



# OSCE Handbook of Best Practices on Conventional Ammunition

# Table of Contents

Decision No. 6/08 Handbook of  
Best Practices on Conventional Ammunition

I. Best Practice Guide on Ammunition Marking, Registration and Record-Keeping	3
II. Best Practice Guide on Procedures for Management of Stockpiles of Conventional Ammunition	15
III. Best Practice Guide on Physical Security of Stockpiles of Conventional Ammunition	39
IV. Best Practice Guide on Ammunition Transportation	81
V. Best Practice Guide on the Destruction of Conventional Ammunition	143

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# Decision No. 6/08 Handbook of Best Practices on Conventional Ammunition

## **The Forum for Security Co-operation (FSC),**

Reaffirming its commitment to the full implementation of the OSCE Document on Stockpiles of Conventional Ammunition (SCA) (FSC.DOC/1/03, 19 November 2003)

Recalling Section VII of the OSCE Document on SCA, in which participating States agreed to consider developing a “best practice” guide of techniques and procedures for the destruction of conventional ammunition, explosive material and detonating devices, and the management and control of stockpiles, and noting that such a document would cover, inter alia, indicators of surplus and risk, standards and procedures for the proper management of stockpiles, norms to be used in determining which stockpiles should be destroyed, as well as standards and technical procedures of destruction,

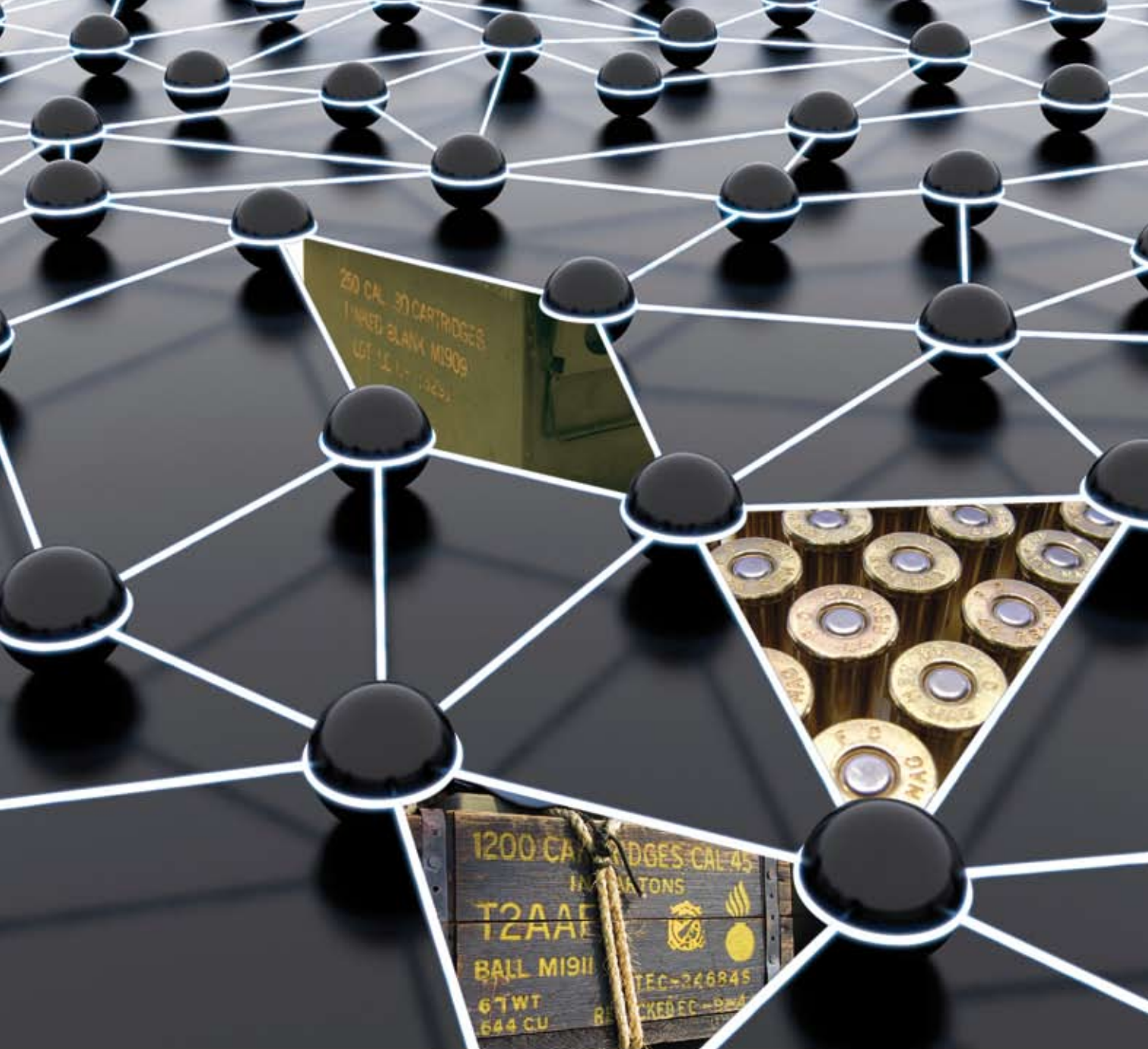
Noting that a handbook gathering these best practice guides could serve as a guide for national policy making by participating States and encourage higher common standards of practice among all participating States,

Acknowledging that such a handbook of best practices could also be useful to OSCE Partners for Co-operation and other United Nations Member States in their efforts to tackle the risks and challenges caused by the presence of stockpiles of conventional ammunition, explosive material and detonating devices in surplus and/or awaiting destruction,

Recognizing the work done by participating States to complete this task,

Decides to:

- Welcome the development of the best practice guides on conventional ammunition and endorse the compilation of those that are currently available and under preparation into a handbook of best practices in all six OSCE languages;
- Ensure that the remaining guides are included in the handbook when finalized and reviewed;
- Encourage participating States to make this handbook available to all relevant national authorities for its implementation as appropriate;
- Task the Conflict Prevention Centre to ensure the widest possible distribution, including the OSCE Partners for Co operation and the United Nations, of this handbook after its completion;
- Take account of this handbook, including the possibility of its further development during the regular review of the OSCE Document on SCA, in accordance with Section VII, paragraph 37 of the Document;
- Append this decision to the handbook in order to be distributed with it.



# Best Practice Guide on Ammunition Marking, Registration and Record-Keeping

# Table of Contents

I. Aim and Scope	5
II. Marking of Ammunition and Ammunition Packaging	5
1. Purpose of Marking Ammunition and Ammunition Packaging	5
2. Types and Methods of Marking Ammunition	6
2.1 Ammunition Marking by Inscriptions	6
2.2 Marking Ammunition with Color Codes	7
2.3 Marking Ammunition with Symbols	7
2.4 Visible and Palpable Markings	7
3. Types and Ways of Marking Ammunition Packaging	8
III. Registration and Record-keeping	8
1. Purpose of Registration and Record-keeping	8
2. Registration and Record-keeping Principles	9
2.1 Registration stages	9
2.2 Registers and Nature of Registered Information	11
IV. Definition of Terms	11
V. References on the Subject „Conventional Ammunition: Marking,Registration and Record-keeping“	14

This Guide was drafted by the government of Germany.

FSC.DEL/73/07/Rev.1/Corr.1

25 October 2007

## I. Aim and Scope

This Best Practice Guide applies exclusively to state-owned stockpiles of conventional ammunition for military, paramilitary and security forces and the police of a participating state as mentioned in section II and III of the OSCE Document on Stockpiles of Conventional Ammunition (FSC.DOC/1/03, dated 19 November 2003). All other ammunition as ammunition in private possession and ammunition used for non-conventional weapons, such as NBC weapons or other CBRN devices are excluded.

The information and recommendations provided may be used for the development of a policy, of general operational guidelines and of procedures on all aspects of ammunition marking, registration and record-keeping.

Any investigation conducted on the basis of the markings to be found on conventional ammunition and its packaging as well as on the basis of the relevant records should contribute toward battling the illicit proliferation of ammunition and thus especially the illicit use of small arms and light weapons (SALW).

## II. Marking of Ammunition and Ammunition Packaging

### 1. Purpose of Marking Ammunition and Ammunition Packaging

Conventional ammunition and its packaging have always been labeled with a wide variety of markings for quality control, logistic and mission-tactical reasons as well as for the purpose of preventing accidents. Such markings can serve the following purposes:

To facilitate the exact identification of all ammunition and its designation in any situation, even in darkness or limited visibility.

To provide information on:

- The caliber of the ammunition and the length of the cartridge case.
- The manufacturer of the ammunition.
- The date the ammunition was produced (year and/or month).
- The production lot to which the ammunition belongs. Within the framework of accident prevention, the lot designation can be used to recall a specific production lot which has shown unwanted peculiarities during use or technical ammunition checks and is therefore to be barred from further use. By analogy, the same applies to production lots which are to be disposed of on the grounds of obsolescence. Lot designations are often used in stockpile management because they provide more detailed information on a specific quantity of ammunition than would the mere indication of the corresponding ammunition type and nature. Ammunition consumption, too, is frequently documented on the basis of the lot designation. The lot designation often contains coded information on the manufacturer, the year of production, the month of production, the sequence of production as well as on the ammunition's state of constitutional change.
- The ammunition's specific serial number. Particularly, more complex types of ammunition (such as MANPADS, anti-tank guided missiles, rockets and torpedoes) have - like weapons - a unique serial

number in addition to the lot designation, allowing the identification a particular piece of ammunition.

- Any specific hazards arising from the ammunition and necessitating specific ammunition handling procedures, e.g. due to the fact that the ammunition contains explosives or other hazardous substances (such as phosphorus). The information given serves to classify the ammunition according to hazard division and compatibility group (cf. OSCE Best Practice Guides on *Stockpile Management and Security* and on *Ammunition Transport*).
- The way the ammunition works and thus on the range of tactical objectives for which it can be used (e.g. demolition, armor-piercing or tracer effect).
- The types of weapons for which the ammunition can be used (guns, howitzers, mortars etc.).
- Any specific fuse effect/capability (e.g. of proximity fuses).
- Any type of modification and any specific quality standards that are met in the production process and as to whether the ammunition or any demolition accessory is exchangeable.

The information provided by the markings referred to above can also help to trace the origin of the ammunition within the framework of disciplinary or criminal investigations (e.g. concerning the illicit possession of, use of or trafficking in ammunition). However, this is not the primary reason why they are originally attached to ammunition or its packaging.

Neither this list of reasons for marking ammunition and/or its packaging is exhaustive, nor does it imply that in reality each and every cartridge or package is labeled with all the aforementioned information.

Marking of packaging facilitates safe and efficient logistic ammunition handling. Markings for logical record-keep-

ing (e.g. ammunition designation or nature, lot designation or serial number) as well as information on specific hazards arising from the ammunition should be affixed to the ammunition packaging because ammunition is usually packaged under storage conditions or being transported.

All ammunition should be marked appropriately and accurately. Markings on ammunition and its packaging may serve all the reasonable purposes mentioned above. Appropriate markings provide a major contribution to safety, security and the administrative management of the ammunition stockpile. To have the maximum effect and to avoid any confusion, ammunition marking should be done upon manufacture. The following section provides more information about types and methods of marking ammunition.

## 2. Types and Methods of Marking Ammunition

Because the markings on ammunition are of significance for the user of it, these markings are usually attached in such a way that they are clearly visible but difficult to alter or remove. This is not the case when information is printed or stenciled on ammunition packaging only.

The most common types of ammunition marking are described in the section below.

### 2.1 Ammunition Marking by Inscriptions

By means of inscriptions (a sequence of letters and/or numbers), information about ammunition should be affixed on the type and nature of the ammunition or on the ammunition model as well as data on the caliber, the length of the cartridge case, the manufacturer, the year/month of production and in particular on the lot designation and/or the serial number.

There are three main ways to convey such information:

### *2.1.1 Permanent Inscriptions*

Depending on the production process, “permanent inscriptions” are usually engraved, cast, stamped or hammered into the outer surface of the ammunition casing – either applying conventional methods of deformation or engraving or using a laser. This type of inscription is considered to be “permanent” because even if a marking appears to have been removed completely it can still be traced by way of forensic methods. As regards small arms ammunition with a cartridge case, permanent markings are usually placed on the bottom of the cartridge case.

### *2.1.2 Non-permanent Inscriptions*

Depending on the production process, “non-permanent inscriptions” are usually painted, drawn or printed directly onto the outer surface of the ammunition casing or packaging. The color of the marking often serves to indicate the type of ammunition, lot number, and intended use or to provide information as to what hazardous substances the ammunition contains.

### *2.1.3 Use of Labels*

Sometimes, filled-in adhesive notes (labels, stickers or metal plates) are attached directly to some types of ammunition or filled-in tags are fastened to it in order to convey the information mentioned above. Caution should be taken with this method of labeling; labels or other material affixed to ammunition that were not part of the manufacturing and testing process might lead to safety and/or performance problems.

## **2.2 Marking Ammunition with Color Codes**

Particularly major-caliber conventional ammunition is

often covered with a coat of paint or dyed (e.g. plastic parts). In most cases, the coat of paint also serves as protective finish and/or as camouflage painting and is thus usually applied to the entire surface of the ammunition casing. The colors used for this purpose indicate, for example, the intended use of the ammunition or provide information as to what hazardous substances the ammunition contains.

Instead of dyeing a large area of the ammunition casing, the ammunition (including small arms ammunition<sup>1</sup>) can also be marked with ring-like color markings (rings of paint) in order to indicate, for instance, the presence of tracer ammunition or hazardous additives such as phosphorus.

## **2.3 Marking Ammunition with Symbols**

Symbols with which ammunition is marked usually provide information on the proper handling of the ammunition concerned (e.g. during transport, storage and use) or on its type (e.g. high-explosive, incendiary, armor-piercing ammunition) or on certain international standards on overall measurements, performance and effectiveness of the ammunition. Such Symbols can be “permanent” or “non-permanent” (cf. paragraphs III.2.1.1 and III.2.1.2).

## **2.4 Visible and Palpable Markings**

Markings that are not only visible but also palpable serve, for example, to identify the type/nature of the ammunition or the ammunition model in darkness or limited visibility. This method of labeling is often best integrated into the ammunition manufacturing process; adding grooves, notches or other palpable markings that were not part of the manufacturing and testing process might lead to safety and/or performance problems.

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<sup>1</sup> The volume of small caliber ammunition production may make this form of marking cost prohibitive, particularly if performed after manufacture. As a result, this method of labeling is often best integrated into the ammunition manufacturing process.



Some examples of visible and palpable markings:

- a knurl circling the cartridge case or the edge of the cartridge case base;
- longitudinal grooves on the jacket of the cartridge case;
- notches on the base of the cartridge case;
- position cams on the jacket of a proximity or time fuse, which indicate the set distance.

### 3. Types and Ways of Marking Ammunition Packaging

Packaging material for ammunition is usually marked with “permanent” (e.g. stamped or burnt-in) labels

or symbols or with “non-permanent” stickers, tags or symbols (e.g. coats of paint, adhesive notes or tags). As has already been mentioned, in addition to identification information, as listed above in section II.2.1, ammunition packaging is usually provided with information of logistic significance, quality control or for the purpose of preventing accidents during handling, transporting or storing the packed ammunition. In order to facilitate record keeping and the control of the records of the ammunition, the producing company should print the numbers and letters defining the cartridge of ammunition onto each ammunition storage box.

## III. Registration and Record-keeping

### 1. Purpose of Registration and Record-keeping

According to the OSCE Document on Stockpiles of Conventional Ammunition, there is general agreement that stockpiles of ammunition, including ammunition identified as surplus and/or ammunition awaiting disposal, destruction should be registered and recorded as accurately as possible.<sup>2</sup>

In the context of this Best Practice Guide, the term “registration” refers to the collection of data needed to facilitate the identification of any piece of ammunition, its legal status and the location of its storage, at a given stage of its life.

The term “record-keeping” involves the maintenance of the data collected during the registration process in order to facilitate the identification of any piece of ammunition, its legal status and the location of its storage, at a given stage of its life.

To this end, registration and record-keeping should span the entire life cycle of ammunition, from its production to its consumption or disposal/destruction. Thorough registration and sustained record-keeping provides:

- accurate information on the exact types and nature or models of the ammunition that is in stock,
- quantities of the different types of ammunition,
- their condition,
- the site where the ammunition is being stored.

The capability to provide accurate information is a basic prerequisite for supplying the respective end users with serviceable ammunition in accordance with their requirements, for preventing accidents involving ammunition as well as for replenishing stockpiles or developing acquisition plans. In addition, the above-mentioned capability facilitates identification at an early stage of any loss resulting from theft or embezzlement and supports subsequent investigations. Registration and Record-

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<sup>2</sup> Cf. OSCE Document on Stockpiles of Conventional Ammunition, Section II, paragraph 16.

Keeping are the keys to controlling legal stocks of ammunition and preventing them from becoming illicit.

## 2. Registration and Record-keeping Principles

This section is to describe a number of essential principles governing the registration and record-keeping of ammunition.

### 2.1 Registration stages

Registration and Record-keeping of ammunition should be conducted at least at the following stages:

- at manufacture,
- at testing,
- at time of shipment & receipt,
- at storage and possession,
- in case of loss or theft,
- at consumption/use or disposal/destruction,
- at any transport and handling.

#### 2.1.1 Registration and Record-keeping during the Production Process

It is a common practice that during the production process the manufacturer divides ammunition, ammunition components and explosives into production batches, called “lots”.

The manufacturer assigns each lot a unique designation which identifies and can be used to register unambiguously the ammunition of a particular production batch from that manufacturer.

Common quantities of ammunition contained in one lot designation during the production process are, for instance, approximately 500,000 cartridges in the area of small arms ammunition, up to 5,000 cartridges with

regard to tank ammunition and up to 500 items in the category of MANPADS<sup>3</sup>.

The manufacturer records the quantities of ammunition produced with production status reports, using the respective lot designation. This registration by the manufacturer marks the beginning of the documentation of the ammunition’s life cycle.

For each lot produced, manufacturers should be required to create an ammunition data card (ADC), which serves as the “birth certificate” of the ammunition., The ADC contains the quantity of ammunition that has actually been produced along with further technical and component details and test results as well. The ADC or a copy thereof, usually accompanies the partial quantities of an ammunition lot.

#### 2.1.2 Registration and Record-Keeping at Testing

In any case, especially if a State participates in a proof-testing or standardization regime for ammunition, a record of testing for each individual lot designation of ammunition should be kept by the agency conducting the testing and by the client.

#### 2.1.3 Registration and Record-Keeping at Possession

One person should be responsible for the transfer of one ammunition stockpile to another. The ammunition to be transferred should be compared with the pertinent data in the stock status reports accompanying the shipment of ammunition (e.g. delivery list, master record card). This comparison should be carried out in the form of a visual inspection both by the person handing over the ammunition and by the person receiving it. Each of the two persons should be furnished with some document about the result of the comparison, which then provides

3 SAMPLING PROCEDURES according to ISO 2859.

the basis for subsequent book-keeping operations (addition to or removal from a stockpile). All relevant data on additions or retirements of ammunition in a depot which has been confirmed by documentary evidence is to be forwarded to the central record office of the organization in charge of the particular depots.

Any major organization (such as the police and the armed forces) that possesses ammunition should keep a central documentary stock record of the ammunition it has purchased or taken possession of. This record should be kept by reliable and well-trained personnel pursuant to the Generally Accepted Accounting Principles (e.g. by way of additions, removal and stocktaking). Dedicated logistic support offices should be established to document and manage the stockpiles and transfers of ammunition for a specific supply area, provide effective support in storage space planning and management, and conduct ammunition surveillance operations. The offices can also provide lot-specific ammunition control and other ammunition management processes and also furnish information for logistic control purposes.

A regular comparison of the content of the stockpiles between a storage facility and the Central Record Office has proven beneficial. To this end, all storage facilities (depots) should draw up lists of the existing lots of individual types of ammunition (so-called "lot lists") and forward them to the central record office. Owing to the fact that many storage facilities house various types of ammunition (e.g. projectiles, missiles, bombs), it is advisable to report the stockpiles of each individual type of ammunition at adequate regular intervals at predetermined dates to the Central Record Office. Procedures of physical inventory are specified in the OSCE Best Practice Guide on *Stockpile Management and Security*.

A procedure like this ensures that each ammunition lot is thoroughly documented during the whole live-cycle, from its production through its useful life to its final consumption or destruction.

Regular internal stock-taking as described in the Best Practice Guide on *Stockpile Management and Security* can also be properly conducted on this basis.

More details on registration and record-keeping during the storage or transport of ammunition are provided by the OSCE Best Practice Guides on *Stockpile Management and Security* and on *Ammunition Transport* developed in the framework of the OSCE Document on Stockpile of Conventional Ammunition.

#### *2.1.4 Registration and Record-Keeping in case of Loss or Theft*

In case of lost or stolen ammunition a record should be kept by the affected storage facility and the central Record Office to facilitate prompt notification of national competent authorities.

#### *2.1.5 Registration and Record-Keeping at consumption/use or disposal/destruction*

All facilities or organizations (i.e. military or police unit, battalion, brigade) consuming or disposing of ammunition should be accountable for all ammunition contained within their inventories or authority. To this end, the facility/organization should keep a stock status report containing all existing ammunition items and listing all ammunition lots and the exact location where they are being stored.

Any consumption, transfer or disposal of ammunition within the framework of training activities (practice firing) or during missions should be documented in consumption records (i.e. ammunition and scoring logs).

Such records serve as documentary evidence and should be preserved for a period of at least three full calendar years after the final entry has been made.

A record should be maintained of the ammunition already disposed or destroyed at the direction of competent national authorities by those carrying out the disposal or destruction.

### **2.2 Registers and Nature of Registered Information**

There are, of course, a wide variety of registration and record-keeping procedures. All registration and record-keeping procedures should be effective and easy to implement.

All registers used for record-keeping should be appropriately authenticated. The authorities of any state should assure the maintenance of active ammunition inventory records until the ammunition is exhausted or disposed. The archived ammunition records should be maintained at a central location for no less than 20 years and ideally indefinitely. Any entities other than governmental bodies that are authorized to maintain certain records, should ensure that all active records of the above-mentioned information are maintained to the same standards as governmental organizations for as

long as they perform this activity. On completion of this function, those entities shall transmit the registers in their possession to the competent governmental authority or to the dealer taking over this activity.

To successfully serve the purposes as described at paragraph III.1, the information to be recorded above should, at a minimum, include:

- the description of the producer,
- the stock number,
- a precise description of the ammunition, notably its type and model, caliber, type of explosives and pyrotechnics,
- the condition of the ammunition or condition code,
- the LOT-description,
- ownership account,
- the serial number (if any),
- hazard division / sub-division.

As appropriate, a record should be kept of the origin and destination of the ammunition and, eventually, of the export or import licenses including end-user-certifications.

All the above information should be made available to competent national authorities if requested by national law.

## IV. Definition of Terms

### **Accountable Agency**

Subunit, unit, agency or facility which is obliged to document its equipment, stocks or stockpiles.

