATG 01.40, para. 3.69.
- 249) UNODA (2015), IATG 01.40, para. 3.71.
- 250) UNODA (2015), IATG 10.10, para. 9.
- 251) UNODA (2015), IATG 10.10, para. 9.1.
- 252) UNODA (2015), IATG 10.10, para. 7.
- 253) UNODA (2015), IATG 10.10, para. 5.4.
- 254) UNODA (2015), IATG 10.10, Table 2.
- 255) UNODA (2015), IATG 11.10.
- 256) UNODA (2015), IATG 01.20.
- 257) UNODA (2015), IATG 01.40, para. 3.9.
- 258) UNODA (2015), IATG 01.40, para. 3.142.
- 259) UNODA (2015), IATG 11.10, para. 6.
- 260) UNODA (2015), IATG 11.10, para. 8.
- 261) UNODA (2015), IATG 11.10, para. 9.
- 262) UNODA (2015), IATG 11.10, para. 10.
- 263) UNODA (2015), IATG 01.70.
- 264) UNODA (2015), IATG 11.20, para. 6.3.
- 265) UNODA (2015), IATG 11.20, para. 6.



- 266) UNODA (2015), IATG 11.20, para. 8.2.
- 267) UNODA (2015), IATG 11.10, para. 9.
- 268) Government of Singapore (1997).
- 269) Government of Singapore (1997).
- 270) Government of Singapore (1997).
- 271) Photo published in RESERVIST magazine (2016).
- 272) UNODA (2015), IATG 12.10, p. ii; IATG 12.20, p. ii.
- 273) UNODA (2015), IATG 12.10, para. 1.
- 274) UNODA (2015), IATG 01.40, para 3.262.
- 275) UNODA (2015), IATG 12.20, p. ii.
- 276) UNODA (2015), IATG 12.10, paras. 4 and 5; UNODA (2015), IATG 12.20, para. 4.
- 277) UNODA (2015), IATG 01.10, p. iii.
- 278) UNODA (2015), IATG 12.10, Annex C.
- 279) UNODA (2015), IATG 12.10, para. 5.
- 280) UNODA (2015), IATG 02.10, para. 5.
- 281) UNODA (2015), IATG 12.10, Table 1.
- 282) UNODA (2015), IATG 12.20, Table 1.
- 283) 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 module 02.10 should be followed. Once the residual risk has been identified, it should be formally accepted at an appropriate level. If human life is still at risk that appropriate level should be at ministerial level (UNODA (2015), IATG 12.20, para. 9).



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