### **Ammunition**

In the context of this Best Practice Guide to the OSCE Document on Stockpiles of Conventional Ammunition

the technical term “ammunition” covers all substances and items that have or may have explosive properties like

- a) **Explosive substances and pyrotechnic mixtures,**
- b) **Items containing explosives,**
- c) **Agents and items** not listed under a) nor b) that were produced to bring about a practical effect by means of an explosion or a pyrotechnic effect,

d) **Agents and substances that produce smoke.**

This definition includes conventional ammunition, explosive material and detonating devices of land-, air- and sea-based weapons systems. The following broad categories serve as an indicator:

- a) Ammunition for small arms and light weapons (SALW),
- b) Ammunition for major weapon and equipment systems, including missiles,
- c) Rockets,
- d) Landmines and other types of mines,
- e) Other conventional ammunition, explosive material and detonating devices,
- f) Flares, signals, grenades, pyrotechnic simulators, and smoke producing munitions,
- g) Training and target practice material for the above, provided that they contain explosive or pyrotechnic fillers.

Due to the Scope of the OSCE Document on Stockpiles of Conventional Ammunition, all statements with regard to ammunition in this Best Practice Guide apply exclusively to state-owned stockpiles of conventional ammunition for military, paramilitary and security forces and the police of a participating state as stated in section II and III of the OSCE Document on Stockpiles of Conventional Ammunition. All other ammunition as ammunition in private possession and ammunition used for non-conventional weapons, such as Improvised Explosive Devices (IED), NBC weapons or other CBRN devices are excluded.

**Ammunition Accident**

Unexpected event involving ammunition in which an unwelcome ammunition-specific effect leads to personal injury or damage to property.

**Ammunition Data Card (ADC)**

Record created at time of ammunition manufacture. Contains list of components used to manufacture the ammo as well as technical, process & quantity details.

**Ammunition Packaging Material**

Ammunition packaging material is packaging for ammunition and forms an ammunition package together with the ammunition. It is made of packaging material designed to enclose ammunition or keep it together in order to make it transportable and storable.

**Ammunition Surveillance**

Identification or evaluation of the actual state of the ammunition and its packaging.

Ammunition surveillance includes:

- a) checking the ammunition for operational safety and serviceability,
- b) checking the ammunition for changes, i.e. corrosion, deterioration of explosives or pyrotechnics,
- c) subjecting ammunition to a visual inspection, disassembly of ammunition for component testing,
- d) performing tests on ammunition (example: continuity test, pull test, tests on components, chemical tests (ageing), functional tests).

**Explosive substances** are solid or liquid substances or mixtures, which can, by chemical reaction, generate gases of such a high temperature, pressure and speed that they can cause destruction in their vicinity.

**Explosives** means blasting agents, propellants, initiating agents, igniting agents, pyrotechnic mixtures. **High explosives** means detonating agents or compositions.

### **Lot (Lot Designation)**

A lot is the quantity of ammunition or explosive material which is produced by a manufacturer on the basis of the same production data, the same production process and under comparable operating conditions in uninterrupted sequence.

### **Lot Surveillance Card**

A lot surveillance card/file serves to monitor stocks in order to determine the date of the last examination. It also contains information on the state of the ammunition.

### **Nature of Ammunition**

Ammunition with the same intended use and the same effect. Examples: high-explosive ammunition, HEAT ammunition, high-explosive plastic ammunition, fragmentation ammunition, illuminating ammunition, armor-piercing ammunition.

### **Provisioning**

Provisioning of ammunition is the stockpiling of ammunition for the purpose of smoothly and immediately meeting any current, planned or short-term demand for ammunition in places which have been earmarked for this.

### **Property Accounting**

Stock management procedure for the purpose of determining authorized levels and requirements, keeping stock records, managing defense materiel, registering records and entering them into the books as well as drawing up reports.

### **Record-keeping**

In this context, the term “Record-keeping” involves maintenance of data in order to facilitate the identification of any piece of ammunition, its legal status and the location of its storage, at a given stage of its life-cycle.

### **Registration**

In this context, the term “registration” involves collection of data in order to facilitate the identification of any piece of ammunition, its legal status and the location of its storage, at a given stage of its life.

**Propellants** mean agents made of solid or liquid deflagrating explosives that are used for propulsion.

**Pyrotechnic mixtures** are substances or mixtures designed to generate an effect in the form of heat, light, sound, gas or smoke or a combination of these effects as a result of nondetonative, self-sustaining, exothermic chemical reactions.

### **Serviceable Ammunition**

Ammunition which meets the minimum technical requirements in terms of serviceability, performance and operational safety and has been cleared for use.

### **Stock Record**

Documentary list of the material which has been taken possession of (including the pertinent records). The list is kept in accordance with the Generally Accepted Accounting Principles.

### **Stock Status Report**

List of existing supply items for materiel planning, stock management etc. Shows the status of on hand assets by stock number, lot number, condition and storage location.

### **Type of Ammunition**

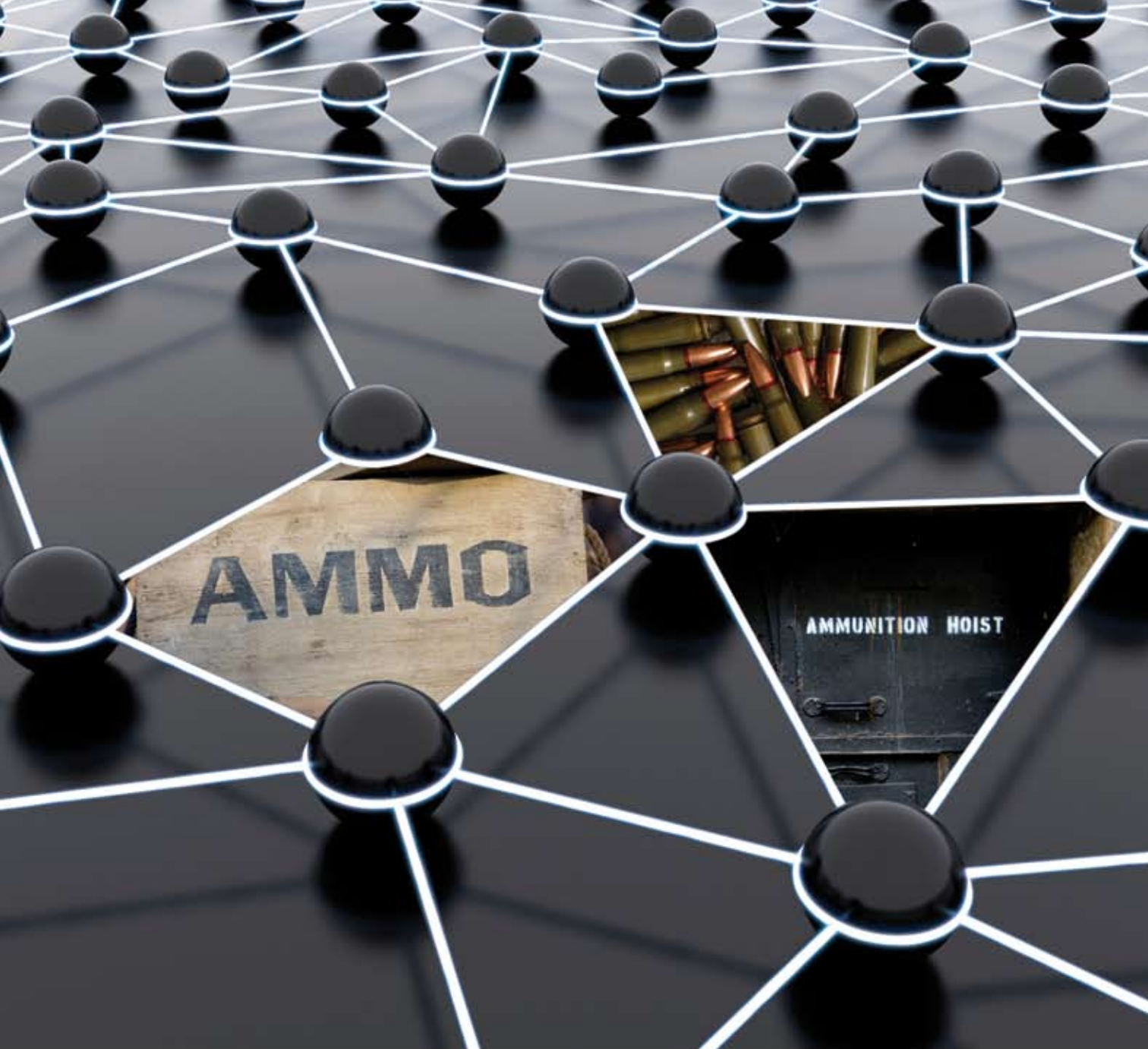
Ammunition having the same basic designation and nominal size and belonging to the same weapon/equipment system.

Examples of ammunition types:

- a) 7.62 x 51 cartridge,
- b) 20 mm x 139 cartridge,
- c) complete ammunition unit (projectile, projectile fuse, propelling charge, primer) for a 155-mm howitzer.

## V. References on the Subject „Conventional Ammunition: Marking, Registration and Record-keeping“

1. UN Resolution 60/74, Problems arising from the accumulation of conventional ammunition stockpiles in surplus, 11 January 2006.
2. OSCE Document on Stockpiles of Conventional Ammunition, FSC.DOC/1/03, dated 19 November 2003.
3. STANAG 2953 The Identification Of Ammunition (AOP-2 (B) ).



Best Practice Guide on  
Procedures for Management of  
Stockpiles of Conventional Ammunition



# Table of Contents

I. Introduction	17
II. Scope and methodology	17
III. General policies and procedures	18
A. Accountability: Inventory Management and Accounting Control Procedures	18
<i>Management responsibilities</i>	18
<i>Records and reporting</i>	18
<i>Physical inventory</i>	19
B. Reporting: Procedures for immediate reporting and recovery of any loss or incidents	19
C. Training: Training of staff in effective stockpile management and security procedures	20
<i>Facility Personnel Training</i>	20
<i>Training Curriculum</i>	20
D. Controls: Supervisory Considerations	20
<i>Responsibilities through the chain of command</i>	20
<i>Inventory Accountability</i>	21
<i>Continuity of Personnel</i>	21
<i>Prioritization</i>	21
<i>Surveillance</i>	21
<i>Planning</i>	22
<i>Accountability of Managers and Personnel</i>	22
IV. Technical recommendations for stockpile facilities	22
A. Safety and Storage: Robustness and capacity of stockpile facilities	22
<i>Facility Capacity</i>	22
<i>Facility Markings</i>	23
B. Facility Standard Operating Procedures	24
C. Quality: Condition of conventional ammunition, explosive material and detonating devices	25
<i>Observation</i>	25
<i>Actions to improve the condition of stockpiled ammunition</i>	25
<i>Storage techniques</i>	26
D. Supply Management: Organization of Stockpiles	26
<i>Ammunition and Explosives Compatibility</i>	26
<i>Net Explosive Quantity (NEQ)</i>	26
<i>Maintaining Organization in a Facility</i>	28
V. Additional information	29
Annexes	
<b>Annex A:</b> <i>Ammunition and Explosives Compatibility Groups and Compatibility Chart</i>	30
<b>Annex B:</b> <i>Sample Planograph that identifies the location of inventory in an ammunition and explosives storage facility</i>	34
<b>Annex C:</b> <i>Sample Form for Tracking Additions or Removals from a Lot in a Grid Location</i>	36
<b>Annex D:</b> <i>Contact Information for Additional Information</i>	36

This Guide was drafted by the government of the United States of America.

FSC.DEL/187/05/Rev.3

14 July 2006

## I. Introduction

This guide provides recommended best practices that will facilitate and enhance proper management of national stockpiles of conventional ammunition, explosive material and detonating devices. It contains information useful for those individuals currently working in ammunition storage locations and those managers involved in the chain of command over these facilities that are working to establish national policy and procedures. These practices will help participating States both use their resources more efficiently and diminish the risk of dangerous situations involving theft, loss, or accident.

Poor management can create situations in which unserviceable ammunition deteriorates and creates an unsafe environment for users or the local population. Conversely, the optimal management of national stockpiles of conventional ammunition and explosives enhances military, paramilitary, internal security forces, and police force readiness and is essential to responsive and effective forces. Proper management also aids in securing a stockpile, providing a means to diminish and deter theft and to quickly identify loss. A clear understanding of what is contained in the stockpile is essential for its optimal management.

## II. Scope and methodology

This guide provides the basic practices that ammunition and explosives storage facilities can employ, while keeping in mind the cardinal principle of, “To protect the general public and environment, it will be the general principle to expose the minimum amount of ammunition and explosives for the minimum amount of time.” Where these practices cannot all be implemented, participating States should implement those practices for which they have the capability, and work on implementing further practices with the aim of creating a comprehensive stockpile management program.

This guide covers the same materials as covered by the OSCE Document on Stockpiles of Conventional Ammunition (OSCE Stockpiles Document)<sup>1</sup>. While the

principles identified in this guide apply to all national stockpiles of conventional ammunition, explosive material and detonating devices, they are relayed largely with military stockpiles in mind. The OSCE Stockpiles Document includes “conventional ammunition, explosive material and detonating devices of land-, air- and sea-based weapon systems. Ammunition used for weapons of mass destruction (nuclear, chemical and biological) is excluded.”<sup>2</sup>

The areas covered in this guide are taken from Section IV of the OSCE Stockpiles Document on Stockpile Management and Security. It recommends the following indicators for use in assessing the current state of the stockpile and where improvements need to be made.

1 FSC.DOC/1/03, 19 November 2003.

2 OSCE Stockpiles Document, Section II, paragraph 16.

This guide expands upon the indicators listed below:

- (i) Safety and Storage: Robustness and capacity of stockpile buildings,
- (ii) Quality: Condition of conventional ammunition, explosive material and detonating devices,
- (iii) Accountability: Ammunition stock control function policies and procedures,
- (iv) Reporting: Procedures for the immediate reporting and recovery of any loss,
- (v) Training: The training of staff in effective stockpile management and security procedures,

- (vi) Management Controls: The system implemented and executed to ensure the ammunition stockpile management process is established and working as intended<sup>3</sup>.

The guide will first provide general information for management personnel working to establish policies and procedures regarding ammunition stockpile management on the local and national levels. Recommended technical practices are then provided for those individuals working directly in an ammunition stockpile facility.

### III. General policies and procedures

#### A. Accountability: Receipt, storage, inventory, and materiel release, procedures

**Management Responsibilities:** Inventory management and accounting control procedures should be implemented at all levels of responsibility for stockpile facilities and there should be an organized system of reporting and communication between these levels. In order to complete regular reporting to higher levels of command, Facility Managers must have a firm grasp of their inventory and procedures and be able to provide higher levels of commands with information necessary for auditing control and for projecting future usage and supply needs. Conducting periodic inspections of facilities not only encourages communication among various levels of organization, but also holds Facility Managers accountable for their reporting. Communication and reporting will help ensure that all facilities are adequately stocked and that the necessary auditing is taking place.

**Records and Reporting:** It is important to note that a lifetime approach should be taken in inventory management, i.e., control and adequate records must be maintained from the moment facilities take control of stock, through the various movements of the stock, until the stock is expended or destroyed. It is particularly important to identify those munitions deemed as excess, obsolete and unserviceable/unrepairable so that they can be demilitarized or destroyed as soon as possible, or set aside for training if the quality permits. Ensuring this type of inventory management will minimize safety and security risks.

On a monthly or quarterly basis, local distribution points should report to their regional distribution point or their national distribution point (depending on the organization of the national system). Reports should contain information on current inventory and distributions for the preceding time period, including destinations for these distributions. This information should be

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3 OSCE Stockpiles Document, Section IV, paragraph 21.

used to identify any inventory losses from accident or theft and to identify areas of insufficient inventory. This information should also be used to conduct periodic cost-benefit reviews to ensure that resources are being used in the most efficient manner.

Ideally, a computerized and networked inventory program should be developed to meet the inventory needs of the national system. This way, regional distribution facilities and/or the central distribution facility will have the ability to produce reports on the distribution activities of the various programs and also on the current inventory status of the facilities. In addition to enhanced reporting, a computerized system would also greatly facilitate inventory management and auditing, as information would be more easily accessible and recoverable. If it is not possible for a computerized system to be developed, organized paper inventory systems can also be very effective, although they are more labor intensive and time-consuming.

**Physical Inventory:** Each facility should also endeavor to take a full physical inventory of their stock annually. The term “physical inventory” means that operators will count the stock by hand or through automation (where applicable in automated inventory systems) to verify the current inventory. A physical inventory is a large resource commitment but it is the best way to truly verify the current inventory levels and ensure that present planning assumptions regarding ammunition and explosives stockpiles are correct. This is also a way to uncover any old reporting errors, which may have been skewing the numbers for subsequent reports. Self-contained weapons and items considered susceptible to theft (i.e. plastic explosives, detonators, High Explosive Hand Grenades, mines with fuzes, shoulder fired rockets) should be accounted for on a quarterly basis.

Maintaining these reports and any other necessary records will greatly facilitate the management of stockpiles while also enabling periodic auditing as well. As record keeping is such an important component in managing stockpiles of ammunition and explosives, it will be addressed in a best practice guide covering marking, registration and accounting of ammunition stockpiles.

## B. Reporting: Procedures for immediate reporting and recovery of any loss or incidents

A key internal management control is accounting for events involving loss, accidents, damage, or destruction of ammunition and/or explosives. Facilities should aim to report any theft or other loss of ammunition or explosives immediately after the event or discovery of the loss, but in any event no later than 72 hours after the event or discovery of the loss, to the appropriate levels of command. As soon as the loss is discovered, the supervisor of the facility should be notified. The sooner an investigation can begin after a theft or loss, the greater the chance of recovering the material or determining the individual responsible. All of the circumstances surrounding the loss should be examined, including the transportation of the stock if it is recently arrived. After the loss is discovered, the appropriate corrections to the facility records should be made, with a notation on the lost inventory.

In order to limit variables surrounding an inventory loss, any inventory transported from another facility should travel under sealed container and the driver of the truck should not be allowed to leave until it is verified that the seal is intact and the number matches the shipment paperwork.

## C. Training: Training of staff in effective stockpile management and security procedures

**Facility Personnel Training:** Individuals involved in the day-to-day management and operations of various ammunition and explosives stockpile facilities should be trained in the procedures and regulations governing the functioning of these facilities. Staff should receive standardized appropriate training in safe handling of these materials and what should be done in the case of an emergency situation when there are accidents or problems with the explosive material. There should be internal training on any national regulations and local requirements regarding the stockpile management of ammunition and explosives, organization and operations of the facility, requisite record keeping and reporting and any computerized inventory programs if they are used. Facility Managers are responsible for ensuring that their personnel are trained and also for maintaining that level of training. A recommended approach would be to institute a periodic cycle of training, with appropriate certification and re-certification or testing integrated into the cycle.

**Training Curriculum:** A curriculum for training facility personnel should be established on the national level and it should be reviewed, evaluated and updated at least annually to ensure the adequacy of the training being conducted. Managers at all levels within the national system should ensure that training requirements are being met and that the training is being properly documented. A “train-the-trainers” course, using curriculum established on the national level, would be useful as it would enable managers to be trained and then return to their facilities to train the rest of their staff on the facility procedures. Safety procedures could also be included in this training curriculum but it is recommended that a separate curriculum be established for training on

safety issues. This would ensure that personnel at these facilities are adequately trained to handle the material. Train-the-trainer courses would also promote communication within the national system to ensure that practices are meeting the needs of the facilities and the end-users. This would also facilitate an exchange of ideas on training where participants could learn from other participants on practices and ideas which have worked well in other facilities.

## D. Controls: Supervisory Considerations

**Responsibilities through the Chain of Command:** “Responsibility” is the obligation of an individual to ensure that Government property and funds entrusted to his or her possession, command or supervision are properly used and cared for, and that proper custody and safekeeping are provided. Those individuals in supervisory roles in ammunition and explosives stockpile facilities have the responsibility to ensure that auditing takes place and that resources are being used in the best way possible. There should be a chain of command that should be followed and each level should have the responsibility for the facility and the property which they oversee. Final distribution points should be held accountable by regional distribution points or by the national distribution point (depending on the organization of the national system). If they exist, regional distribution points should be held accountable by the national distribution point. The national distribution point should be held accountable by a final committee or office at the national level which has been given oversight authority over the entire stockpile management process. “Being held accountable” means that each level of command audits the level beneath them to ensure that all of the property delivered to them is accounted for. Each storage organization performing the ammunition stock control function should implement

and execute a quality control program. This program will periodically sample receipts, ammunition transfer records, and materiel release orders, at a minimum to ensure that stored assets are being properly accounted for in terms of condition code, location, quantity, and ownership.

**Inventory Accountability:** Personal inspection of facilities and records is a vital part in holding Facility Managers accountable for their actions along with facility employees. As there are tremendously high quantities of ammunition, it may not be possible to ensure 100% accountability. Facilities should still be mandated that they reach as high a level of accountability as possible. Where any variation from 100% is identified, the discrepancy must be immediately reported and investigated, the reasons for it ascertained, and any necessary remedial action taken to prevent a recurrence.

**Continuity of Personnel:** Ensuring the accountability of ammunition and explosives facilities is an essential responsibility of those supervisors involved in the ammunition stockpile management system. It is also essential for supervisors to focus on other areas affecting the day-to-day functioning of a facility. One of the most critical elements in maintaining a well-organized, accountable system is the personnel whose job it is to support the facilities. Every effort should be made to ensure that reliable personnel are hired and that they obtain further training and education so that they can remain current in the latest methods and practices used in the management of ammunition and explosives. Personnel should be encouraged to continue to develop expertise and knowledge in their occupational specialty which can, in turn, encourage the longevity of employment. The maintenance of knowledgeable personnel in key positions for the long term is essential to ensuring that the stockpiles are being properly and safely managed. Maintenance of

personnel is the specific and ongoing responsibility of Facility Managers and those at higher levels of command within the system.

**Prioritization:** Supervisors must also pay great attention to their available resources and be able to prioritize their use in ways that will be of greatest use to the facility. Different participating States have different resources and there may be different resources available for various facilities. Those in management positions must be able to assess the needs of the facilities and prioritize the use of their resources. A necessary component of this assessment would be establishing the requirements of the facility (e.g., Which components are the facility supporting? What are the training needs? What are the wartime needs?) Resources can then be prioritized to ensure fulfillment of these requirements. Explosive safety & security should be the highest priority, be it securing the facility, ensuring that unstable ammunition and/or explosives are safely disposed of, or ensuring that a safe combination of ammunition and explosives are being stored together.

**Surveillance:** An important way to assess these facilities and ensure readily accessible information for prioritizing resources is for Facility Managers to ensure that there is continuous ammunition surveillance in their facility. This surveillance includes: 1) quality assurance and logistics functions related to the inspection, testing, and classification of ammunition and explosives; 2) functions that affect explosives safety during handling, storage, transportation, maintenance, use, and disposal of ammunition and explosives; 3) core functions of inspecting and determining the reliability of the stockpile, inspecting and monitoring ammunition/explosives operations for compliance with regulatory explosives safety requirements, and protecting the public and government assets from unnecessary expo-

asures to explosives hazards. Continuous ammunition surveillance managed and/or conducted by the facility manager is key to identifying safety risks and ensuring the accountability of the facility while also facilitating resource prioritization.

**Planning:** The long-term planning at the facility level and at the national level will help in ensuring a productive use of resources and will facilitate resource prioritization. Being able to anticipate long-term needs will enable Participating States and facilities to plan and allocate their resources in a way that will best benefit their facilities. Some long-term needs to anticipate could include updating any technology such as computers used in inventory processes; replacing any degraded shelving; or performing a physical inventory. Anticipating these needs will allow resources to be allocated in such a way that they will not have to be re-allocated at the last minute at the expense of other essential components of a facility such as personnel or security measures.

**Accountability of Managers and Personnel:** Facility Managers have the responsibility for managing the resources at their disposal with the end-goal of effectively managing a stockpile of ammunition and explosives. These resources include both available finances and personnel. Facility Managers must hold their personnel accountable for their activities and use of resources in a facility. Furthermore, Facility Managers must also be held accountable for the responsibility entrusted to them. Handling ammunition and explosives is a serious responsibility and all levels of management should emphasize the seriousness of this task by ensuring accountability at all levels. This is done by checking reports, periodic inspections, and ensuring punitive actions are taken if illegal actions are taking place.

## IV. Technical practices for stockpile facilities

### A. Safety and Storage: Robustness and capacity of stockpile facilities

**Facility Capacity:** In order to organize and maintain an ammunition stockpile properly, the storage facility must be able to safely store and physically contain the various classes of ammunition and explosives and also have sufficient capacity to perform the necessary activities of a stockpile storage facility. National facilities supplying smaller, local facilities must have the capacity to handle large amounts of ammunition and have the ability to facilitate the staging and shipping of that ammunition.




Smaller, local stockpile facilities must have the capacity to receive shipments of ammunition and provide adequate storage and security. In addition, the buildings must have the capacity to organize its stockpiles. Facilities must be large enough to facilitate the organization of various types of ammunition so that they are kept separate and not mixed with other incompatible stock. Because of the chemical characteristics of different types of ammunition and explosives, storing improper categories of these materials together can significantly increase either an accident's probability or, for a given quantity, the magnitude of an explosive incident's effects. Ammunition and

explosives categories and compatibility will be further discussed in a later section (see Section III.D).




Storage facilities should be constructed, designed and maintained to provide the greatest possible degree of protection to the public and the environment, as well as to prevent the spread of fire or explosion to other buildings in the facility. Regular trimming of vegetation will enhance security as well as safety.

**Facility Markings:** Stockpile facilities should be marked with the appropriate signs to indicate the appropriate fire hazard symbol for that facility. Facilities should use

the United Nations Organization (UNO) Hazard Classification System, which designates nine hazard classes. Class 1 is applicable to ammunition and explosives and is divided into the following subcategories to indicate the level of fire hazard in the facility. The six fire divisions are indicated by four distinctive symbols in order to be recognized by the firefighting personnel approaching the fire scene. A fire division number is shown on each symbol. Because of similar firefighting hazards, the Fire Division 1 fire symbol and number are also used for Fire Division 5 and the Fire Division 2 fire symbol and number are also used for Fire Division 6:

Category and Description	Example of what would be in category	Symbol used for each category
<p><b>1.1- Mass Detonation</b>                      (a mass explosion is one which affects almost the entire load instantaneously)</p>	<p>Artillery High Explosive Projectiles, e.g.:</p> <ul style="list-style-type: none"> <li>- Dynamite</li> <li>- Anti-tank Mines</li> <li>- 155mm Projectiles</li> <li>- Detonating Cords</li> <li>- Fragmentation Grenades</li> <li>- Most guided missiles and launchers</li> </ul>	
<p><b>1.2- Detonation with Fragments</b>                      (have a projection hazard but not expected to mass detonate)</p>	<p>High Explosive Mortar Ammunition, e.g.:</p> <ul style="list-style-type: none"> <li>- 120mm, 60mm, 81mm cartridges</li> <li>- Some Guided Missiles and Launchers</li> </ul>	
<p><b>1.3- Mass Fire</b>                      (have a fire hazard and either a minor blast hazard or minor projection hazard or both- no mass explosion hazard)</p>	<p>Propellants, e.g.:</p> <ul style="list-style-type: none"> <li>- 155mm Propellant Charge</li> <li>- Surface Trip Flares</li> <li>- Ground Illumination Signal</li> </ul>	



<p><b>1.4- Moderate Fire</b> (present only a small hazard in the event of ignition or initiation- no projection of appreciable fragments are expected)</p>	<p>Small Arms Ammunition, e.g.: - 9mm, 5.56mm, .50cal, 7.62mm cartridges</p>	
<p><b>1.5 – Mass Explosion Hazard</b> (are so insensitive that there is very little probability of initiation or transition from burning to detonation under normal condition)</p>	<p>Commercial Blasting Agents, e.g.: - ammonium nitrate fuel oil (ANFO) and ammonium nitrate emulsions</p>	
<p><b>1.6 – Explosion</b> (articles that contain only extremely insensitive detonating substances and limited to the explosion of a single article)</p>	<p>Nonmass Explosion, e.g.: - extremely insensitive detonating substances (EIDS)</p>	

## B. Facility Standard Operating Procedures<sup>4</sup>

The SOP is a written directive that provides detailed procedures prescribing all safety requirements for the facility. This document should be based on national regulations if they exist. Otherwise, SOPs should be based on the circumstances, needs and responsibilities of the facility. An SOP should be developed prior to starting any operation involving ammunition or explosives. Inside the facility, the Standard Operating Procedures (SOP) for the facility should be posted in conspicuous locations. The Document should include:

- (i) Minimum training requirements for explosives operators or munitions handlers,
- (ii) Emergency notification procedures for accidents
- (iii) Responsibilities and duties of personnel authorized entry into the facility,
- (iv) Non-emergency explosive ordnance disposal,
- (v) Fire safety, including lightning protection,
- (vi) Drawings, specifications, gauge schedules, tools, apparatus, and restriction lists,
- (vii) Static electricity grounding (earthing) requirements,
- (viii) Maximum and/or minimum humidities,
- (ix) Clothing and foot-wear requirements,
- (x) The maximum number of personnel to be in the workshop or laboratory at any one time,
- (xi) The maximum quantity of explosive items per-

or incidents resulting in personnel injury or damage to ammunition stock,

<sup>4</sup> Standard Operating Procedures that have been expanded to address local facility operations and conditions are often referred to as 'Standing Orders.' For purposes of this handbook, no distinction is made between the two types of documents.

mitted in the building and/or to be worked on at any one time,

- (xii) Any additional safety precautions necessary for the ammunition being worked on, such as the provision of evacuation routes and assembly points.

The Facility Manager has the approval authority for all SOPs and any future changes to the document. All personnel working in the facility should be required to read the SOP and sign as having understood the content of the SOP. Any questions on the meaning of the SOP should be asked prior to the employee signing the SOP. In addition to an SOP being posted, signs should be posted inside the facility indicating the safety precautions and regulations for the specific material stored in the facility. Emergency evacuation plans should be practiced periodically. The SOP should clearly describe each part of the operation, so that no doubt or flexibility is left in the manner in which the specific operation is to be conducted. The SOP should also include a complete listing of the tools and equipment approved for the completion of the specific task.

National regulations should determine the maximum number of personnel permitted to be present in the facility. Until national regulations are established, the Facility Manager should determine the appropriate number of personnel for the facility. This number should be kept to the minimum required to properly perform the work safely and efficiently. A sign stating the maximum/minimum number of personnel allowed in a facility containing ammunition and explosives should be posted in a conspicuous location. This number should include supervisors as well as the number of visitors permitted.

### C. Quality: Condition of conventional ammunition, explosive material and detonating devices

**Observation:** A process for overall management of the quality of the ammunition and explosives must be established within the national system. Quality must be monitored upon initial receipt, while in storage and transport, during interim storage in other locations, during use by national authorities, during maintenance and finally during demilitarization. Continually observing and maintaining records on the condition of ammunition, explosive material, and detonating devices will aid both in ensuring safety for the facility and the surrounding areas and in increasing the cost-effectiveness of the stockpile facility. By constantly examining the condition of the ammunition, Participating States can identify deteriorated or unsafe ammunition and remove it from the stockpile. If ammunition stockpiles are managed properly, older ammunition can be used prior to the newer stocks, ensuring that the older ammunition does not deteriorate and require disposal. Ammunition which has already degraded past a useable stage should not be used and should be destroyed. Ammunition that is considered unsafe for storage should be moved to an Isolation Storage Area while awaiting disposal actions.

**Actions to improve the condition of stockpiled ammunition:** Facilities can work on de-rusting, cleaning, painting, and repackaging of material to upgrade stocks and correct nonfunctional defects of the ammunition and explosives. These activities could come as a result of regular surveillance inspections by facility personnel or from management decisions. These duties should be performed multiple times a year to keep the stockpiled material in an optimal state. Applying good supply techniques such as “first in-first out” will reduce the need for maintenance and rework caused by deterioration. Improving the condition of these stocks will also improve the security of the

entire stockpile by ensuring that stock is not degraded to a point that it becomes unstable and poses a threat to the facility and surrounding areas. The ammunition required for immediate peacetime needs or for primary war reserve<sup>5</sup> requirements should receive the priority attention for cleaning, painting, repackaging, etc. Ammunition required for peacetime needs during the first year or for the second level of war reserve requirements should receive the next level of priority.

**Storage Techniques:** Proper storage techniques can help maintain or improve the condition of ammunition and explosives within a facility. Ammunition and explosives should be separated in stacks by nature, type, and lot number and they should always be stored inside their shipping containers. These containers should be stacked to maintain an orderly arrangement that will facilitate the safe and effective handling of ammunition. The bottom layer of a stack of ammunition and/or explosives should be raised off the floor by suitable means, preferably metal or wood, to provide ventilation and to protect the material from water and dampness. Wooden pallets are suitable means to raise the stacks when they are received as part of the packaged unit. Unobstructed aisles should be maintained between stacks to ensure that the ammunition and explosives can be inspected, inventoried, and removed as necessary. These aisles should be at least eighteen inches (46 centimeters) wide so that individual containers or stacks are accessible for inspection. It is recommended that a clearance of at least two feet (61 centimeters) be maintained from the front wall of the facility along with a space of at least six inches (15 centimeters) from stacks to the sides, rear, and ceiling of

the facility. Ammunition stacks should be placed at least one meter from doorways to provide protection from direct sunlight, rain, etc. when doors are open. If pallets are unbanded, stack heights should not exceed two meters or one pallet.

## D. Supply Management: Organization of Stockpiles

**Ammunition and Explosives Compatibility:** Quantities of conventional ammunition can be in the hundreds of thousands in a single stockpile. Furthermore, there are different types of ammunition, different calibers, different manufacturers and different ages, all with varying degrees of volatility. The combination of these factors makes the strict organization of a stockpile essential in ensuring safety and the effective use of materials. In order to facilitate the organization of ammunition and explosives and to ensure that they are safely housed in a facility, they are assigned to specific groupings. These “ammunition compatibility groups” are assigned to ammunition in order to reduce the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident. Refer to Annex A for the Compatibility Group Assignments and Storage Facilities Compatibility Chart that details which groups can be safely stored together.

**Net Explosive Quantity (NEQ):** A factor that is affected by the organization of stockpiles is the NEQ<sup>6</sup>. The NEQ is the weight in kilograms (pounds) of the explosive content of an individual round of ammunition. The NEQ must be calculated to determine the safe distance ammunition may be stored from inhabited buildings, public

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5 The term “war reserve” can be defined as follows: “Stocks of materiel amassed in peacetime to meet the increase in military requirements consequent upon an outbreak of war. War reserves are intended to provide the interim support essential to sustain operations until re-supply can be effected.”

6 “Net Explosive Quantity” (NEQ) is a term used by many States, where the quantity of explosives is identified in kilograms (kg). Other States may use “Net Explosive Weight” (NEW), where the quantity of explosives is identified in pounds (lbs).

traffic routes, ammunition operating buildings, and other storage sites. The NEQ for each item of ammunition in the stockpile must be identified and published by the appropriate authority. When ammunition and explosives of more than one Hazard Division are stored in a single site, the required Quantity-Distances or permissible NEQ should be calculated using the following rules:

- a) When Hazard Divisions 1.1 and 1.2 are located in the same site, determine the distances for the total quantity considered first as 1.1 and then as 1.2. The required distance is the greater of the two. When the 1.1 requirements are controlling and the HE equivalence of the 1.2 is known the HE equivalent weight of the 1.2 items may be added to the total explosive weight of 1.1 items to determine the NEQ for 1.1 distance determination; otherwise, the total explosive weight of the 1.2 items (including the net propellant weight) is to be added to the total explosive weight of the 1.1 items to determine the NEQ for 1.1 distance determination.
- b) When Hazard Divisions 1.1 and 1.3 are located in the same site, determine the distances for the total quantity as 1.1. However, when the HE equivalence of the 1.3 is known, the HE equivalent weight of the 1.3 items may be added to the total explosive weight of 1.1 items to determine the NEQ for 1.1 distance determinations; otherwise the total net propellant weight of the 1.3 items is to be added to the total explosive weight of the 1.1 items to determine the NEQ for 1.1 distance determinations.
- c) When Hazard Divisions 1.2 and 1.3 are located in the same site, determine the required distance for each separately. The two quantities do not need to be added together for Q-D purposes. The required distance is the greater of the two.
- d) When Hazard Divisions 1.1, 1.2, and 1.3 are located in the same site, determine the distances for the total quantity considered first as 1.1, next as 1.2, and finally as 1.3. The required distance is the greatest of the three. As permitted by paragraphs C9.2.1.3. and C9.2.1.4., above, HE equivalent weights for 1.2 and 1.3 items may be used in NEQ determinations for Q-D purposes; otherwise the rules for adding total explosive (and/or propellant) weight of 1.2 and 1.3 items is to be added to the explosive weight of the 1.1 items (when controlling) to determine the NEQ for 1.1 distance requirements.
- e) Explosives designated as Hazard Division 1.5 for transportation are considered to be Hazard Division 1.1 for Q-D purposes (storage).
- f) When Hazard Division 1.6 is located with Hazard Division 1.1 or 1.5, Hazard Division 1.6 is considered Hazard Division 1.1 for Q-D purposes. When Hazard Division 1.6 is located with Hazard Division 1.2, Hazard Division 1.6 is considered Hazard Division 1.2 for Q-D purposes.
- g) When Hazard Division 1.6 is located with Hazard Division 1.3, then add the explosives weight of the Hazard Division 1.6 to the weight of Hazard Division 1.3 and determine the distances for the total quantity considered first as Hazard Division 1.3 (if demonstrated by testing or analogy; otherwise, treat as Hazard Division 1.1) and second as Hazard Division 1.6. The required distance is the greater distance of the two.
- h) The Q-Ds for Hazard Division 1.1, 1.2, 1.3, 1.5 or 1.6 individually or in combination are not affected by the presence of Hazard Division 1.4.i). If approved buffer

configurations are provided, the NEQ for Q-D purposes is the explosives weight of the largest stack plus the explosives weight of the buffer material.

The NEQ is also involved in another equation, the Explosive Safety Quantity Distance (ESQD). This equation provides the acceptable levels of protection (distance) based on the type and quantity of explosives, the type of structure they are stored in and the relationship to the exposed sites, (e.g., inhabited buildings, public transportation routes, and different ammunition storage facilities). The equation used to determine the ESQD is  $D = XQ^{1/3}$ , where D = Distance (m), X = Safety factor (the X variable<sup>7</sup> is a constant and represents the degree of damage that is acceptable. Typical constants range from 1.25 to 50; the lower the factor, the greater the damage that is accepted), Q = NEQ (kilograms). A full and complete explanation of ESQD calculations is beyond the scope of this document. However, there are several national and other documents, which can further explain the ESQD implementation. Annex D contains contact information for regional organizations and other OSCE participating States' practices in this area.

**Maintaining Organization in a Facility:** Ammunition should be organized in such a way that promotes the timely receipt, storage, and issue of stock and also promotes the accuracy within ammunition location records. A way of promoting this organization is by utilizing an "ammunition locator record" which provides a record of each lot of ammunition and identifies the site location in which it is stored. Included in the locator record could be a "planograph"<sup>8</sup> which is a diagram reflecting all of the items stored in the facility, grid locations of the items, and occupied and vacant storage space within an

ammunition storage structure or site. A "grid location" is a specific area within the confines or boundaries of an ammunition storage structure or site, which relates the location of the stocks in the facility to the floor plan/layout/or planograph of the location. The organization of a stockpile should facilitate the objectives of seeking to 1) accelerate the selection of stock for issue or shipment to facilities; 2) expedite the movement of received stock to its proper location in the facility; 3) achieve maximum use of storage space; 4) provide rapid response to inquiries for location information; and 5) maintain high accuracy standards for ammunition locator records.

Once a diagram of the facility has been completed which facilitates the objectives of an organized stockpile, any changes to the diagram should be highly regulated and documented if location changes are necessary.

Stocks within the individual grid locations should also be highly organized and separated according to lot number and condition. It is important to separate stocks by lot number and condition largely for quality control reasons. Often ammunition or explosives from a certain lot are sent to multiple regional distribution facilities. If a particular lot of ammunition is found to be unstable or dangerous, then the inventory from this lot would be re-called (i.e. it would be returned to the proper authorities for safe disposal). It is essential that facilities be able to immediately identify lots in question so that the risk to those in the facility or surrounding areas is minimized. Higher cost ammunition such as rockets and guided missiles may be assigned individual serial numbers. The serial numbers should also be carefully kept and the location of these items should also be designated on the planograph.

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<sup>7</sup> Some countries denote this factor with a 'K'.

<sup>8</sup> Refer to Annex B for a sample planograph.

To keep stocks organized within grid locations, forms can be attached to each lot in a grid location which would be used to track additions or removals from that lot<sup>9</sup>. If multiple lots are stored in one grid location, then there should be a separate form for each lot. If storage locations cause the deterioration of these forms (due to climactic conditions or the presence of rodents or insects, etc.) they should be placed in plastic envelopes or suitable substitutes to prevent deterioration of the forms. When the last of the lot of ammunition is removed from the facility, the form should be maintained for at least two years in case there are any questions or issues with that stock.

Clearly identified physical security procedures are also a valuable way to maintain the organization of a stockpile. Less complex measures, such as controlling who has keys to the facility and sign-in/ check-out lists are cost-effective measures to enhance loss-prevention efforts in a facility. Other measures such as increased lighting and fencing around the facility, increased security staff, and an intrusion detection system can provide invaluable protection for an ammunition stockpile facility.

## V. Additional information

Participating States looking for more specific information on stockpile management can refer to the regulations in place of other OSCE participating States. Regional organizations such as NATO have also produced regulations on ammunition and explosives topics which have been agreed to by all NATO members, with

many Partnership for Peace and Mediterranean Dialogue countries participating in their development. Annex D contains contact information for regional organizations and other OSCE members' practices in this area.

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<sup>9</sup> Refer to Annex C for a sample form.

# Annex A

## Ammunition and Explosives Compatibility Groups and Compatibility Chart

### Aboveground Storage of Explosive Substances Rules for Mixing of Compatibility Groups.

Compatibility Group	A	C	D	G	L	S
A	X					
C		X <sup>1)</sup>	X <sup>1)</sup>	<sup>3)</sup>		X
D		X <sup>1)</sup>	X <sup>1)</sup>	<sup>3)</sup>		X
G		<sup>3)</sup>	<sup>3)</sup>	X		X
L					<sup>2)</sup>	
S		X	X	X		X

LEGEND: X = Mixing permitted

NOTES:

- 1) Mixing permitted provided substances have all passed UN Test Series 3. Storage of substances of any Compatibility Groups C, D or G which have failed UN Test Series 3 will require special consideration by the National Competent Authority.
- 2) Compatibility Group L substances must always be stored separately from all substances of other compatibility groups as well from all other substances of Compatibility Group L.
- 3) The mixing of Compatibility Group G substances with other compatibility groups is at the discretion of the National Competent Authority.

## Aboveground Storage of Explosive Articles - Rules for Mixing of Compatibility Groups.

Compatibility Group	B	C	D	E	F	G	H	J	K	L	N	S
B	X		X <sup>1)</sup>	X <sup>1)</sup>	X <sup>1)</sup>							X
C		X	X	X	<sup>2)</sup>	<sup>4)</sup>					X <sup>5)</sup>	X
D	X <sup>1)</sup>	X	X	X	<sup>2)</sup>	<sup>4)</sup>					X <sup>5)</sup>	X
E	X <sup>1)</sup>	X	X	X	<sup>2)</sup>	<sup>4)</sup>					X <sup>5)</sup>	X
F	X <sup>1)</sup>	<sup>2)</sup>	<sup>2)</sup>	<sup>2)</sup>	X	<sup>4)</sup>						X
G		<sup>4)</sup>	<sup>4)</sup>	<sup>4)</sup>	<sup>4)</sup>	X						X
H							X					X
J								X				X
K									X			
L										<sup>3)</sup>		
N		X <sup>5)</sup>	X <sup>5)</sup>	X <sup>5)</sup>							X <sup>6)</sup>	X <sup>7)</sup>
S	X	X	X	X	X	X	X	X			X <sup>7)</sup>	X <sup>6)</sup>

LEGEND: X= Mixing permitted

## NOTES

- 1) Compatibility Group B fuzes may be stored with the articles to which they will be assembled, but the NEQ must be aggregated and treated as Compatibility Group E.
- 2) Storage in the same building is permitted if effectively segregated to prevent propagation.
- 3) Compatibility Group L articles must always be stored separately from all articles of other compatibility groups as well as from all other articles of different types of Compatibility Group L.
- 4) Mixing of articles of Compatibility Group G with articles of other compatibility groups is at the discretion of the National Competent Authority.
- 5) Articles of Compatibility Group N should not in general be stored with articles in other compatibility groups except S. However, if such articles are stored with articles of Compatibility Group C, D and E, the articles of Compatibility Group N should be considered as having the characteristics of Compatibility Group D and the compatibility groups mixing rules apply accordingly.
- 6) It is allowed to mix 1.6N munitions. The Compatibility Group of the mixed set remains N if the munitions belong to the same family or if it has been demonstrated that, in case of a detonation of one munition, there is no



instant transmission to the munitions of another family (the families are then called „compatible“). If it is not the case the whole set of munitions should be considered as having the characteristics of Compatibility Group D.

- 7) A mixed set of munitions 1.6N and 1.4S may be considered as having the characteristics of Compatibility Group N.

#### 1.2.3.3. *Mixed Storage - Special Circumstances*

- a) There may be special circumstances where the above mixing rules may be modified by the National Competent Authority subject to adequate technical justification based on tests where these are considered to be appropriate.
- b) Very small quantity HD 1.1 and large quantity Hazard Division 1.2.1/1.2.2.  
It should be possible to arrange storage in such a manner that the mixture will behave as 1.2.1/1.2.2.
- c) Mixing of Hazard Division 1.1, Hazard Division 1.2.1/1.2.2 and Hazard Division 1.3  
The quantity distance to be applied in these unusual circumstances is that which is the greatest when considering the aggregate NEQ as Hazard Division 1.1, Hazard Division 1.2.1, Hazard Division 1.2.2 or Hazard Division 1.3.
- d) With the exception of substances in Compatibility Group A, which should not be mixed with other compatibility groups, the mixing of substances and articles is permitted as shown in Tables 5 and 6.

## Compatibility Group Assignments

**Group A:** Primary explosive substance. Examples are lead azide, lead styphnate, mercury fulminate, tetracene, dry RDX, and dry PETN. Group A materials are prohibited aboard combatant ships.

**Group B:** Articles containing a primary explosive substance and not containing two or more effective protective features. Some articles, such as detonators for blasting, detonator assemblies for blasting and primers, cap-type, are included, even though they do not contain primary explosives. Examples are detonators, blasting caps, small arms primers, and fuzes without two or more safety features.

**Group C:** Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance. Examples are single-, double-,

triple-based, and composite propellants, rocket motors (solid propellant), and ammunition with inert projectile.

**Group D:** Secondary detonating explosive substance or black powder or articles containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features. Examples are bulk TNT, Composition B, wet RDX, bombs, projectiles, warheads, or fuzes with two or more safety features.

**Group E:** Article containing a secondary detonating explosive substance, without means of initiation, with a propelling charge (other than one containing flammable liquid or gel or hypergolic liquid). Examples are artillery ammunition, rockets, or guided missiles.

**Group F:** Articles containing a secondary detonating explosive substance with its own means of initiation, with a propelling charge (other than one containing flammable liquid or gel or hypergolic liquid) or without a propelling charge. An example is a grenade.

**Group G:** Pyrotechnic substance or article containing a pyrotechnic substance, or article containing both an explosive substance and an illuminating, incendiary, tear-producing or smoke-producing substance (other than a water-activated article or one containing white phosphorous (WP), phosphide or flammable liquid or gel or hypergolic liquid). Examples are flares, signals, incendiary or illuminating ammunition, and other smoke and tear producing devices.

**Group H:** Ammunition containing both explosives and WP or other pyrophoric material. Ammunition in this group contains fillers which are spontaneously flammable when exposed to the atmosphere. Examples are WP, plasticized white phosphorus (PWP), or other ammunition containing pyrophoric material.

**Group J:** Ammunition containing both explosives and flammable liquids or gels. Ammunition in this group contains flammable liquids or gels other than those which are spontaneously flammable when exposed to water or the atmosphere. Examples include liquid- or gel-filled incendiary ammunition.

**Group K:** Articles containing both an explosive substance and a toxic chemical agent. Articles in this group contain chemicals specifically designated for incapacitating effects more severe than lachrymation. Examples are artillery or mortar ammunition, fuzed or unfuzed, grenades, and rockets or bombs filled with a lethal or incapacitating chemical agent.<sup>10</sup>

**Group L:** Explosive substance or article containing an explosive substance and presenting a special risk needing isolation of each type. Examples are prepackaged hypergolic liquid-fueled rocket engines, TPA (thickened TEA), and damaged or suspect ammunition of any group.

**Group N:** Hazard Division 1.6 ammunition containing only extremely insensitive detonating substance (EIDS). Examples are bombs and warheads. If dissimilar Group N munitions, such as Mk 82 and Mk 84 Bombs, are mixed together and have not been tested to assure non-propagation; the mixed munitions are considered to be Hazard Division 1.2, Compatibility Group D for purposes of transportation and storage.

**Group S:** Substance or article so packed or designed that any hazardous effects arising from accidental functioning are confined within the package. That is unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit firefighting or other emergency response efforts in the immediate vicinity of the package. Examples are explosive switches or valves.

**Items that should be stored separately from other items of ammunition:**

- Detonators and blasting caps (separated from Compatibility Groups C, D, E, and F by a dividing wall capable of preventing sympathetic detonation of other items,
- White Phosphorous (storage site equipped with appropriate equipment required to take Immediate Actions in case of leakage)

<sup>10</sup> All OSCE participating States have ratified the Chemical Weapons Convention.

- Damaged ammunition (if considered unsafe for storage, damaged munitions should be destroyed at the earliest convenience),
- Ammunition in an unknown condition (should be stored at such distance that detonation of this ammunition will not jeopardize the national stocks),
- Ammunition which has deteriorated and become hazardous (should be stored in Isolation and destroyed at the earliest convenience),
- Pyrotechnics and propellants.

## Annex B

Sample planograph that identifies the location of inventory in an ammunition and explosives storage facility.

Strathmore Facility

Planograph- Site Number 107010

Latitude Grid = 02 Feet

Longitude Grid = 05 Feet

Date: 12/04/05

	AA	BB	CC	DD	EE	FF	GG	HH	JJ	KK	LL	MM	NN	
A	I												I	A
A	I												I	A
B	I	(BCAB)I		(BCCD)I									I	B
B	I	I		I									I	B
C	I	I		I									I	C
C	I	I		I									I	C
D	I							(DEAH)I					I	D
D	I							I					I	D
E	I							I					I	E
E	I							I					I	E
F	I													F
F	I													F
G	I													G
G	I													G
H	I			(HJAD)I								(HJJM)I		H
H	I			I								I		H
J	I			I								I I		J
J	I			I								I I		J
K	I												I	K
K	I												I	K
L	I												I	L
L	I												I	L
M	I							(MNAH)I					I	M
M	I							I					I	M
N	I							I					I	N
N	I							I					I	N
	AA	BB	CC	DD	EE	FF	GG	HH	JJ	KK	LL	MM	NN	

<b>Grid</b>	<b>Serial/Lot Number</b>	<b>Quantity</b>	<b>Stock Number</b>
BCAB	HAQ-3162-7BY	89	15406544050PD62
BCCD	HAQ-3148-2AY	48	15406544089PD62
DEAH	VRD-9873-4AH	45	15402246597AH74
HJAD	RTS-542-3GV	67	15405265014HY54
HJJM	RSV-432-4RD	59	15402546540HP74
MNAH	HYO-740-6ST	121	15409701657YO12

### Explanation of Sample Planograph:

This is a sample planograph for an imaginary facility. Participating States and/or facilities can adjust the planograph and the included information to best fit their needs. The goal is to provide a map of the facility and ensure that, 1) there is an awareness of all stock in the facility, and 2) that there is control over that stock and its movements.

**Strathmore Facility:** Name of the facility

**Planograph-Site Number 107010:** Facility identification number (sometimes facilities are assigned identification numbers along with names)

**Latitude Grid:** Length of the grid containing the ammunition/explosives

**Longitude Grid:** Width of the grid containing the ammunition/explosives

**Date:** Date the planograph was printed from the system or date it was created

**BCAB, BCCD, DEAH, etc.:** Names for grid locations. First two letters indicate the vertical length of the grid. Last two letters indicate the horizontal width of the grid. These grid locations indicate that a specific type and lot of ammunition are stored in these locations.

**I:** These markings indicate the front and back of the building. The lack of these markings through grids FE, GG, and HH on the right hand side indicate the entrance to the facility.

- These markings also indicate the end of a specific location of ammunition, e.g. for grid location name DEAH, the I's indicate that this certain type of ammunition ends at grid HH.

Grid location names can then be matched up with the specific type of ammunition stored in that location, as is done at the bottom of the planograph. Participating States should include whatever information necessary for the identification of the ammunition.

## Annex C

Sample Form for Tracking Additions or Removals from a Lot in a Grid Location

Lot Data Card						
Internal Control Number (if applicable):		Description of Lot:				
Lot Number:		Site Location:			Grid Location:	
Date	Document Number (of paperwork used to track internal supply movements)	Received From or Issued To	+ Or -	Quantity Received (+) Or Issued (-)	Balance	Signature

## Annex D

### Regional Organizations

North Atlantic Treaty Organization (NATO)  
 Military Agency for Standardization (MAS)  
 B - 1110 Brussels  
 Tel: 707.55.76  
 Fax: 707.57.18  
 Email: mas@hq.nato.int

NATO AC/326 Ammunition Safety Group  
 Mortier, Mrs. Marie Claire, Secretary  
 Armaments Directorate  
 Defense Investment Division  
 Room J 344  
 NATO Headquarters  
 B - 1110 Brussels  
 Tel: +32-2-707.3942  
 Fax: +32-2-707.4103  
 Email: mc.mortier@hq.nato.int

South Eastern European Clearinghouse for the Control  
of Small Arms and Light Weapons (SEESAC)

Team Leader,  
SEESAC,  
UNDP Belgrade,  
Janka Veselinovica,  
11000 Belgrade,  
Serbia  
Tel: (+381)(11)244.29.02  
Fax: (+381)(11)245.43.51  
Email: rmds@undp.org.yu

Tel : ++45 31541313  
Fax : ++45 32968055

AIR FORCE  
Flyvematerielkommandoen  
Postboks 130  
DK - 3500 Vaerlose  
Tel : ++45 44682255  
Fax : ++45 44662533

## Participating States

### **Belgium**

- a. Military ammunition and explosives:  
Logistiek Steuncomplex NOORD-SIPEG  
Fort Colonel IMF Brosius  
B - 2070 Zwijndrecht  
Tel: 03/253 7248  
Fax: 03/253 7269
- b. Civil ammunition and explosives  
MINISERE DES AFFAIRS ECONOMIQUES  
Administration des Mines  
Service des Explosifs  
Rue J.H. De Mot 28-30  
B - 1040 Bruxelles 4

### b. Civil ammunition and explosives

Justitsministeriet  
Civilkontoret  
Slotholmsgade 10  
DK - 1216 Kobenhavn K  
DK - 1216 Kobenhavn K  
Tel : ++45 33923340  
Fax : ++45 33933510

### **Netherlands**

Military Committee on Dangerous Goods  
DMKL/Bevod/Milan  
PO Box 90822  
2509 LV The Hague  
Netherlands  
Tel: --31 70 316 5090  
Fax: --31 70 316 5091

### **Denmark**

- a. Military ammunition and explosives ARMY  
Haerens Materielkommando  
Arsenalvej 55  
DK - 9800 Hjørring  
Tel : ++45 98901322  
Fax : ++45 98900623
- NAVY  
Sovaernets Materielkommando Holmen  
DK - 1433 Kobenhavn K

### **Norway**

- a. For military ammunition and explosives
  - 1) Haerens forsyningskommandos  
ammunisjonskontroll  
Postboks 24,  
N-2831 RAUFOSS  
Norway  
Tel: ++47 61 19 1230

2) Sjøforsvarets forsyningskomando

Postboks 3,  
N-5078 HAAKONSVERN  
Norway  
Tel: ++47 55 50 2000

3) Luftforsvarets forsyningskommando

Postboks 10,  
N-2007 KJELLER  
Norway  
Tel: ++47 63 80 8000

b. For civilian explosives and articles containing explosive substances:

DIREKTORATET FOR BRANN OG  
EXPLOSIONSVÉR  
Postboks 355, Sentrum  
N-3101 TONSBERG  
Norway  
Tel: ++47 33 39 8800

**Turkey**

a. For military ammunition and explosives:

Ministry of Defense  
ANKARA

b. For non-military explosives:

Ministry of Internal Affairs  
ANKARA

**United Kingdom**

Explosives Storage and Transport Committee (ESTC)  
Room 755, St Giles Court  
1-13 St Giles High Street  
London WC2H 8LD  
(civil net) Tel: ++44 171 305 7109/7006  
Fax: ++44 171 305 6022  
(mil net) Tel: LHQ 57109/57006  
Fax: LHQ 56022

**United States**

a. Military ammunition and explosives

Chairman DoD Explosives Safety Board  
Room 856C, Hoffman Building I  
2461 Eisenhower Avenue  
Alexandria, VA 22331-0600  
USA  
Tel: ++1-703-325-8624 (DSN 221-8624)  
Fax: ++1-703-325-6227

b. Non-military explosives

Associate Administrator for Hazardous Materials  
Safety  
Material Transportation Bureau  
RSPA/DOT  
400 7th Street, SW  
Washington, D.C. 20590  
USA  
Tel: ++1-202-366-0656  
Fax : ++1-202-366-3753



# Best Practice Guide on Physical Security of Stockpiles of Conventional Ammunition





The aim of this Best Practice Guide (BPG) is to provide guidance on the following safety and security requirement for the management of conventional ammunition stockpiles:

**PHYSICAL SECURITY OF STOCKPILES OF CONVENTIONAL AMMUNITION IN  
MILITARY AMMUNITION DEPOTS  
IMPLEMENTATION OF THE STOCKHOLDERS DUTY OF CARE**

Every holder of ammunition has a legal and moral duty of care to those it employs in the management of the ammunition and the general public that may be affected by the theft and potential use of ammunition stolen from ammunition storage facilities and from an explosive event within an ammunition storage site. It is anticipated that this guide will contribute to and facilitate the development and application of high common standards to provide the required levels of public safety and stock protection.

# Table of Contents

I. PHYSICAL SECURITY OF STOCKPILES OF CONVENTIONAL AMMUNITION IN MILITARY AMMUNITION DEPOTS	43
1. Aim	43
2. Scope	43
3. Introduction	43
4. Security categories	43
5. Protection modes – ingress/egress	44
6. Intergrated security systems	45
7. Intrusion Detection Systems (IDS)	45
8. Restricted area posting	47
9. Explosive storehouse physical security	47
10. Drainage culverts and utility openings under fences	47
11. Security lighting	47
12. Door locks and padlocks	48
13. Security breaches	49
II. IMPLEMENTATION OF THE STOCKHOLDERS DUTY OF CARE	49
1. Introduction	49
2. Scope	49
3. Definitions	50
4. UN Classification of Dangerous Goods	54
5. Explosion Effects	56
6. Hazard and Risk Analysis	57
7. Hazard Mitigation	59
8. Safe Guarding of Explosive Sites	62
9. Waivers and Exemptions	63
10. Fire Prevention and Firefighting	64
11. Environmental Impact on Ammunition	67
12. Ammunition Surveillance	68
Annexes	
A. UN Hazard Divisions	70
B. UN Compatibility Groups	71
C. Explosive Limit Licence	72
D. Quantity Distance Tables	74

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2 June 2008

# I. PHYSICAL SECURITY OF STOCKPILES OF CONVENTIONAL AMMUNITION IN MILITARY AMMUNITION DEPOTS

## 1. Aim

The aim of this Best Practice Guide (BPG) is to provide guidance for the effective management and security of national conventional ammunition stockpiles in military ammunition depots. It is anticipated that this guide will contribute to and facilitate the development and application of high common standards in this field.

## 2. Scope

This BPG deals with conventional ammunition except those specifically excluded by the OSCE Document on Stockpiles of Conventional Ammunition (OSCE, 2003). The scope of the guide is to elaborate a methodology for the development of policy and general operational guidelines and procedures on all aspects of conventional ammunition security. It outlines the various requirements to ensure that the responsible ammunition stockpile managers provide the appropriate duty of care.

## 3. Introduction

Every holder of ammunition has a legal and moral duty of care to those it employs in the management of the ammunition and the general public that may be affected by the theft and potential use of ammunition stolen from ammunition storage facilities.

Where these practices cannot all be implemented, participating States should implement those practices for which they have the capability, and work on implement-

ing further practices with the aim of creating a comprehensive stockpile management program.

### RESPONSIBILITIES with regard to CONVENTIONAL AMMUNITION

Responsible ministries and governmental agencies possessing conventional ammunition should:

- Plan, program, and budget resources to ensure that ammunition in their custody is secure;
- Establish procedures to review all military ammunition storage construction and installation modification projects prior to contract award to ensure that they meet the required security criteria;
- Consolidate ammunition stocks within operational, safety, and mission requirements to reduce security costs.

If required, the security of existing facilities should be upgraded. Such facilities shall be prioritized for security upgrade<sup>1</sup> as follows:

- Facilities storing Category I items;
- Facilities storing Category II items;
- Facilities storing Category III and IV items.

## 4. Security categories

On the basis of their use, attractiveness, and availability to subversive and criminal elements, ammunition is categorized according to the risks involved. As a general rule, only arms, missiles, rockets, explosives rounds,

<sup>1</sup> See paragraph V.

mines, and projectiles that have an unpacked unit weight of 45 kilograms or less shall be categorized as sensitive for purposes of this BPG. Any single container that contains a sufficient amount of components that, when assembled, will perform the basic function of the end item shall be categorized the same as the end item. The following provides guidance based on commonly accepted security applicability:

#### **Category I**

- Man portable missiles and rockets in a ready-to-fire configuration.

#### **Category II**

- Missiles and rockets requiring a crew-served platform mounted launcher or other equipment to function.

#### **Category III**

- Missiles and rockets requiring a crew-served platform mounted launcher or other equipment to function and complex hardware and software equipment to function;
- Launch tube and grip stock for the Man Portable Air Defence Systems missile;
- Ammunition, .50 calibre and larger, with explosive filled projectile with an unpacked weight of 45 kilograms or less;
- Incendiary grenades and fuses for high explosive grenades;
- Blasting caps;
- Supplementary charges;
- Bulk explosives;
- Detonating cord.

#### **Category IV**

- Hand or rifle grenades (high explosive and white phosphorous);
- Antitank or antipersonnel mines with an unpacked weight of 22 kilograms or less;
- Explosives used in demolition operations, C-4, military dynamite, and TNT with an unpacked weight of 45 kilograms or less;
- Ammunition with non-explosive projectile (unpacked weight of 45 kilograms or less);
- Fuses (other than those for high explosive grenades);
- Illumination, smoke, and CS grenades;
- Incendiary destroyers;
- Riot control agents with an unpacked weight of 45 kilograms or less;
- Explosive compounds of sensitive missiles and rockets (except warheads);
- Warheads for precision-guided munitions with an unpacked weight of more than 45 kilograms.

## 5. Protection modes – ingress/egress

### **Modes of operation**

An integrated real-time security system can be designed to operate in the following modes of operation:

- Ingress Prevention.  
Unauthorized persons (or weapons effects) are prevented from entering (or destroying) the denial zone containing the assets at risk.
- Egress Prevention.  
Unauthorized persons are prevented from exiting with the assets.

Depending upon the assets and the threat, one or both of the above security modes may be used. For example, security for arms, ammunition, and explosives-type assets may require ingress prevention to assure that an intruder never gains access to the weapons because of

potential engagement advantages against the guards offered by the weapons, or because of political embarrassment, or other considerations. On the other hand, egress prevention may be more appropriate for property assets when the objective is theft and not sabotage. In this case allowance can be made in the timeline calculations and design for intruder ingress and egress from the installation. When both of the above operating modes are combined into one integrated system, it can be considered to be in-depth security capability.

## 6. Integrated security systems

*The security elements associated with the installation to ensure the effectiveness of an integrated security system design are:*

- Barrier layout and construction to delay the intruder;
- Access control at points of entry to protect against covert entry threats;
- Intrusion detection sensors and alarms to detect an attack on or within the installation, and/or unauthorized insiders after hours;
- Closed Circuit Television (CCTV) to assess whether an alarm is actually a threat;
- Guards to respond to the location of a real threat.

All these elements are important. None of them can be eliminated or compromised if an effective security system is to be achieved but an optimal combination of them should be strived for. Also, without detection, the response force would not be alerted. In addition, the delay offered by the physical protection must provide sufficient time after detection for threat assessment and guard force response.

## 7. Intrusion Detection Systems (IDS)

### *Applicability*

Ammunition storehouses storing Categories I and II missiles and rockets, Category I and II explosives should be protected by an IDS unless the areas where they are located are continuously manned or under constant surveillance in such a manner that unauthorized entry into and around the structures can be detected.

### *IDS Suitability*

The detection of an intruder can be accomplished using on-site guards, IDS, or combinations of both. Locating guards in towers or deploying sensors along extended fence lines adds to the intruder's ingress/egress time to cover the distance from the fence to the stockpiles. This option involves operating costs for guards or, if sensors are used, initial purchase, installation, and maintenance costs. The cost effectiveness of using exterior detection along extended perimeters to gain added intruder ingress/egress time must be weighed against the cost of physical protection and installing IDS in a smaller area or on building(s). The time to penetrate or climb over a perimeter fence is often only a few seconds and that the ingress time for an intruder carrying cutting tools and covering a hundred metres between the fence and stockpile is less than a minute. Given the nominal amount of time gained relative to the expense involved, the use of guards or IDS on extended fence perimeter may not be mandatory unless specified by the appropriate national security and explosive safety regulators. For security guards to respond to an intrusion, threat detection either by security personnel or remote systems IDS is required. The function of an exterior perimeter IDS is to detect a threat and initiate the security system response timeline at the exterior perimeter of the site. IDS performance parameters of concern include:

- Completeness of coverage;

- False and nuisance alarm rates;
- Probability of detection;
- Zone at which the alarm occurred;
- Detection at the installation perimeter.

Guards or sensors may be located to ensure deployment before the physical protection is penetrated by intruders. For a barrier to be effective in delaying an intruder, detection must occur before penetration of the barrier has occurred. Surface sensor systems, such as vibration sensors, are usually more cost-effective than stationing guards.

### ***Contractual Service Agreements***

An IDS should be installed by reputable security suppliers with proven relevant experience. The contract should include a robust service agreement to ensure the continuous effectiveness of the system. Service/maintenance must be provided as required by the specifics for the installation.

### ***Interior IDS systems***

Amongst the many available IDSs the following are most common:

- Fence-mounted strain-sensitive cable on the fence fabric in combination with a „Y“ taut wire on the fence outriggers;
- Ported coaxial cable clear zone sensor;
- Microwave fence sensor.

### ***Closed circuit television (CCTV)***

A properly designed CCTV assessment system provides a rapid and cost-effective supplement to guards for determining the cause of intrusion alarms and assessing a potential threat. CCTV enables evaluations to be made from remote locations. Using video event recorders, events can also be viewed later when multiple alarms or delayed guard force attention occurs. In general, CCTVs

increase the efficiency and effectiveness of security personnel and security response timelines. They can be a cost-effective alternative to human on-the-spot assessment, which typically involves extended time delays for guards to respond, or the use of costly on-site guards.

### ***IDS Integrity***

To ensure the integrity, reliability and serviceability of IDS the responsible authority must ensure that:

- All IDSs must be approved by the responsible security authority;
- All alarm signals will enunciate at a central control or monitoring station from which a response force can be dispatched. The reaction time of the response force must allow action before the physical protection is penetrated;
- Where an IDS is installed in a installation outside a military installation, arrangements shall be made to connect to local police or commercial monitoring companies from which immediate response to activated alarms can be directed.

A daily log shall be maintained of all alarms received. Logs shall be maintained for a minimum of 90 days and shall be reviewed to identify and correct IDS reliability problems. The log shall reflect the following:

- Nature of the alarm (nuisance, system failure, illegal entry);
- Date, time, and location of alarm;
- Action taken in response to the alarm.

IDS transmission lines shall have line security electronically monitored to detect evidence of tampering or attempted compromise. Upon loss of either communication path, the system shall immediately initiate notification to the monitoring installation via the other communication link. Additionally, a protected backup independent power source of four-hour minimum dura-

tion shall be provided. Systems shall be tested quarterly to ensure the proper functioning of the alarm sensors.

## 8. Restricted area posting

An installation containing explosives shall be designated as a military „RESTRICTED AREA“ and be managed according to national requirements as applicable.

## 9. Explosive store house physical security

### **Security fences**

In general, security fences are made of either taut wire or standard chain link metal fabric with various enhancements. Fence enhancements include different configurations of barbed wire outriggers. In general, fences (both with and without enhancements) offer delays of less than 1 minute against low-level threats to as little as 3 to 8 seconds against trained and dedicated high-level intruder teams. The height of the fence or the degree of enhancements used makes little difference on this time. In general, fence material can be easily cut, or climbed over. This includes barbed wire which can easily be climbed over with the aid of blankets, etc. However, fences do offer some advantage in limiting the amount of tools and equipment that an intruder can readily carry into the site. In general the delay time offered is not a significant factor in selecting a fence. A simple fence without enhancements will be adequate in most cases to define the installation boundary, deter the casual intruder, or support an exterior IDS system. The use of fence enhancements offers the increased appearance of impregnability, but this should be weighted in terms of the increased material and maintenance costs.

## 10. Drainage culverts and utility openings under fences

Special protective measures must be designed for culverts, storm drains, sewers, air intakes, exhaust tunnels and utility openings that pass through cleared areas, traverse under or through security fences.

## 11. Security lighting

Security lighting aids threat detection, assessment, and interdiction. Lighting may also have value as a deterrent. Security lighting increases the effectiveness of guards and CCTV by increasing the visual range during periods of darkness or by illuminating an area where natural light is insufficient. Exterior security lighting is typically located along exterior perimeters and entry points to the installation. Each installation presents its particular deployment problems based on physical layout, terrain, weather conditions, and security requirements.

Lighting may operate continuously or on a standby basis. Continuous lighting is the most common security lighting system. It consists of a series of fixed luminaries arranged to flood a given area continuously during the hours of darkness with overlapping cones of light. The two primary methods of using continuous lighting are glare projection and controlled lighting:

- Glare lighting uses luminaries slightly inside a security perimeter and directed outward. It is considered a deterrent to a potential intruder because it makes it difficult for him to see inside the area being protected. It also facilitates for a guard inside the installation to observe intruders by keeping him in comparative darkness.
- Controlled lighting is used when it is necessary to limit the width of the lighted strip outside the perimeter because of adjoining property or nearby highways, railroads, navigable waters, airports and like facilities.



Switches for exterior lights shall be installed in such a manner that they are accessible only to authorized personnel.

## 12. Door locks and padlocks

Each explosives storehouse door should have either:

- A single mortise lock requiring two separate unique keys;
- Two mortise locks each requiring its own unique key;
- Two padlocks and hasps to the required national security standard each with its own unique key.

The padlock is commonly used as it is applicable on all door assemblies. Preferably the padlock body has an extension shielding over the shackle of at least 9,5 millimetres above the top and on three sides that will allow close onto the associated hasps the hasps. These padlocks and special hasps are highly resistant to forced and surreptitious entry and should meet the following resistance criteria:

- Defeat the use of devices, equipment and methods such as picking, shimmying, bypassing, impressioning, and other methods used by locksmiths to open padlocks without harm to the padlock or clearly visible evidence of attempts to open, for not less than 15 minutes.
- Defeat the use of saws and drills (manual or batter powered), hammers, chisels, punches, jimmies, wrecking bars, torque levers, common hand tools chemicals (excluding explosives) for not less than five minutes accumulated work time.

### **Key control**

The following control requirements are an imperative part of the overall security strategy:

- Keys to explosives storage areas, buildings, rooms, racks, containers, and IDS shall be maintained separately from other keys;

- They shall be accessible only to personnel whose official duties require access to them;
- A current roster of personnel authorized key access shall be maintained and kept from public view;
- The number of keys shall be held to the absolute minimum;
- Master keying of locks and the use of a master key system is prohibited for explosives exterior access doors;
- Keys shall not be left unsecured or unattended at any time;
- In the event of lost, stolen, or misplaced keys, the affected locks or lock cores shall be replaced immediately;
- When not attended or in use, operational keys to Category I and II explosives shall be secured in approved high security containers;
- Keys to Category III and IV explosives may be stored in secure containers with an approved built-in three position changeable combination lock;
- Reserve or replacement locks, cores, and keys shall also be secured as prescribed above;
- Keys shall not be removed from the explosives site except for operational necessity;
- Installation Commanders, or their designees, shall appoint in writing explosives lock and key custodians;
- Key custodians shall not be unit armourers or other persons responsible for the explosives storage facilities;
- Key control registers shall be maintained to reflect continuous key accountability;
- Key registers shall contain the following information:
  - Name and signature of individuals receiving keys;
  - Date and hour of issuance;
  - Key serial numbers or other identifying information;
  - Signature of individuals issuing keys;
  - Keys return date and hour;
  - Name and signature of individual receiving returned keys.

### **Key Rotation**

“In-use” keys should be rotated on a regular basis with reserve and replacement keys to ensure even wear and tear.

## 13. Security breaches

Documented and practiced procedures should be in place to undertake a suitable and timely response to incidents involving the loss or theft of ammunition, and any other breaches of security, which can be considered to result in an ammunition security threat. This process should include coordination with other police and national security organisations. Effective lines of communication should be in place to ensure that any incident can be immediately reported to the appropriate senior staff.

Any such incidents should be fully investigated to determine any failings in existing procedures and identify practicable and reasonable remediation. Whilst the specific mechanisms will be determined by internal national organisations and structures the reporting procedure should follow the following general process:

- Depot level investigation to verify the facts and subsequent Command level reporting;
- Command level assessment and coordination with other responsible authorities;
- If appropriate Ministerial response and action;
- Initial remediation response;
- Formal enquiry, report and implementation of recommendations;
- Continued related oversight.

# II. IMPLEMENTATION OF THE STOCKHOLDERS DUTY OF CARE

## 1. Introduction

The handling, maintenance, transport and storage of munition are an inherently hazardous and risky process. Whilst ammunition is designed and manufactured to be safe in storage and transport, the significant number of recent catastrophic ammunition storage accidents starkly confirms that these are not the result of “credible accidents”, but the result of stockpile management failings. Every holder of ammunition has a legal and moral duty of care to those it employs in the management of the ammunition and the general public that may be affected by an explosive event within the explosive area.

The correct compliance with agreed norms of ammunition stockpile management will ensure, as far as is

reasonable and practical, that adequate protection will be provided; the management of ammunition cannot, nor seeks to, provide absolute protection. Where these practices cannot all be implemented, participating States should implement those practices for which they have the capability, and work on implementing further practices with the aim of creating a comprehensive stockpile management program.

## 2. Scope

This best practice guide covers the various requirements for ammunition stockpile managers to follow. It is based on the requirement for above ground storage, although certain sections are relevant to all ammunition storage modes.

These requirements are designed to manage risks and hazards associated with the storage and handling of ammunition and explosives by providing protection criteria to minimize loss of life, serious injury and damage to property, both military and civilian. They are not intended to be so rigid as to prevent the Services from accomplishing their assigned missions.

The steps required to ensure the duty of care will afford a high degree stock protection.

This Guide covers the following general requirements:

- UN Classification of Dangerous Goods;
- Explosion Effects;
- Hazard and Risk Analysis;
- Hazard Mitigation;
- Explosives Quantity Distances;
- Safe Guarding of Explosive Sites;
- Waivers and Exemptions.

### 3. Definition

#### ***Aboveground Storage***

Storage in magazines with or without earth-cover or in open stacks at surface level. An accidental explosion at the storage site may result in blast, fire and projections.

#### ***Ammunition***<sup>2</sup>

General: An item which, in order to perform its function, requires to contain energetic materials.

Specific: A complete device charged with explosives, propellants, pyrotechnics, initiating compositions, or nuclear, biological or chemical material for use in military operations.

Note 1: In logistic configuration, the logistic packaging of the munition is included.

#### ***Assembly Place***

A building or place where it is customary for people to assemble (e.g. church, school, sports stadium).

#### ***Barricade***

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

#### ***Buried Storage***

Storage in chambers or magazines below surface level. In case of an accidental explosion at the storage site, the hazard of low-angle, high velocity projections is reduced significantly. The other hazardous effects are similar to those in aboveground storage, but are gradually reduced as the cover is increased.

#### ***Classification Code***

The alpha-numeric symbol which denotes the complete hazard classification for a particular type of ammunition. The code comprises two digits, indicating the hazard division, followed by a letter corresponding to the compatibility group.

#### ***Compatibility Classification***

Ammunition and explosives are considered to be compatible if they may be stored or carried together without significantly increasing either the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident.

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<sup>2</sup> The term „ammunition“ in its restricted meaning is used throughout this Manual in the same sense as „explosive article“ is used by UN and IMO in the Orange Book and IMDG Code respectively to mean an article containing one or more explosive substances.

### ***Debris***

Any portion of the natural ground or of a structure (rocks, structural materials, fittings, equipment, barricade materials etc.) which is propelled from the site of an explosion.

### ***Deflagration***

Chemical explosion in which the zone of chemical reaction propagates through the initial medium at a subsonic velocity, mainly by thermal conduction.

### ***Deflagrating Explosive***

A secondary explosive which reacts by deflagration rather than detonation when used in its intended role.

### ***Detonation***

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

### ***Detonating Explosive***

An explosive which reacts by detonation rather than deflagration when used in its intended role.

### ***Explosion***

A nuclear, chemical or physical process leading to the sudden release of energy.

### ***Explosive<sup>3</sup> Material***

A substance (or a mixture of substances), which is capable by chemical reaction of producing gas at such a temperature and pressure as to cause damage to the surroundings.

Note 1: The term explosive material includes solid and liquid high explosives, propellants and pyrotechnics.

Note 2: It also includes pyrotechnic substances even when they do not evolve gases.

Note 3: The term explosive is often used in short for explosive material.

### ***Explosives Area***

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

### ***Explosives Workshop***

Any structure used for the inspection, maintenance and renovation of ammunition and explosives.

### ***Exposed Site***

A magazine, cell, stack, truck or trailer loaded with ammunition, explosives workshop, inhabited building, assembly place or public traffic route, which is exposed to the effects of an explosion (or fire) at the Potential Explosion Site under consideration.

### ***Exterior Quantity-Distance***

The minimum permissible distance between a PES and an ES outside the explosives area.

### ***Fragment***

Any metal portion of the ammunition or its package which is propelled from the site of an explosion.

<sup>3</sup> The term „explosive“ is used throughout this Manual in the same sense as „explosive substance“ is used by UN and IMO in the Orange Book and IMDG Code.

### ***Hazard Classification or Classification***

The assignment of a type of ammunition to the correct hazard division, according to tests or other assessment, and the appropriate compatibility group. Thus there are two components in the complete classification.

### ***Heavy-Walled Building***

A building of non-combustible construction used for explosives storage with walls of at least 45 cm reinforced concrete (70 cm brick) or equivalent penetration resistance of other materials, with or without a protective roof. The door is barricaded if it faces a PES.

### ***High Velocity Projections***

Debris or fragments at high velocity as the result of an explosion and with sufficient remaining energy to propagate an explosion to another stack.

### ***Inhabited Building Distance***

The separation between potential explosive sites and non-associated exposed sites requiring a high degree of protection from an accidental explosion.

### ***Igloo***

A magazine - normally built at ground level - earth-covered, and constructed in corrugated steel or reinforced concrete, provided with a strong headwall and door(s). The earth covers the roof, the sides and the rear. The magazine and its earth-cover are designed to stringent criteria for resistance to external blast loading and attack by high velocity projections. The cross-section of the igloo may be semi-circular, elliptical, rectangular or a combination of these.

### ***Initiation***

Action by means of a suitable pyrotechnic device leading to a detonation, deflagration or combustion.

### ***Initiation system***

System to initiate an explosive train or component in a munition.

### ***Interior Quantity-Distance***

The minimum permissible distance between a PES and an ES inside the explosives area.

### ***Light Structure***

A structure erected to protect a stack against weather.

### ***Lobbed Ammunition***

Unexploded ammunition projected from an exploding stack. It may explode on impact.

### ***Mass Explosion***

An explosion which affects virtually the entire quantity of explosives under consideration practically instantaneously. The term usually relates to detonation but also applies to deflagration when the practical effects are similar, for example the mass deflagration of propellants under very strong confinement so as to produce a bursting effect and a serious hazard from debris.

### ***Mass Fire***

A deflagration of the entire quantity of explosives under consideration in circumstances that avoid a bursting effect and a serious hazard from debris. A typical mass fire occurs in a few seconds at most and produces extensive flame, intense radiant heat and minor projection effects.

### ***Means of Initiation***

Any device used to cause a detonation of an explosive.

### ***Moderate Fire***

A fire comparable with that involving an ordinary commercial warehouse which burns comparatively slowly

and with a moderate flame radius. Some items may be thrown out of such a fire for a short distance.

### ***Net Explosives Quantity***

The total explosives contents of an ammunition item.

### ***Potential Explosion Site***

The location of a quantity of explosives that will create a blast, fragment, thermal or debris hazard in the event of an accidental explosion of its content.

### ***Primary Explosive***

Substance, or mixture of substances, used to initiate a detonation or a burning reaction.

Note 1 : In their intended role, these materials are sensitive to a range of thermal, mechanical and electrical stimuli, like for instance heat, impact, friction, electricity, and undergo a rapid reaction upon initiation.

Note 2 : Primary explosives are used in initial or intermediary charges in devices such as primers, detonators, caps, relays, electric matches, etc.

### ***Projections***

Overarching term for debris, fragments, non-metallic portions of the ammunition or its package, and lobbed ammunition.

### ***Protective Roof***

A 15 cm reinforced concrete roof or its equivalent designed to protect the contents of a building from debris, fragments and lobbed ammunition. The roof should not collapse if the walls are damaged, except in the case of earth-covered structures.

### ***Public Traffic Route***

A road used for general public traffic; a railway outside the explosives area which is used for public passenger traffic; a waterway, such as a river having tidal water and a canal, used by passenger vessels.

### ***Pyrotechnic Composition***

Substance or mixture of substances which when ignited, undergoes an energetic chemical reaction at a controlled rate intended to produce on demand and in various combinations, specific time delays or quantities of heat, noise, smoke, light, or infrared radiation.

Note 1 : Pyrotechnic compositions may be used to initiate burning reactions such as in igniters.

Note 2 : Pyrotechnics, in most of their applications, are required not to undergo a deflagration-to-detonation transition.

Note 3 : The term excludes propellants and (high) explosives.

### ***Secondary Explosive***

A substance or mixture of substances which will detonate when initiated by a shock wave but which normally does not detonate when heated or ignited.

Note 1 : As opposed to primary explosive.

### ***Serious Structural Damage***

Damage that renders buildings uninhabitable and is not readily repairable. For example: serious weakening or displacement of foundation, supporting walls, interior supports, side walls, floors or ceiling structures, breaking numerous rafters or other important supporting members of roofs or floors.

### **Spall**

Material, especially small pieces of rock, detached from a surface by passage of a shock.

### **Static Pressure**

The pressure due to the increased mass and temperature of gases inside a structure aftershock effects from an explosion have ceased.

### **Vulnerable Buildings**

Large building constructed with external non loadbearing panels or with more than 50% of its wall area glazed.

Note : These buildings are sited at two times inhabited building distance because they are expected to be heavily damaged from an explosion at inhabited building distance (i.e.,  $22.2 Q^{1/3}$ ).

### **With a Propelling Charge**

The propelling charge is assembled to the projectile or packed with the projectile in the same package or palletized with the projectile on the same pallet.

## **4. UN Classification of Dangerous Goods**

### **UN Dangerous Goods Class 1**

In order to promote the safe transport of dangerous goods, an International System for Classification has been devised<sup>4</sup>.

The system consists of 9 classes of which Class 1 comprises ammunition and explosives. Class 1 is divided into divisions. The Hazard Division indicates the type of hazard to be expected primarily in the event of an accident involving a stack of ammunition. Class 1 ammunition is further divided into 14 Compatibility Groups designed

to minimise the risk of storing items together that will either increase the significantly increasing either the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident. Whilst initially produced for the transport of dangerous goods the principles have been applied by many nations as the basis for a simplified consequential hazard and risk assessment for the storage of ammunition. This process does not take into account the probability of an incident. It assumes that if it can happen it will, and when it does, it identifies the extent of the hazards. The associated UN Hazard Divisions and Compatibility Groups for ammunition definitions are at Annexes A and B respectively.

### **UN Hazard Divisions**

The UN Recommendations for the Transport of Dangerous Goods sub-divides dangerous goods into separate groups according to their Hazard Class. Explosive substances and articles are Hazard Class 1. The 6 HDs are fully defined at Annex A. The following is a simplified description for the purposes of this Section:

- Division 1.1. Ammunition that has a mass explosion hazard.
- Division 1.2. Ammunition that has a projection hazard but not a mass explosion hazard.
- Division 1.3. Ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.
- Division 1.4. Ammunition that presents no significant hazard.
- Division 1.5. Very insensitive substances which have a mass explosion hazard.
- Division 1.6. Extremely insensitive articles which do not have a mass explosion hazard.

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<sup>4</sup> The UN Recommendations on the Transport of Dangerous Goods (ISBN: 92-1-139057-5).

HDs can be mixed within the guidance provided in Annex A of the OSCE Best Practice Guides on Procedures for Management of Stockpiles of Conventional Ammunition. In general such combinations are aggregated and assessed as the worst case. A combination of HD 1.1 and HD 1.2 will be considered to be HD 1.1.

### UN Classification Code

The UN Classification Code is an integral part of ammunition management for both transport<sup>5</sup> and storage; for many OSCE participating States it is a mandatory package marking<sup>6</sup> requirement. The classification code is composed of the number of the Hazard Division and the letter of the Compatibility Group, for example “1.1 B”.



### Mixing of UN Compatibility Groups for Ammunition Storage

It must be noted that due to the differing risks associated with ammunition storage and transport many national competent authorities apply modified mixing rules for the storage of ammunition. The following table is based on storage mixing rules that have been adopted by many OSCE participating States:

### Effect of Package on Classification

As the packaging may have a decisive effect on the classification, particular care must be taken to ensure that the correct classification is determined for each configuration in which ammunition and explosives are stored or transported. Therefore, every significant change in the packaging (e.g. degradation) may well affect the classification awarded.

Compatibility Group	A	C	D	G	L	S
A	X					
C		X <sup>1)</sup>	X <sup>1)</sup>	X <sup>3)</sup>		X
D		X <sup>1)</sup>	X <sup>1)</sup>	X <sup>3)</sup>		X
G		X <sup>3)</sup>	X <sup>3)</sup>	X		X
L					X <sup>2)</sup>	

- 1) Mixing permitted provided substances have all passed UN Test Series 3.
- 2) Compatibility Group L substances must always be stored separately from all substances of other compatibility groups as well from all other substances of Compatibility Group L.
- 3) The mixing of Compatibility Group G substances with other compatibility groups is at the discretion of the National Competent Authority.

5 OSCE Best Practice Guide on the Transportation of Ammunition (FSC.DEL/554/85/Rev 2).

6 OSCE Best Practice Guide on Ammunition Package Markings and Record Keeping (FSC.DEL/73/07/Rev 1).

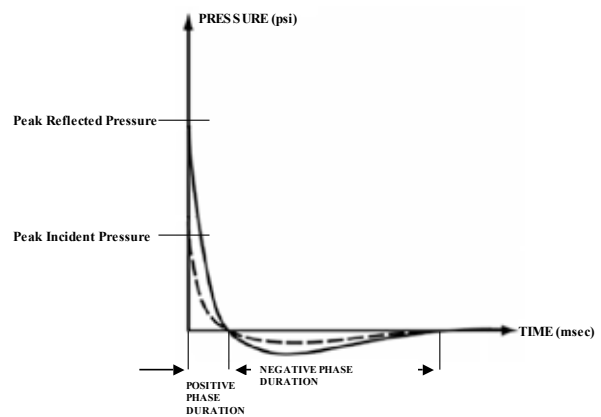


## 5. Explosion Effects

### *Hazard Division 1.1 Explosion Effects*

In an incident involving the mass detonation of explosives (HD 1.1), the violent release of energy creates a sudden and intense pressure disturbance termed the „blast wave“. The blast wave is characterized by an almost instantaneous rise from ambient pressure to a peak incident pressure. This pressure increase, or „shock front“, travels radially outward from the detonation point. Gas molecules making up the front move at lower velocities. This velocity, which is called the „particle velocity“, is associated with the „dynamic pressure“, or the pressure formed by the winds produced by the shock front. As the shock front expands into increasingly larger volumes of the medium the incident pressure decreases whilst the duration of the pressure-pulse increases. If the shock wave impinges on a rigid surface (e.g., a building) at an angle to the direction of the wave’s propagation, a reflected pressure is instantly developed on the surface and this pressure rises to a value that exceeds the incident pressure. This reflected pressure has the propensity to inflict considerable damage.

When an explosion occurs within a structure, the peak pressure associated with the initial shock front will both be high and amplified by reflections within the structure. In addition, the accumulation of gases from the explosion will exert additional pressure and increase the load duration within the structure. This effect may damage or destroy the structure unless the structure is designed to either withstand or vent the gas and shock pressures. Structures that have one or more strengthened walls may be vented for relief of excessive gas by either frangible construction of the remaining walls or roof or through the use of openings.



PRESSURE TIME CURVE

An important consideration in the analysis of the hazards associated with an explosion is the effect of any fragments produced. Depending on their origin, fragments are referred to as „primary“ or „secondary“ fragments. Primary fragments result from the shattering of the ammunition in direct contact with the explosive. These fragments usually are small, initially travel at thousands of metres per second and may be lethal at long distances from an explosion. Secondary fragments are debris from structures and other items in close proximity to the explosion. These fragments, which are somewhat larger in size than primary fragments and initially travel at hundreds of metres per second, do not normally travel as far as primary fragments.

### *Hazard Division 1.2 Explosion Effects*

In an incident involving ammunition that has a projection hazard but not a mass explosion hazard (HD 1.2) can be expected to both explode sporadically and burn. Fire will propagate through the mass of the ammunition over time. Some ammunition may neither explode nor burn. Blast effects from the incident are limited to the immediate vicinity and are not considered to be a significant hazard.

HD 1.2 events may occur over a prolonged period of time. Generally, the first reactions are relatively non-violent and, typically, begin a few minutes after flames engulf the ammunition. Later reactions tend to be more violent. Reactions can continue for some time, even after a fire is effectively out. Generally, smaller ammunition tends to react earlier in an incident than larger ammunition.

The primary hazard from a HD 1.2 event is fragmentation. Fragmentation may include primary fragments from ammunition casings or secondary fragments from containers and structures. At longer ranges, primary fragments are the major contributors to fragment hazards. During a HD 1.2 event, fragmentation may extensively damage exposed facilities. However, less fragmentation damage can be expected from a given quantity of HD 1.2 than would be expected from the corresponding quantity of HD 1.1 because not all the HD 1.2 will react.

#### ***Hazard Division 1.3 Explosive Effects***

In an incident involving ammunition that has a fire hazard and either a minor blast hazard or a minor projection hazard (HD 1.3) the heat flux presents the greatest hazard to personnel and assets. Internal gas pressures may produce fragments from the bursting of containers or the rupture of containment facilities. In general, such fragments will be large and of low velocity. These fragments are considerably less hazardous than those produced by HD 1.1 and HD 1.2 events.

#### ***Hazard Division 1.4 Explosive Effects***

As the products of this ammunition are contained within the package it does not present a significant hazard.

#### ***Hazard Division 1.5 and 1.6 Explosive Effects***

These two divisions comprise of very insensitive substances (HD 1.5) and extremely insensitive articles (HD 1.6) which will require special consideration if held within the inventory.

## **6. Hazard and Risk Analysis**

### ***Objectives***

Any explosives safety management system must care for risks associated with the activities. The storage of ammunition aims to provide a reasonable and practical level of protection; it does not guarantee absolute protection.

### ***Hazard and Risk Assessment***

In the event that the prescriptive ammunition storage regulations are unable to meet the required levels of stockpile and personnel safety the explosives safety authority may consider the application of a Risk and Explosive Safety Hazard assessment. This may require expert guidance from suitably qualified Hazard and Risk Assessors, or suitable publications. The following guidance outlines the processes and procedures.

### Hazard

A hazard can be defined as any real or potential condition that can cause mission degradation, injury, illness, death to personnel or damage to or loss equipment or property.

### Risk

An expression of the impact and possibility of a mishap in terms of severity and the likelihood of occurrence.

The relationship between the two can be shown by the following graphic:

HAZARD PROBABILITY					
	frequent	likley	occasional	seldom	unlikely
catastrophic	extremely high	extremely high	high	high	low
critical	extremely high	high	high	medium	low
moderate	high	medium	medium	low	low
negligible	low	low	low	low	low

■ extremely high  
■ high  
■ medium  
■ low

The combinations of probability and consequence in red in the picture, “extremely high”, must be dealt with first hand.

### Risk Analysis

Risk analysis is the application of quantitative or qualitative measures to determine the level of risk associated with a specific hazard. The process defines the probability and severity of a mishap that could result from the exposure of personnel or assets to that hazard. The associated steps are:

- Identify the hazards;
- Analyze risk control measures;
- Make control decisions;
- Implement risk controls;
- Implementation requires commitment of time and resources;
- Supervise and review.



## 7. Hazard Mitigation

### Definition

Explosive hazard mitigation can be defined as: “Any cost-effective action taken to eliminate or reduce the long-term risk to life and property from an explosive event”.

### Hazard Principles and Objectives

The effect of explosive hazards and the problems related to inter-magazine propagation can be mitigated by the construction of the explosive storehouse and associated barricades. It is the lack of effective hazard mitigation that invariably results in the catastrophic loss of ammunition facilities due to a single explosive event.

### Protective Construction

Construction features and location are important safety considerations in planning facilities. The effects of potential explosions may be significantly modified by construction features that limit the amount of explosives involved, attenuate blast overpressure or thermal radiation, and reduce the quantity and range of hazardous fragments and debris. The location of Exposed Sites (ES) in relation to Potential Explosion Sites (PES) also helps to minimize unacceptable damage and injuries in the event of an incident. The major objectives in installation planning are to:

- Protect against explosion propagation between adjacent bays or buildings.
- Protect personnel, within and outside the Explosives Area, against death or serious injury from incidents in adjacent bays or buildings.
- The construction of separate buildings to limit explosion propagation, rather than the use of either protective construction or separation of explosives within a single building should be considered when safety would be greatly enhanced.

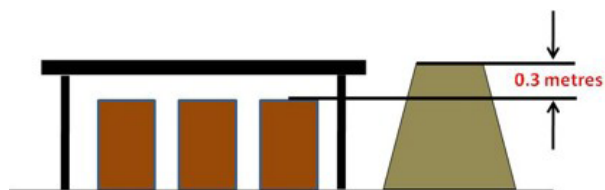
### Reduced Distances

Hardening an ES or constructing a PES to suppress explosion effects to provide an appropriate degree of protection, or the use of effective container traverses, may allow a reduction of the separation distances required by Quantity Distance (QD) tables.

### Barricades

Properly constructed and sited barricades and undisturbed natural earth have explosives safety applications for both protecting against low-angle fragments and reducing shock overpressure loads very near the barricade. Barricades provide no protection against high angle fragments or lobbed ammunition. If the traverse is destroyed in the process of providing protection, then secondary fragments from the destroyed barricade must also be considered as part of any hazards analysis.

To reduce hazards from high-velocity, low-angle fragments, the barricade must be placed between the PES and the ES so that the fragments of concern impact the barricade before the ES. The barricade must both be thick enough so that it reduces fragment velocities to acceptable levels and high enough to intercept high velocity, low trajectory fragments. The recommended norm is 0.3 metres.



EXPLOSIVES QUANTITY DISTANCES.

### ***Application of Quantity Distance Criteria***

To ensure that an explosive event within an ammunition storage location does not result in the propagation of other locations, potentially resulting in a catastrophic event, and at the same time ensure reasonable protection to facilities outside the explosives area, ammunition locations are suitably separated from each other and external at-risk facilities. The resulting separation distances, referred to as Quantity Distances (QD) are based on a matrix of the following criteria:

- The associated United Nations (UN) Hazard Division (HD).
- The net explosive quantity of the storage location.
- The building design and construction.
- The aspect of the building relative to other storage locations.

Quantity-distances are generated by distance functions subject, in certain cases, to fixed minimum or maximum distances.

### ***Degree of Protection***

There are varying levels of inter-magazine protection based on the QD separation. They are:

- Virtually complete protection against instantaneous propagation.
- High degree of protection against instantaneous propagation.
- Moderate degree of protection against instantaneous propagation.

### ***Application of Storage Criteria***

The application of storage principles, as accepted by many OSCE participating States, will provide the following levels of personal protection at the Inhabited Building distance:

- The peak incident (side-on) overpressure will not exceed 5 kPa; the accepted threshold level of pressure

for ear damage is 35 kPa.

- Un-strengthened buildings will suffer minor damage, particularly to parts such as windows, door frames and chimneys. In general, damage is unlikely to exceed approximately 5% of the replacement cost but some buildings may suffer serious damage. The debris will not exceed one lethal fragment (energy > 80 J) per 56 m<sup>2</sup> at the Inhabited Building Distance. They are not sufficiently large enough to prevent breakage of glass and other frangible materials.
- Injuries and fatalities are very unlikely as a direct result of the blast effects. Injuries that do occur will be caused principally by glass breakage and flying/falling debris.

### ***UN Hazard Divisions***

See Section IV and Annex A.

### ***Net Explosive Quantity***

The Net Explosives Quantity (NEQ) is the total explosives contents of ammunition unless it has been determined that the effective quantity is significantly different from the actual quantity. It does not include such substances as white phosphorus, war gases or smoke and incendiary compositions unless these substances contribute significantly to the dominant hazard of the hazard division concerned.

### ***Building Design and Construction***

The effects of an event within an ESH for any HD, and the resulting damage to other ESHs, can be mitigated by design features (Section. VII - Hazard Mitigation).

### ***Scaled Distances***

The propagation relationship between a Potential Explosion Site (PES) and the Exposed Site (ES) can be expressed as a mathematical relationship between the NEQ and a derived function (f). This relationship is

based on known blast wave and fragmentation throw data. The blast overpressure effects at a given scaled distance can be predicted with a high degree of confidence. For example the inhabited distance is derived using the formula  $D=22.2Q^{1/3}$ . Thus the distance at which the blast over pressure will be 5 kPa the Inhabited Building Distance, (IBD) is  $D = 22.2 \times 1.000^{1/3} = 222$  metres.

The following scaled distances are generally accepted to predict HD 1.1 effects for any given NEQ:

Scaled Distance (Q in kg, distance in m)	Peak Incident (Side-on) Overpressure Expected (kPa)	Exposed Site
44.4 $Q^{1/3}$ to 33.3 $Q^{1/3}$	2 to 3	Vulnerable Building distance
22.2 $Q^{1/3}$	5	Inhabited Building Distance
14.8 $Q^{1/3}$	9	Inter-magazine Distance
9.6 $Q^{1/3}$	16	Inter-magazine Distance
8.0 $Q^{1/3}$	21	Ammunition Process Building Distance <sup>7</sup> (APB)
7.2 $Q^{1/3}$	24	Inter-magazine Distance
3.6 $Q^{1/3}$	70	Inter-magazine Distance
2.4 $Q^{1/3}$	180	Inter-magazine Distance

This methodology is well developed and the effects of blast may be treated deterministically, however, the techniques for determining the hazards from projections are considerably less developed and the effects require a probabilistic approach.

The following scaled distances are generally accepted to predict the distance at which HD 1.2 effects are acceptable for any given NEQ to meet a required degree of protection:

- $D1 = 0.53 Q^{0.18}$  (high degree of protection).
- $D2 = 0.68 Q^{0.18}$  (limited degree of protection).

HD 1.3 utilises a fixed separation distance of 2 metres between protected buildings and scaled distances for inhabited buildings and public traffic routes.

### Structural Relationship between ES and PES

The construction of an ammunition store may result in relatively weaker sections, for example the access end of an earth covered bunker and therefore not provide the same degree of all-round containment and protection. Such buildings with the doors facing each other will require a larger QD than a back to front configuration. The following is an example of separation distances for standard earth covered bunker where the roof and face wall are not designed to withstand the same side-on and rear over pressure.

PES (Potential Exposed Site)			
ES (Exposed Site)			
	30 metres	30 metres	30 metres
	30 metres	30 metres	67 metres
	30 metres	30 metres	180 metres

REQUIRED QUANTITY DISTANCES FOR 50.000 KILOGRAMS OF HD 1.1 AMMUNITION

<sup>7</sup> APBs are used for the inspection and repair of ammunition. They are therefore continuously manned and are required to provide increased protection to the process workers. They also represent a greater PES risk.

### ***Explosives Storehouse Licence***

In order to provide documentary evidence that an explosive hazard assessment of explosives in an explosive storehouse has been undertaken, an Explosive Limit Licence (ELL) is prepared and approved by the appropriate explosive licensing authority. An example of a licence for an earth covered 700 kPa Igloo<sup>8</sup> containing 10.000 kilograms of HD 1.1 ammunition, based on the factors outlined above, is at Annex C. It is a visual matrix of the explosives NEQ, the associated HDs, the structural relationships between PES and ES and the associated scaled functions.

The required data can either be derived from known scaled distance functions or by the use of available tables based on the functions.

A licence should be prepared for each explosives storehouse and ammunition process building in an explosive site. This process will require appropriately trained practitioners; this guide does not provide sufficient information to effectively complete an ELL. Further advice can be sought from the OSCE or other member nations who have the required expertise.

## **8. Safe Guarding of Explosive Sites**

### ***The Yellow Line***

Any effective explosive licensing methodology will determine the Outside Quantity Distances (OQD) between the explosives storehouses and the limit of the explosive hazard. The OQD defines the distance at which the public and inhabited buildings are ensured reasonable protection from an explosive event within the explosive site. The OQD may extend beyond the secure explosives area. The demarcation between the hazard zone and the safe zone is commonly known as the Yellow Line<sup>9</sup>.

If unrestricted development is subsequently permitted within the Yellow Line the explosives capacity of the area may be seriously prejudiced or any development unduly hazarded.

It is therefore necessary to have a consultative procedure agreed by central and local government, preferably enforceable by law, whereby all development within the OQD of an explosive area, known as the safeguard area, are referred through the local planning authority and the appropriate Central Government Ministries for consideration.

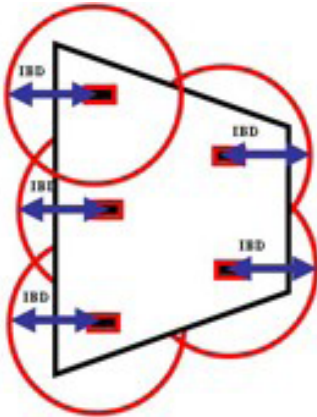
### ***Preparing the Yellow Line***

The following example is base on an explosive site with 5 ESHs.

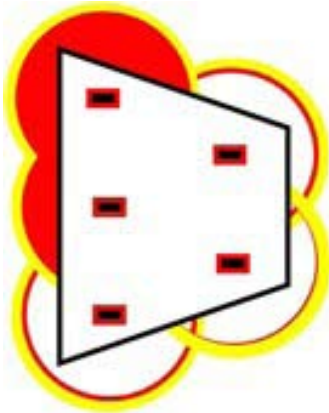
---

8 An earth covered building with at least 0,6 m depth of earth cover. The head-walls and the doors (single sliding door) are designed to resist an external blast loading of 7 bar and an impulse of 14 kPas.

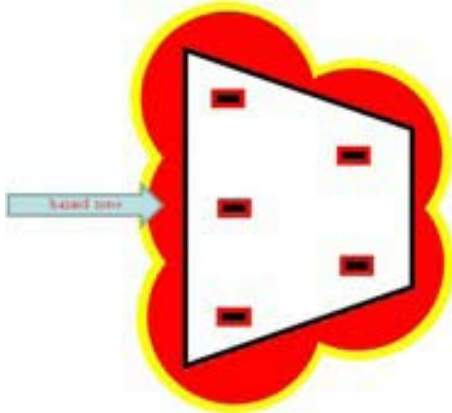
9 The Yellow Line takes its name from the common practice of marking the separation zone with a yellow marker on associated plans and maps.



A circle radius the IBD is drawn around each ESH IBD



A yellow line is drawn on all external arcs of the circles



The red area inside the yellow line defines the hazardous area and the yellow line the limit of the risk to the public.

### **Existing Explosive Sites**

The Yellow Line will identify the hazard area for the PESs within the explosives site and delineate the consolidated Inhabited Building Distances. Any encroachment within the Yellow line will require either:

- The remediation of the hazard.
- The reduction of explosives held in the offending explosive stores.
- The improvement of the store houses to remediate the hazard.
- The issuance of a Waiver or Exemption.

### **New Developments**

New developments will need to be planned within the limitations of the Yellow line.

### **Purple Line**

The Purple Line is a continuous line encircling the explosives area delineating a distance twice the IBD to buildings of vulnerable construction<sup>10</sup>.

## **9. Waivers and Exemption**

### **Compelling Justification**

Ammunition and explosives safety standards are designed to protect against serious injury, loss of life, and damage to property, but are not intended to be so rigid as to prevent the Services from accomplishing its assigned mission. When deviating from the accepted national ammunition storage regulations there must be compelling strategic or operational reasons to justify the added risk to personnel and property. Formal approval of any deviation is the issue of an authorized waiver or exemption. It must acknowledge and accept the added risk to personnel or property.

<sup>10</sup> Buildings that are of curtain wall construction with four storeys or more, of largely glass construction or employs non load-bearing cladding panels. For a fuller explanation see Section III. Definitions.



### **Waiver**

A waiver is written authority that permits temporary deviation from accepted national ammunition storage regulations for strategic or other compelling reasons. Waivers are generally granted for a short period of time pending the remediation of the cause of the waiver requirement. Waivers should:

- Only be granted for periods not exceeding 5 years. Exceptional situations may require time for completing corrective action or actions that exceed 5 years, in which case the waived conditions must be reviewed and approved by the next higher approval authority.
- Only be granted by officials assigned responsibilities consistent with the level of risk identified, the authority to control the resources required to accomplish corrective actions, and the type of deviation.
- Be reviewed at least annually for relevancy and applicability of control measures.

### **Exemptions**

An exemption is written authority that permits long-term non-compliance with these standards for strategic or other compelling reasons. Exemptions require statutory approval. Exemptions should be reviewed for applicability at intervals not to exceed 5 years. Exemptions must meet all the following conditions:

- Be required by a strategic or compelling need.
- Required for a long-term (exceeding 5 years) or permanent departure from the accepted National ammunition storage regulations.

### **Risk Analysis**

Any exemption request should be supported by a Hazard Risk Analysis.

References:

On safety principles for the storage of ammunition  
NATO AASTP-1.

On Risk Analysis NATO AASTP-4.

## **10. Fire Prevention and Firefighting**

### **Fire prevention**

The spread of fire is the most common cause of catastrophic ammunition events. The following outline requirements are included to provide guidance on the preparation of specific fire fighting response.

- Responsible fire officer  
The installation Commanding Officer will nominate a suitably trained member of the installation staff as the responsible Depot Fire Officer.
- Fire orders.  
Fire orders are to be published in accordance with national MOD regulations.
- Fires and naked lights.  
Ideally, the use of fires and naked lights within an explosives area should be completely prohibited; however such an absolute ban is not practical. Fire and naked lights may be authorized subject to the conditions laid down in the following paragraphs.
- Hot water heating.  
Boiler houses are to be located outside any building used for the storage, processing or handling of ammunition. The use of open fires, including slow combustion stoves, for heating or cooking anywhere in the explosives area is totally prohibited. When practicable, fires in boiler houses are to be extinguished before close of work each day. When this is not possible, arrangements are to be made for a competent boiler attendant to visit the boiler house during silent hours.
- Chimneys.  
Installation chimneys, within and without the explosives area, are to be cleaned on a regular basis. Those which could be a potential hazard are to be fitted with spark arresters.
- Incinerators.  
Domestic incinerators for the disposal of non-salvageable material, rubbish, classified waste paper etc

are to be sited outside the explosives area. Incinerators for the disposal of explosive items and waste will be constructed and operated in accordance with the national MOD rules.

- Smoking.  
Smoking is to be strictly prohibited within the explosives area except in places and at the times specially authorized by the Commanding Officer in consultation with the depot fire officer. Control measures are to be laid down in depot standing orders.
- Conveyance of controlled articles.  
All smoking materials and means of producing a flame are regarded as controlled articles. Where smoking areas or fires are authorized, special arrangements are to be made for the conveyance of the required articles through the explosives area. Lockable containers are to be used for the conveyance and the keys are to be held by a responsible person.
- Dangerous articles and spontaneously combustible materials.  
The introduction into an explosives area of any article, which is likely to increase the risk of an explosion or fire, is to be strictly controlled. Bulk stocks of oils, paints and solvents are not to be stored within the explosives area. Quantities of oils, paints and solvents sufficient and essential for the normal day to day maintenance of ammunition, not exceeding a five day supply, may be held in a non-combustible store. Each item is to be held in a secure metal container. Only limited quantities sufficient for one day use are to be taken into buildings containing ammunition or explosives. All oils, paints and solvents are to be removed before close of work each day and returned to the store. Articles liable to spontaneous combustion, such as oily rags, are only to be taken into buildings when required for immediate use. They are to be removed from buildings containing ammunition and held in closed metal or other non-combustible containers every time the building is vacated and

disposed of daily in a designated place outside the explosives area.

- Temporary use of flame producing equipment.  
All flame and spark producing equipment, fires and naked lights required to be used in the explosives area on a temporary basis by depot personnel or contractors are to be considered as prohibited articles and controlled in accordance with national regulations.
- Grass and undergrowth.  
All undergrowth and flammable vegetation is to be cleared or kept short for at least 15 m around open stacks and buildings containing ammunition. This does not apply to ground ivy or similar vegetation used to bind traverses, although excessive growth should be cleared as necessary.
- Cut vegetation.  
Cut vegetation is to be removed immediately and stacked beyond a distance of 50 m from any building containing ammunition. It is to be removed from the explosives area for burning, but where this is impracticable burning within the explosives area may be permitted provided that:
  - o Burning is carried out in the open at a safe distance from any building on a site approved by the Commanding Officer on the advice of the Depot Fire Officer.
  - o The fire is kept under close supervision and attended by trained fire-fighting personnel with adequate equipment and supply of water ready for immediate use to prevent any spread of fire.
  - o The fire is extinguished and thoroughly wetted at least one hour before close of work and at least one hour before sunset.
- Refuelling of grass cutting equipment.  
Petrol driven grass cutters, strimmers and similar vegetation control machinery may be used within an explosives area. Refuelling may be carried out within the explosives area. However the refuelling point must be 25 m from any explosives and fire extin-

guishers are to be readily available.

- Use of weed killers.

Only chlorate-free approved weed killers are to be used in explosives areas and in fire breaks established at the explosives area perimeter.

- Fire breaks.

Fire breaks are to be maintained in the explosives area and at the perimeter of the areas as advised by the local fire adviser. The following minimum widths of fire breaks are to be observed in areas which are heavily wooded with coniferous trees:

- o Perimeter. 30 m.
- o Internal Roads. 5 m clearance either side.
- o Internal Sections. 30 to 50 m clearance.

- Fire extinguishers on vehicles.

No mechanically propelled vehicle is to be allowed to enter the explosives area unless it is equipped with a fire extinguisher of a suitable size and type to extinguish any fire originating in a vehicle when not containing explosives. Types and sizes of extinguishers are to be approved by the Depot Fire Officer.

### **FIRE-FIGHTING MEASURES**

Effective fire-fighting is achieved by a combination of the following:

- First aid fire-fighting.
- Additional fire-fighting measures.
- Liaison with civil authorities.
- Speed.

#### **Speed**

Speed is the essence of successful first aid fire-fighting. Attack the fire before it can develop. When persons are present at the actual outbreak of a fire, provided that the outbreak is not already overwhelming, much can be done by immediately dousing the fire with large quantities of water, except where this is specifically forbidden. Where practicable the burning object should be removed or isolated by the removal of other inflammable objects nearby.

### **Fire Divisions**

The fire divisions are synonymous with the storage and transport Hazard Divisions 1.1 through 1.4 for ammunition and explosives. They are serially numbered by Arabic figures from 1 to 4. The four fire divisions correspond to the UN and NATO hazard divisions as follows:

Fire Division	Hazard Division
1	1.1
2	1.2
3	1.3
4	1.4

Fire Division 1 indicates the greatest hazard. The hazard decreases with ascending fire division numbers as follows:

Fire Division	Hazard involved
1	Mass explosion
2	Successive explosions with projections
3	Mass fire, or fire with minor blast or projections
4	No significant hazard

For details of hazards, see Annex A.

The four fire divisions have been assigned distinctive symbols for easy recognition by fire-fighting personnel approaching the scene of fire.



Fire Division 1



Fire Division 2



Fire Division 3



Fire Division 4

### **Training**

A proportion of the depot personnel are to be trained in fire-fighting duties. All personnel working within the explosives area are to be instructed in first aid fire-fighting. All personnel employed on ammunition duties are to be trained in the action to be taken with the different divisions and to be able to judge whether or not the fire can be controlled. The following general requirements apply to all fire divisions:

- **Hand Held Fire Extinguishers**  
 In the outbreak of fire, the prompt application of fire-fighting first aid measures to prevent the development of a serious fire. This will normally be affected by the use of hand held fire extinguishers.
- **Fire Alarm**  
 The fire alarm is to be sounded immediately and the appropriate first aid measures vigorously applied. All non-essential personnel are to be evacuated to a safe predetermined position.
- **Prevent Spread**  
 When ammunition is not involved, action should be directed to preventing the extension of the fire to adjacent buildings containing ammunition or other inflammable material.
- **Substantial Cover**  
 The fire-fighting of ammunition should be fought from behind substantial cover.
- **Water supply**  
 Provision is to be made for adequate water supplies to be available throughout the explosives area. The number, size and siting of the static water tanks and the number of hydrants and volume of water to be provided will be advised by the appropriate Defence Fire Service.
- **Water supply maps**  
 Water Supply Maps showing details are to be maintained in each depot.
- **Fire alarm system**

An efficient fire alarm system including adequate telephonic communication is to be maintained. Telephone test calls are to be made frequently. At least one test call in three should be made outside normal working hours.

## 11. Environmental Impact on Ammunition

### **General Requirements**

Ammunition may deteriorate or become damaged unless it is correctly stored, handled and transported, with the resultant effect that it may fail to function as designed and may become dangerous in storage, handling, transport and use. The factors which cause deterioration or damage are:

- Damp.
- Heat.
- Careless and rough handling.

Good storage, handling and the use of ammunition requires that the above factors are kept constantly in mind. It is essential that ammunition be:

- Kept dry and well ventilated.
- Kept as cool as possible and free from excessive or frequent changes of temperature.
- Protected from the direct rays of the sun.
- Handled with care.

### **Protection from Moisture**

Rain, snow and damp quickly cause irremediable damage to ammunition. Exceptional efforts are often necessary to ensure dry conditions during storage and in transportation. Providing an ammunition store is given adequate protection against the access of moisture, good ventilation of the ammunition will not only keep it cool but prevent condensation in and around the containers and the ammunition therein. The effects of moisture on various types of ammunition and associated materials are as follows:

- Unboxed ammunition

The most harmful effect is corrosion. In the early stages basic cover and stencil markings (essential for identification) are obliterated. Later, pitting of the ammunition may occur to such an extent as to make it unserviceable.

- Steel containers

Steel containers not only lose their basic colour and markings, but eventually become perforated with rapid deterioration of the contents following. Substances particularly subject to decay under damp conditions in steel containers are components made from certain alloys and paper cylinders.

- Explosive compositions

Some substances used in explosive compositions attract and hold moisture with the consequent falling off or even total loss of the explosive properties. They can also become unserviceable and sometimes dangerous after short periods in damp conditions.

- Non-explosive materials

The decay of soft woods through moisture is not a common source of trouble with ammunition containers. However, fabrics, felt and paper materials, by absorbing moisture, create conditions favourable to corrosion and decay in other materials in the same container.

All sites are inspected periodically to ascertain if the conditions of storage are having a deleterious effect on the contents. These inspections are to be carried out at least once every four months and at the times when the storage conditions are likely to be most adverse, for example, at times of excessive damp or heat. Dampness on surfaces within buildings is generally due to one or both of the following causes:

- Condensation of moisture on the comparatively cold surfaces of walls, ammunition and ammunition containers from the warm, damp air admitted, when

buildings are opened.

- Free moisture may penetrate inadequately drained or badly constructed roofs, or walls having unsatisfactory damp courses. Ground moisture may penetrate walls which abut on to native rock/soil or earth traverses.

### ***Temperature Considerations***

Extremes of temperature may affect the performance of solid propellants such as rocket motors. They also can cause rapid deterioration in explosives, whether the explosives are the fillings of rounds and components or are held in bulk. Very low temperatures are not as objectionable as high ones, but it must be borne in mind that explosives containing Nitroglycerine can become dangerous at very low temperatures.

### ***Careless Handling***

Careless or rough handling may not only cause visual damage to ammunition but can also affect the internal mechanisms of components which cannot be detected. Such damage may render the ammunition unserviceable or unsafe to use. Ammunition containers are specifically designed to protect ammunition during storage and transportation. Damage to a container through careless handling may directly affect the contents. It may also reduce the effectiveness of the protection provided to the contents which could consequently deteriorate. Identification markings may also become obliterated or difficult to decipher.

## **12. Ammunition Surveillance**

### ***Methods***

Ammunition surveillance can be carried out in any of the following ways:

- In-Service Proof.
- Component Proof.
- Surveillance of Ammunition Performance at Training (SOAPAT).

- Performance Failure, Accident and Defect Reporting (PAD).
- Inspection.
- Repair.

### **Inspection**

An Inspection is a type of surveillance which involves the physical examination of the ammunition and or its container in order to assess its condition. Types of inspection tasks may include:

- Initial Acceptance.
- Preparation of ammunition for ISP.
- Pre-issue, including fractioning.
- Ex-unit Inspection, Returned Ammunition Group (RAG).
- Special Inspection, e.g. confirmation of condition or quantity.

### **Repair**

Repair is defined as the maintenance or modification of ammunition in order to maintain or improve its condition. Types of repair tasks include:

- Modification of ammunition.
- Maintenance of ammunition.
- Special, e.g. de-fuze or re-fuze.

### **Ammunition Defects**

During inspection or repair, ammunition may be found, which is defective in some way. All defects will fall into one of the following categories:

- Critical  
Defects affecting safety in storage, handling, transportation or use.
- Major  
Defects that affect the performance of the ammunition and that require remedial action to be taken.

- Minor  
Defects that do not affect the safety or performance of the ammunition, but are of such a nature that the ammunition should not be issued prior to remedial action having been taken.
- Insignificant  
Any defect that does not fall into any of these categories, but which could conceivably deteriorate into one of them if no remedial action is taken.
- Technical  
Any defect that requires further technical investigation.

### **Ammunition Conditions**

Based on the identified serviceability of the ammunition is given an Ammunition Condition. The Ammunition Condition is used to define the degree of serviceability of the ammunition and the degree of any constraints imposed.

In general these conditions designate the ammunition as:

- Serviceable stocks available for use.
- Stocks banned from use pending technical investigation.
- Stocks in suspension pending technical inspection, repair, modification or test.
- Stocks for disposal.

# Annex A

## UN Hazard Divisions

These HDs are used commonly for the process for determining safe separation distances (Quantity Distances) between storage locations and other facilities outside the explosive perimeter. The 6 UN Hazard Divisions are:

### Hazard Division 1.1:

There is a mass explosion hazard; a mass explosion is one which affects the entire load virtually instantaneously.

The major hazards of this division are blast, high velocity projections and other projections of relatively low velocity. The explosion results in severe structural damage, the severity and range being determined by the amount of high explosives involved. There may be a risk from heavy debris propelled from the structure in which the explosion occurs or from the crater.

### Hazard Division 1.2:

Substances and articles which have a projection hazard but not a mass explosion hazard.<sup>11</sup>

The explosion results in items burning and exploding progressively, a few at a time. Furthermore fragments, firebrands and unexploded items may be projected in considerable numbers; some of these may explode on impact and cause fires or explosions. Blast effects are limited to the immediate vicinity.

For the purpose of determining quantity-distances a distinction, depending on the size and range of fragments, is made between those items which give small fragments of moderate range (for instance, projectiles and cartridges from 20 to 60 mm) and those which give large fragments with a considerable range (for instance projectiles and cartridges exceeding 60 mm, rockets and rocket motors in a propulsive state which do not have a mass explosion hazard).

### Hazard Division 1.3:

Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard<sup>12</sup>.

This division comprises substances and articles:

- which give rise to considerable radiant heat;
- which burn one after another, producing minor blast or projection effects or both.

This division includes some items which burn with great violence and intense heat emitting considerable thermal radiation (mass fire hazard) and others which burn sporadically. Items in this division may explode but do not usually form dangerous fragments. Firebrands and burning containers may be projected.

### Hazard Division 1.4:

This division includes items which have primarily a moderate fire hazard. They do not contribute exces-

---

11 In order to differentiate between the two associated hazards some nations apply the following sub-divisions that are not part of the UN system:

HD 1.21 - the more hazardous part of Hazard Division 1.2

HD 1.22 - the less hazardous part of Hazard Division 1.2

12 In order to differentiate between the two associated hazards some nations apply the following sub-divisions that are not part of the UN system:

HD 1.33 - propellants

HD 1.34 - other than propellants

sively to a fire. The effects are largely confined to the package. No fragments of appreciable size or range are to be expected. An external fire does not cause the simultaneous explosion of the total contents of a package of such items.

Some but not all of the above items are assigned to Compatibility Group S. These items are so packed or designed that any explosive effect during storage and transportation is confined within the package unless the package has been degraded by fire.

### Hazard Division 1.5:

Very insensitive substances which have a mass explosion hazard.

This division comprises substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions.

The probability of transition from burning to detonation is greater when large bulk quantities are transported or stored.

For storage purposes, such substances are treated as Hazard Division 1.1 since, if an explosion should occur, the hazard is the same as for items formally assigned to Hazard Division 1.1 (i.e. blast).

### Hazard Division 1.6:

Extremely insensitive articles without a mass explosion hazard.

This division comprises articles which contain only extremely insensitive detonating substances and which demonstrate a negligible probability of accidental initiation or propagation.

The risk from articles of Hazard Division 1.6 is limited to the explosion of a single article.

## Annex B

### Compatibility Groups

The 14 UN Compatibility Groups are:<sup>13</sup>

#### Group A

Primary explosive substance.

#### Group B

Article containing a primary explosive substance and not containing two or more effective protective features.

#### Group C

Propellant explosive substance.

#### Group D

Secondary detonating article containing a secondary detonating explosive substance without means of initiation and without a propelling charge.

<sup>13</sup> The CG definitions have been simplified. The full definitions can be found in the UN Orange Book.



## Group E

Article containing a secondary detonating explosive substance without means of initiation, with propelling charge.

## Group F

Article containing a secondary detonating explosive substance with its own means of initiation, with a propelling charge.

## Group G

Pyrotechnic substance, or article containing a pyrotechnic substance, or article.

## Group H

Article containing both explosive substance and white phosphorus.

## Group J

Article containing both an explosive substance and a flammable liquid or gel.

## Group K

Article containing both an explosive substance and a toxic chemical agent.

## Group L

An explosive substance or item containing an explosive substance and presenting a special risk (e.g. due to water-activation or presence of hypergolic liquids, phosphides or a pyrophoric substance) requiring isolation of each type.

## Group N

Articles which contain only extremely insensitive detonating substances.

## Group S

Substances or articles so packed or designed that any hazardous effects arising from accidental functioning are confined within the package.

# Annex C

## EXPLOSIVE LIMIT LICENCE

The following is an example of an Explosive Limit Licence between a 7-bar earth covered ESH (the PES) and 2 Exposed Sites; a second 7-bar earth covered ESH and an Inhabited Building (the ES). The separation distance

between the ESHs is <11 metres and 480 metres to the Inhabited Building. Based on the appropriated QD tables the fixed separation distance will allow an NEQ of up to 10.000 kilograms of HD 1.1 and unlimited NEQs for HDs 1.2, 1.3 and 1.4.

EXPLOSIVE LIMIT LICENCE													
Site		Munitions Disposal Facility		For use as									EXPLOSIVE STORE
Construction details - EARTH COVERED IGLOO WITH FRONT FACING EFFECTIVE TRAVERSE													
Location													
	>11	>11										480	
												480	
assessed net explosive quantities (units of 100 kilograms)													
HD 1.1	10000											10000	
	D2											D13	
HD 1.21	unlimited												
	D2												
HD 1.22	unlimited												
	D2												
HD 1.33	unlimited												
	D2												
HD 1.34	unlimited												
	D2												
maximum permitted NEQ (kilograms) permitted by quantity distance													
HD 1.1	10000	or	HD 1.21	unlimited	or	HD 1.33	unlimited	or	HD 1.34	unlimited	any combination of HDs not exceeding one of these quantities when mixed in accordance with National regulations		
			HD 1.22	unlimited		HD 1.34	unlimited						
Licencing Authority													

# Annex D

## QUANTITY DISTANCE TABLE FOR HD 1.1 AMMUNITION

The following tables are provided as an example of the methodology used by NATO to determine storage quantity distances. The various HD 1.1, 1.2 and 1.3 reflect the differing hazards and protective requirements. HD 1.4 ammunition has fixed separation distances.

Each HD table comprises of 2 parts. The first provides a matrix in which each cell represents a combination of a PES and an ES and refers to one or more D-distances or constant values of distance. The second provides col-

umns of tabulated values of D-distances generated from the distance function shown at the foot of each column, subject to any overriding minimum or maximum fixed distances. Where a cell in the matrix shows more than one option the selection is made on the basis of special conditions and the desired level of protection.

It must be emphasised that the application of these tables should only be undertaken by a suitably trained practitioner. They are provided to enable ammunition stockholders to undertake an initial hazard assessment.

TABLE 1		Q-D TABLE FOR HAZARD DIVISION 1.1					
PES	ES	(a)	(b)	(c)	(d)	(e)	(f)
	1	D3 <sup>9E</sup>	D3 <sup>9E</sup>	D5 <sup>a</sup>	D5 <sup>a</sup>	D5 <sup>a</sup>	D4 <sup>9E</sup>
	2	D3 <sup>9E</sup>	D3 <sup>9E</sup>	D5 <sup>b</sup>	D5 <sup>b</sup>	D5 <sup>b</sup>	D4 <sup>9E</sup>
	3	D4 <sup>9E</sup> or D5 <sup>9E</sup>	D4 <sup>9E</sup> or D5 <sup>9E</sup>	D6 <sup>9E</sup>	D6 <sup>9E</sup>	D6 <sup>9E</sup>	D4 <sup>9E</sup> or D6 <sup>9E</sup>
	4	D3 <sup>9E</sup>	D3 <sup>9E</sup>	D5 <sup>b</sup>	D5 <sup>b</sup>	D5 <sup>b</sup>	D5 <sup>9E</sup>
	5	D3 <sup>9E</sup>	D3 <sup>9E</sup>	D6 <sup>b</sup>	D6 <sup>b</sup>	D6 <sup>b</sup>	D5 <sup>9E</sup>
	6	D4 <sup>9E</sup> or D6 <sup>a</sup>	D4 <sup>9E</sup> or D6 <sup>a</sup>	D6 <sup>9E</sup>	D6 <sup>9E</sup>	D6 <sup>9E</sup>	D6 <sup>9E</sup>
	7	D4 <sup>9E</sup>	D4 <sup>b</sup> or D5 <sup>a</sup>	D8 <sup>9E</sup> , D9 <sup>9E</sup> or D12 <sup>9E</sup>	D8 <sup>9E</sup>	D8 <sup>9E</sup>	D8 <sup>9E</sup>
	8	D6 <sup>a</sup>	D6 <sup>a</sup>	D9 <sup>9E</sup> , D9 <sup>9E</sup> or D12 <sup>9E</sup>	D8 <sup>9E</sup>	D8 <sup>9E</sup>	D8 <sup>9E</sup>
	9	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D9 <sup>9E</sup>	D4 <sup>9E</sup> or D9 <sup>9E</sup>	D9 <sup>9E</sup>	D9 <sup>9E</sup>
	10	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D9 <sup>b</sup>	D9 <sup>b</sup>	D9 <sup>b</sup>	D9 <sup>b</sup>
	11	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D9 <sup>9E</sup>	D4 <sup>9E</sup> or D9 <sup>9E</sup>	D9 <sup>9E</sup>	D9 <sup>9E</sup>
	12	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D5 <sup>9E</sup> or D7 <sup>b</sup>
	13	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D5 <sup>9E</sup> or D7 <sup>b</sup>
	14	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D1 <sup>9E</sup> , D2 <sup>9E</sup> D4 <sup>9E</sup> or D7 <sup>b</sup>	D1 <sup>9E</sup> , D2 <sup>9E</sup> D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>
	15	D4 <sup>9E</sup> or D7 <sup>b</sup>	D4 <sup>9E</sup> or D7 <sup>b</sup>	D9 <sup>9E</sup> or D12 <sup>9E</sup>	D1 <sup>9E</sup> , D2 <sup>9E</sup> D4 <sup>9E</sup> or D7 <sup>b</sup>	D9 <sup>9E</sup> or D12 <sup>9E</sup>	D9 <sup>9E</sup> or D12 <sup>9E</sup>
	16	D10	D10	D10	D10	D10	D10
	17	D10 (≥ 270m)	D10 (≥ 270m)	D10 (≥ 270m)	D10 <sup>9E</sup>	D10 <sup>9E</sup>	D10 (≥ 270m)
	18	D10 (≥ 270m)	D10 (≥ 270m)	D13	D10 <sup>9E</sup>	D13	D13
	19	D11 (≥ 270m) <sup>h</sup> D16 (≥ 270m) <sup>9E</sup> D13 (≥ 400m) D14 (≥ 400m) <sup>9E</sup>	D11 (≥ 270m) <sup>h</sup> D17 (≥ 270m) <sup>9E</sup> D13 (≥ 400m) D15 (≥ 400m) <sup>9E</sup>	D11 (≥ 270m) <sup>h</sup> D13 (≥ 400m)	D11 <sup>h</sup> D13	D11 <sup>h</sup> D13	D11 (≥ 270m) <sup>h</sup> D13 (≥ 400m)
	20	D13 (≥ 400m) <sup>l</sup> D14 (≥ 400m) <sup>9E</sup>	D13 (≥ 400m) <sup>l</sup> D14 (≥ 400m) <sup>9E</sup>	D13 (≥ 400m) <sup>l</sup>	D13 <sup>l</sup> D13 (≥ 400m)	D13 <sup>l</sup> D13 (≥ 400m)	D13 (≥ 400m) <sup>l</sup>

Table 1 (Page 2) - Q-D Table for Hazard Division 1.1

Net Explosives Quantity in kg	Quantity-Distances in metres											
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
500	3		4	7	9	15	20	29	39	64	180	180
600	3		5	7	10	16	21	31	41	68	180	190
700	4		5	8	10	16	22	32	43	72	180	200
800	4		5	8	11	17	23	34	45	75	180	210
900	4		5	8	11	18	24	35	47	78	180	215
1 000	4		5	8	11	18	24	36	48	80	180	225
1 200	4		6	9	12	20	26	39	52	86	180	240
1 400	4		6	9	13	21	27	41	54	90	180	250
1 600	5		6	10	13	22	29	43	57	94	180	260
1 800	5		7	10	14	22	30	44	59	98	180	270
2 000	5		7	11	14	23	31	46	61	105	180	280
2 500	5		7	11	15	25	33	49	66	110	185	305
3 000	6		8	12	16	26	35	52	70	120	205	325
3 500	6		8	13	17	28	37	55	73	125	220	340
4 000	6		8	13	18	29	39	58	77	130	235	355
5 000	6		9	14	19	31	42	62	83	140	255	380
6 000	7		10	15	20	33	44	66	88	150	270	405
7 000	7		10	16	22	35	46	69	92	155	285	425
8 000	7		10	16	22	36	48	72	96	160	300	445
9 000	8		11	17	23	38	50	75	100	170	310	465
10 000	8		11	18	24	39	52	78	105	175	320	480
12 000	9		12	19	26	42	55	83	110	185	340	510
14 000	9		13	20	27	44	58	87	120	195	360	540
16 000	9		13	21	28	46	61	91	125	205	375	560
18 000	10		14	21	29	48	63	95	130	210	390	590
20 000	10		14	22	30	49	66	98	135	220	405	610
25 000	11		15	24	33	53	71	110	145	235	435	650
30 000	11		16	25	35	56	75	115	150	250	460	690
35 000		15	17	27	36	59	79	120	160	265	485	730
40 000		16	18	28	38	62	83	125	165	275	510	760
50 000		17	19	30	41	67	89	135	180	295	550	820
60 000		18	20	32	44	71	94	145	190	315	580	870
70 000		19	21	33	46	75	99	150	200	330	610	920
80 000		19	22	35	48	78	105	160	210	345	640	960
90 000		20	23	36	50	81	110	165	220	360	670	1000
100 000		21	24	38	52	84	115	170	225	375	690	1040
120 000		22	25	40	55	89	120	180	240	395	730	1100
140 000			26	42	58	94	125	190	250	420	770	1160
160 000			28	44	60	98	135	200	265	435	810	1220
180 000			29	46	63	105	140	205	275	455	840	1260
200 000			30	47	65	110	145	215	285	470	870	1300
250 000			32	51	70	115	155	230	305	510	940	1400
Distance Functions	$D1=0.35 Q^{1/3}$	$D2=0.44 Q^{1/3}$	$D3=0.5 Q^{1/3}$	$D4=0.8 Q^{1/3}$	$D5=1.1 Q^{1/3}$	$D6=1.8 Q^{1/3}$	$D7=2.4 Q^{1/3}$	$D8=3.6 Q^{1/3}$	$D9=4.8 Q^{1/3}$	$D10=8.0 Q^{1/3}$	$D11=3.6 Q^{1/2}$ for $Q \leq 4500$ $D11=14.8 Q^{1/3}$ for $Q > 4500$	$D12=22.2 Q^{1/3}$
a. see 1.4.1.9.a)&1.4.1.9.b)1)	- virtually complete protection against instantaneous propagation						h. see 1.4.5.3. - excluding items at the ES vulnerable to attack by heavy spalling					
b. see 1.4.1.9.a)&1.4.1.9.b)2)	- high degree of protection against instantaneous propagation						i. see 1.4.3.1. - modular storage of bombs in open stacks					
c. see 1.4.1.9.a)&1.4.1.9.b)3)	- moderate degree of protection against instantaneous propagation						j. see 1.4.3.3. - untraversed stacks of robust shell					
d. see 1.4.5.6.a)1)	- effect of high velocity projections						k. see 1.4.1.14.b) - reaction of drivers on busy roads					
e. see 1.4.5.6.a)2)	- effect of lobbed ammunition						l. see 1.4.1.15.b) - flying and falling glass, etc.					
f. see 1.4.1.8.c)	- degree of protection depends on structure at ES and sensitiveness of its contents						m. see 1.4.1.15.c) - 400 m minimum to built up areas					
g. see 1.4.3.6.	- excluding very sensitive explosive substances						n. see 1.4.6.7.b) - reduced Q-D for large earth-covered buildings containing NEQ<45 000kg					
							o. see 1.4.1.13. - serious fragment hazard					

TABLE 2		Q-D TABLE FOR HAZARD DIVISION 1.2					
ES	PES						
		(a)	(b)	(c)	(d)	(e)	(f)
	1	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>
	2	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>
	3	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>
	4	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>
	5	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>
	6	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>	2m <sup>ai</sup>
	7	2m <sup>ai</sup>	2m <sup>ai</sup>	10m <sup>bd</sup> , 25 <sup>ad</sup> or 90m <sup>a</sup>	10m <sup>ad</sup> or 25m <sup>a</sup>	25m <sup>bd</sup> or 90m <sup>a</sup>	25m <sup>bd</sup> or 90m <sup>a</sup>
	8	2m <sup>ai</sup>	2m <sup>ai</sup>	10m <sup>bd</sup> , 25 <sup>ad</sup> or 90m <sup>a</sup>	10m <sup>ad</sup> or 25m <sup>a</sup>	25m <sup>bd</sup> or 90m <sup>a</sup>	25m <sup>bd</sup> or 90m <sup>a</sup>
	9	2m <sup>ai</sup>	2m <sup>ai</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>a</sup>	25m <sup>b</sup> or 90m <sup>a</sup>	25m <sup>b</sup> or 90m <sup>a</sup>
	10	2m <sup>ai</sup>	2m <sup>ai</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	25m <sup>b</sup> or 90m <sup>a</sup>	25m <sup>b</sup> or 90m <sup>a</sup>
	11	90m <sup>a</sup>	90m <sup>a</sup>	90m <sup>a</sup>	90m <sup>a</sup>	90m <sup>b</sup>	90m <sup>b</sup>
	12	2m <sup>ai</sup>	2m <sup>ai</sup>	10m <sup>a</sup>	10m <sup>a</sup>	10m <sup>a</sup>	10m <sup>a</sup>
	13	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>c</sup>
	14	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>c</sup>
	15	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>b</sup>	90m <sup>c</sup>	90m <sup>c</sup>
	16	25m	25m	25m	25m	25m	25m
	17	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>
	18	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>	90m <sup>h</sup> or 135m <sup>g</sup>
	19	90m <sup>hk</sup> , 135m <sup>gk</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	90m <sup>hk</sup> , 135m <sup>gk</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	90m <sup>hk</sup> , 135m <sup>gk</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	90m <sup>hk</sup> , 135m <sup>gk</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	90m <sup>hk</sup> , 135m <sup>gk</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	90m <sup>hk</sup> , 135m <sup>gk</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>
	20	180m <sup>hi</sup> , 270m <sup>gi</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	180m <sup>hi</sup> , 270m <sup>gi</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	180m <sup>hi</sup> , 270m <sup>gi</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	180m <sup>hi</sup> , 270m <sup>gi</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	180m <sup>hi</sup> , 270m <sup>gi</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>	180m <sup>hi</sup> , 270m <sup>gi</sup> , D1 <sup>h</sup> or D2 <sup>g</sup>

TABLE 2 - Q-D TABLE FOR HAZARD DIVISION 1.2

Net Explosives Quantity Q in kg	Quantity-Distances in metres	
	D1	D2
500	180	270
600	180	270
700	180	270
800	180	270
900	185	270
1 000	185	270
1 200	190	270
1 400	195	270
1 600	200	270
1 800	205	270
2 000	210	270
2 500	220	280
3 000	225	290
3 500	230	300
4 000	235	310
5 000	245	320
6 000	255	330
7 000	260	340
8 000	270	345
9 000	275	355
10 000	280	360
12 000	290	370
14 000	300	385
16 000	305	390
18 000	310	400
20 000	320	410
25 000	330	425
30 000	345	440
35 000	350	450
40 000	360	460
50 000	375	480
60 000	390	500
70 000	400	520
80 000	410	530
90 000	410	540
100 000	410	560
120 000	410	560
140 000	410	560
160 000	410	560
180 000	410	560
200 000	410	560
250 000	410	560
Distance Functions	$D1 = 53 Q^{0.18}$	$D2 = 68 Q^{0.18}$

a. see 1.4.1.10.1)	- virtually complete protection	g. see 1.4.1.5.b)	- PES contains rounds above 60 mm, etc.
b. see 1.4.1.10.2)	- high degree of protection	h. see 1.4.1.5.c)	- PES contains rounds up to 60 mm, etc.
c. see 1.4.1.10.3)	- limited degree of protection	i. see 1.4.5.1.c)	- practical considerations may require a greater distance
d. see 1.4.5.6.b)	- resistance of headwalls and doors at ES	j. see 1.4.1.15.d)	- buildings are isolated and are evacuated promptly
e.	- (reserved)	k. see 1.4.1.14.c)	- traffic is stopped promptly to avoid worst attack
f.	- (reserved)		

TABLE 3A		Q-D TABLE FOR HAZARD DIVISION 1.3					
ES	PES	Q-D TABLE FOR HAZARD DIVISION 1.3					
		(a)	(b)	(c)	(d)	(e)	(f)
	1	2m <sup>9g</sup>	2m <sup>9g</sup>	2m <sup>9g</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>
	2	2m <sup>9g</sup>	2m <sup>9g</sup>	2m <sup>9g</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>
	3	2mag	2m <sup>9g</sup>	2m <sup>9g</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	D1 <sup>a</sup>
	4	2m <sup>9g</sup>	2m <sup>9g</sup>	2m <sup>9g</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>
	5	2m <sup>9g</sup>	2m <sup>9g</sup>	2m <sup>9g</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>	10m <sup>9d</sup> or 25m <sup>9</sup>
	6	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	D1 <sup>b</sup>	D1 <sup>b</sup>	D1 <sup>b</sup>
	7	2m <sup>9g</sup> or 25m <sup>a</sup>	2m <sup>9g</sup> or 25m <sup>a</sup>	2m <sup>9g</sup> or 25m <sup>a</sup>	25m <sup>9d</sup> or D1 <sup>a</sup>	25m <sup>9d</sup> or D1 <sup>a</sup>	D1 <sup>9d</sup> , D1 <sup>9f</sup> or 240m <sup>b</sup>
	8	2m <sup>9g</sup> or 25m <sup>a</sup>	2m <sup>9g</sup> or 25m <sup>a</sup>	2m <sup>9g</sup> or 25m <sup>a</sup>	25m <sup>9d</sup> or D1 <sup>a</sup>	25m <sup>9d</sup> or D1 <sup>a</sup>	D1 <sup>9d</sup> , D1 <sup>9f</sup> or 240m <sup>b</sup>
	9	2m <sup>9g</sup>	2m <sup>9g</sup>	2m <sup>9g</sup>	25m <sup>a</sup>	25m <sup>a</sup>	D1 <sup>a</sup>
	10	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>9f</sup> or 240m <sup>b</sup>
	11	25m <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>b</sup>	D1 <sup>b</sup>	240m <sup>b</sup>
	12	2m <sup>9g</sup>	2m <sup>9g</sup>	2m <sup>9g</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	10m <sup>b</sup> or 25m <sup>a</sup>	D1 <sup>a</sup>
	13	25m <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>b</sup>	D1 <sup>b</sup>	240m <sup>a</sup>
	14	25m <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>b</sup>	D1 <sup>b</sup>	240m <sup>a</sup>
	15	25m <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>a</sup>	D1 <sup>b</sup>	D1 <sup>b</sup>	240m <sup>a</sup>
	16	D2	D2	D2	D2	D2	D2
	17	D2	D2	D2	D2	D2	D2 <sup>f</sup> or 240m
	18	D2	D2	D2	D2	D2	240m <sup>f</sup> or D4 (3240m)
	19	D3 <sup>b</sup> or D4	D3 <sup>b</sup> or D4	D3 <sup>b</sup> or D4	D3 <sup>b</sup> or D4	D3 <sup>b</sup> or D4	D3 (3160m) <sup>b</sup> or D4 (3240m)
	20	D4	D4	D4	D4	D4	D4 (3240m)



TABLE 3A - Q-D TABLE FOR HAZARD DIVISION 1.3

Net Explosives Quantity Q in kg	Quantity-Distances in metres			
	D1	D2	D3	D4
500	25	60	60	60
600	25	60	60	60
700	25	60	60	60
800	25	60	60	60
900	25	60	60	62
1 000	25	60	60	64
1 200	25	60	60	69
1 400	25	60	60	72
1 600	25	60	60	75
1 800	25	60	60	78
2 000	25	60	60	81
2 500	25	60	60	87
3 000	25	60	62	93
3 500	25	60	65	98
4 000	25	60	68	105
5 000	25	60	73	110
6 000	25	60	78	120
7 000	25	62	82	125
8 000	25	64	86	130
9 000	25	67	89	135
10 000	25	68	92	140
12 000	25	74	98	150
14 000	27	78	105	155
16 000	28	81	110	165
18 000	30	84	115	170
20 000	32	87	120	175
25 000	35	94	125	190
30 000	39	100	135	200
35 000	42	105	140	210
40 000	44	110	150	220
50 000	50	120	160	240
60 000	54	130	170	255
70 000	59	135	180	265
80 000	63	140	185	280
90 000	66	145	195	290
100 000	70	150	200	300
120 000	77	160	215	320
140 000	83	170	225	335
160 000	88	175	235	350
180 000	94	185	245	365
200 000	99	190	250	375
250 000	110	205	270	405
Distance Functions	$D1 = 0.22 Q^{1/3}$	$D2 = 3.2 Q^{1/3}$	$D3 = 4.3 Q^{1/3}$	$D4 = 6.4 Q^{1/3}$

a. see 1.4.1.11.1)	- virtually complete protection	e.	- (reserved)
b. see 1.4.1.11.2)	- high/limited degree of protection	f. see 1.4.6.6.a)	- door barricade at PES
c.	- (reserved)	g. see 1.4.5.1.c)	- practical considerations may require a greater distance
d. see 1.4.5.6.b)	- resistance of headwall and door(s) at ES	h. see 1.4.1.14.b)	- reaction of drivers on busy roads



# Best Practice Guide on Ammunition Transportation

# Table of Contents

I. Introduction	84
II. Aim and Scope	84
III. General information on the transportation of ammunition by land	85
1. Responsibilities, training and qualification of the personnel involved in transportation	85
2. Safety	85
2.1. Transportation planning	85
2.2. Ammunition transportation safety / approval for transportation	86
2.3. Determination of the hazard potential of ammunition	86
2.4. Mixed loads of class 1 materials for transportation	87
2.5. Ammunition packaging material	87
2.6. Information / markings on ammunition packaging	87
2.7. Approval of ammunition means of transportation	88
2.8. Ammunition transshipment sites	88
2.9. General principles on ammunition storage	89
2.10. Additional ammunition safety issues	89
2.11. Accident Response during the transportation of ammunition	90
3. Security	90
4. Stockpile management	91
IV. Special aspects of external transportation of ammunition by road	92
1. Safety	92
1.1. Vehicle crew	92
1.2. Safety equipment for the transportation of ammunition by road vehicles	93
1.3. Marking of vehicles transporting ammunition by road	93
1.4. Accident instruction sheets and additional instruction sheets	93
1.5. Loading of ammunition on road vehicles	94
1.6. Conduct of transportation by road	94
2. Security	95
3. Stockpile management	95
V. Special aspects of external transportation of ammunition by rail	95
1. Safety	95
2. Security	96
3. Stockpile management	96
VI. Special aspects of internal transportation of ammunition	97
1. Safety	97
2. Security	97
3. Stockpile management	98
VII. General information on the transportation of ammunition by air	98

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## Annexes

### List of Annexes

1. Definitions	99
2. Recommendation for the distribution of responsibilities of the Personnel Involved in the Transportation of Ammunition	101
3. Knowledge and Skills for the Transportation of Ammunition	104
4. Classification of Class 1 Substances into Hazard Divisions / Compatibility Groups / Classification Codes	106
5. Prohibition of Mixed Loads Concerning Class 1 Hazardous Goods	109
6. Specimen: Hazard Labels	111
7. Specimen: Fire Placards for Class 1 Hazardous Goods	112
8. Specimen: Accident Information Sheets (AIS) "Ammunition and Explosives Class 1" for Transportation of Ammunition by Road	113
9. Specimen: Additional Instruction Sheets for Transportation of Ammunition by Road	126
10. Specimen: Transport Document	141
11. Sources of further information on "Ammunition Transport"	142

### References

ADR	European <b>A</b> greement concerning the international carriage of <b>D</b> angerous goods by <b>R</b> oad / <b>A</b> ccord européen relatif au transport international des marchandises <b>D</b> angereuses par <b>R</b> oute
RID	<b>R</b> egulations concerning the <b>I</b> nternational Carriage of <b>D</b> angerous Goods by rail / <b>R</b> èglement concernant le transport <b>I</b> nternational ferroviaire des marchandises <b>D</b> angereuses)
AC/258	NATO Group of Experts on Safety Aspects of Transportation and Storage of Ammunition and Explosives
AC/326	NATO Group of Experts on the Safety Aspects of Transportation and Storage of Ammunition and Explosives
OSCE	Best Practice Guide on National Procedures for Stockpile Management and Security (FSC.GAL/14/03/Rev.2 dtd. 19.09.2003)

# I. Introduction

In addition to Small Arms and Light Weapons (SALW) the existing surplus and/or over-aged stockpiles of conventional ammunition pose significant dangers for people, the environment and the security of countries. The OSCE participating States therefore addressed, in their decision FSC.DOC/1/03 of 19 November 2003, the problem of stockpiles of conventional ammunition with the aim of clearly improving the current situation through a set of specific measures and international cooperation. The agreed OSCE Document on Stockpiles of Conventional Ammunition calls on the participat-

ing States, *inter alia*, to elaborate Best Practice Guides. The aim of these Best Practice Guides is to increase the knowledge of, and experience with, certain aspects of the problem of conventional ammunition, which already exist within the OSCE area and are available to all participating States. The information contained will therefore support them in solving problems with ammunition, such as preventing accidents or incidents during ammunition transportation or keeping the extent of damages as limited as possible.

# II. Aim and Scope

This OSCE Best Practice Guide provides general recommendations and practical advice for the planning, preparation and conduct phase of ammunition transportation<sup>1</sup> by land.

This guide applies only to conventional ammunition as categorized by the OSCE Document on Stockpiles of Conventional Ammunition to be transported during peacetime.

This guide addresses the external transportation by road and rail as well as the internal transportation with the usual materials handling equipment. Special consideration is being given to aspects of *safety (accident prevention)*, security and *administrative stockpile management*.

This guide is not meant to be any kind of binding directive or regulation. However, the information provided by this guide may be used for the development of policy and general operational guidelines and procedures on all aspects of ammunition transport.

This guide is based essentially on the ADR<sup>2</sup> and the RID<sup>3</sup>. Both guidelines are already legally binding in many states within the OSCE area as concerns the transportation of hazardous goods by road or rail. Thus, they constitute a specially suited and broad international basis for the recommendations in this guide<sup>4</sup>. Nevertheless, similar guidelines exist in addition to these and may be used instead.

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1 Definition of "Transportation" in this context: see Annex 1.

2 ADR: «European Agreement concerning the International Carriage of Dangerous Goods by Road».

3 RID: «Regulations concerning the International Carriage of Dangerous Goods by Rail».

4 ADR and RID were both referred to in Section II.6 on SALW transports in the OSCE Best practice Guide on National Procedures for Stockpile Management and Security.

The vast numbers of provisions in the ADR and RID and other legally binding regulations are naturally far more comprehensive than the recommendations and advice contained in this guide.

## III. General information on the transportation of ammunition by land

This chapter and the related annexes contain general recommendations and practical advice that should be observed during all types of ammunition transportation by land. As necessary, they are supplemented by the chapters on *Road Transportation*, *Rail Transportation* and *Internal Transportation* of ammunition as regards the peculiarities of these types of transport.

Annex 1 contains a list of definitions of special terms that are important in the context of “transportation of ammunition by land”; they are used throughout this guide.

### 1. Responsibilities, training and qualification of the personnel involved in transportation

An important key for achieving accident-free and safe ammunition transportation is the clear assignment of personal responsibilities to the personnel involved in the transportation and their specialized training. Furthermore, the personnel must be physically, mentally and morally qualified to carry out the assigned responsibilities.

Taking part in the transportation of ammunition does not only comprise the actual conveyance of the ammunition by a means of transportation but also the phases of

planning and preparation. Hence, the following personnel are generally involved: the dispatcher, the loader, the packer, the ammunition specialist, the carrier, the chief transportation officer, the transportation escort team, the co-driver and the driver. Annex 2 contains a brief summary of an appropriate distribution of responsibilities among these personnel involved in the transportation of ammunition.

The personnel involved in the transportation should receive adequate specialized training so that they are able, within the scope of their responsibilities and irrespective of the quantity of ammunition, to make the arrangements necessary in accordance with the nature and extent of the predictable risks to prevent damage and, if an incident occurs, to keep the extent of the damage as limited as possible. Annex 3 contains a list of knowledge and skills, which should be taught during such specialized training.

### 2. Safety

#### 2.1. Transportation planning

Besides the production of ammunition, its transportation poses the greatest risk in the handling of ammunition. For this reason, ammunition transportation should be limited to a minimum. It should be carefully planned, prepared and conducted so as to ensure that the am-

munition arrives accident-free and safely at its destination. In this context, the aspects of Safety, Security and Stockpile Management must always be taken into consideration. The type, route and time of ammunition transportation must be selected so as to keep the risk for all personnel involved in the transportation at a justifiable low level. Due to the lower risk of a traffic accident, ammunition transportation should primarily be conducted by inland watercraft rather than by rail, while transportation by rail should be preferred to transportation by road. Special attention is to be paid to the planning of ammunition transports, which have inevitably to pass through potentially dangerous waypoints like tunnels or bridges.

## **2.2. Ammunition transportation safety / approval for transportation**

Before ammunition is transported, a competent and adequately qualified agency should establish whether the ammunition is technically safe to transport at all. On the basis of this determination, a decision can be made as to whether the ammunition is approved for transportation or not, or which requirements are to be met for the transportation of this ammunition.

The results of the transportation safety check and the decision to approve the ammunition for transportation are to be recorded in writing in a protocol stating the reasons for the relevant decision. This protocol should be handed over to the person responsible for managing the ammunition concerned; it should also be carried along during the transportation of this ammunition. In addition, all ammunition transport packaging should be marked with the issued approval for transportation and, if applicable, with requirements applying to the transportation.

It is especially important to determine the transportation safety of ammunition that has been exposed to extreme stresses (e.g. fire, accident, jettisoned ammunition, inundation, modifications because of technical examinations) or that is damaged, corroded, oxidized or outdated, or of ammunition items that are unexploded ordnance (UXO), duds or recovered or extraneous ammunition.

All reasonable efforts should be undertaken to minimize the risks of any ammunition accident, when transporting seriously stressed or damaged ammunition as described above.

## **2.3. Determination of the hazard potential of ammunition**

Conventional ammunition is a *hazardous good*. The main danger for human beings and animals in the vicinity of detonating ammunition is generally a combination of blast, fragmentation and incendiary effects. Moreover, some types of ammunition also contain toxic and/or corrosive material.

The Safety Measures taken during transportation should be based on the danger or combination of dangers posed by the ammunition concerned.

Different effective approaches exist for the determination of the hazard potential of ammunition. One of them is the so-called ADR<sup>5</sup>.

The ADR divides hazardous goods into nine different classes. Conventional ammunition and explosive is grouped in class 1 as *hazard divisions 1.1 to 1.6*. Due to the considerable differences between the types of ammunition or explosives, goods of *hazard divisions 1.1 to*

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5 «European Agreement concerning the International Carriage of Dangerous Goods by Road ».

1.6 are again subdivided into *compatibility groups*. More details are provided at Annex 4.

A competent and specially qualified agency should be appointed to decide whether a substance or item belongs to a *hazard division* and a *compatibility group*, thus providing a reliable basis for the planning of appropriate safety measures for the transportation.

#### **2.4. Mixed loads of class 1 materials for transportation**

Due to its hazard potential ammunition should not be transported together with hazardous goods belonging to other classes (i.e. inflammable or radioactive materials etc.).

Due to the often greatly differing characteristics of ammunition types, even some combinations of ammunition or explosives in one shipment for transportation should be avoided for safety reasons, whenever the situation allows doing so. Information on dangerous and on acceptable mixed loads is provided in the following sub-paragraphs:

##### *2.4.1 Mixed loads within a vehicle, trailer, railroad wagon and container*

Annex 5 exemplarily contains a table of dangerous and of acceptable mixed loads. It is strongly recommended to avoid mixed loads indicated as dangerous, when the cargo for a vehicle, a trailer, a railroad car or a bulk container is put together.

##### *2.4.2 Mixed packing within a package*

In general, the same principles apply to the mixed packing of ammunition within one package (e.g. ammunition box) as to the mixed loads within one vehicle (cf. III.2.4.1 and Annex 5). In addition, duds, increment charges and unserviceable ammunition parts containing hazardous

material must not be packed in one package together with serviceable ammunition or nonhazardous goods, and should be packed separately for each *compatibility group*.

#### **2.5. Ammunition packaging material**

The packaging (e.g. ammunition box, propellant charge container, container) primarily serves to protect the ammunition from the influence of the weather and damage; it is thus a means of safety. A proper packaging includes the securing of the ammunition inside the package against slipping.

The ammunition packaging should be made of robust material so as to withstand the stresses expected during transportation. The entire packaging and tie-down material should be nonflammable or flameproof. As a rule, the original packaging provided by the arms industry for the transportation of a certain type of ammunition is the best choice.

A competent and specially qualified agency should be appointed to technically check ammunition packaging and issue a certification if the packaging is deemed suitable.

#### **2.6. Information / markings on ammunition packaging**

In case of an accident involving ammunition, it might be vital that the emergency response personnel (i.e. police, fire brigade, explosive ordnance disposal (EOD) etc.) is able to identify quickly which packaging (e.g. ammunition boxes, propellant charge containers) actually holds ammunition and which kind of ammunition is present.

For this reason, transportation packaging containing ammunition should have inscriptions and/or signs on the outside that provide information on the actual con-



tents of the packaging and the potential danger deriving from it. For the latter purpose so called hazard labels (cf. Annex 6) are particularly useful.

In order to avoid inappropriate actions of the emergency response personnel in case of an accident, the aforementioned *hazard labels* should be removed from packaging containing no ammunition.



### **2.7. Approval of ammunition means of transportation**

Vehicles, trailers and other equipment used for the transportation of ammunition by road, by rail or within sites should be specifically approved for this purpose by a competent and qualified agency.

The approval should be based on an examination of, at least, the suitability of the transportation equipment in terms of ammunition safety and roadworthiness. The examination of such vehicles, trailers or equipment as to their suitability for the transportation of ammunition should be repeated regularly after an appropriate period of time to account for negative influences due to use and age.

The competent agency should confirm in writing the approval of transportation equipment for the transportation of ammunition. The certificate of approval should

be carried along on the vehicle during transportation of ammunition.

### **2.8. Ammunition transshipment sites**

The transshipment, i.e. the loading and unloading as well as the transfer of ammunition from one vehicle to another, constitutes a particularly hazardous situation, because the ammunition or its packaging may be easily damaged during this process, which can result in accidents involving ammunition. That is why the following advice on how to set up and run transshipment sites should be followed:

- If possible, the transshipment site should be delimited and marked in a clearly visible manner. The access routes to the transshipment site should be marked with the appropriate *fire division placards* (see Annex 7) so that in the event of an accident rescue personnel may conduct a proper situation assessment for the firefighting operation.
- Uninvolved bystanders should be kept away from the transshipment site. If this cannot be achieved, loading should be discontinued until any disturbance by uninvolved bystanders is eliminated.
- Escape or rescue routes should be specified, kept clear and marked (if necessary) before loading commences. The personnel working in the loading area should be briefed accordingly.
- When it is dark, the transshipment site should be lighted to a sufficient degree. However, no artificial light except electric lights, electric lamps or floodlights of an approved type (protected against causing ammunition to detonate or deflagrate) should be used when handling ammunition.
- At the transshipment site, ammunition should be present only in such quantities as are necessary for the loading activities to continue smoothly.
- When several vehicles are loaded or unloaded at the same time, efforts should be made to ensure that each

of these vehicles could easily leave the transshipment site in case of emergency. During loading and unloading, the minimum distance between vehicles should be at least 50 m.

- Freight cars, containers, vehicles and trailers should be secured against unintentional movements during the loading process.
- Appropriate fire precautions need to be taken. Smoking, fire and naked lights should not be allowed in the vehicle, or within 25m of it.
- Loading and/or unloading should be suspended during thunderstorms. Ammunition and explosives at the transshipment site should be covered with tarpaulins and hanging wires or ropes should be secured at least 3 meters from the base of a stack of ammunition.

### 2.9. General principles on ammunition storage

All cargo that is being transported is affected by various forces, which occur in normal road traffic. During transportation, lateral, transversal and vertical forces exert their effects upon the loaded goods. It is possible that the cargo or the vehicle tips or topples over due to acceleration or centrifugal forces when turning a corner or due to rolling movements or tilt angles. To avoid such incidents, all cargo must be secured laterally and transversally to prevent horizontal shifts, as well as vertically to prevent the lifting, tipping or toppling over of the cargo.

In addition to the recommendations on mixed loads of different *compatibility groups* of ammunition (cf. paragraph III.2.4) and the recommendations on proper packaging (cf. paragraph III.2.5), it is especially important to properly stow away ammunition during the loading procedure so as to ensure that the transportation of ammunition will not impede the roadworthiness of the vehicle. This includes observing

the maximum load weight permitted for a particular means of transportation.

Additionally, the total net weight of the explosive matter to be loaded on one transport unit should be limited based on the *hazard division* (cf. paragraph III.2.4) and the type of vehicle used for the transport (spark ignition, electric or special explosion protected vehicle etc.).

### 2.10. Additional ammunition safety issues

Depending on the specific type of ammunition, the impact of extreme heat, physical shock, high frequencies (i.e. emitted by radar or radiotelephones), electric energy or electromagnetic radiation may cause ammunition to detonate or deflagrate. These circumstances should be considered when planning and conducting a transport of ammunition, and adequate precautionary measures should be taken.

Sensitive or potentially dangerous waypoints like, i.e., tunnels or bridges, mountainous terrain or water protection areas should be avoided by ammunition transports. If it is inevitable to pass through these waypoints, one should be obliged to obtain special permission to do so from a designated competent agency. This permission should be given in writing and should prescribe the specific route to be used, the date and timeframe for the transport, the maximum speed, restraints in reference to the load, safety equipment to be carried along, employment of escort vehicles or other constraints or restraints deemed necessary by the responsible agency issuing the permission.

Repeatedly prescribed routes to by-pass sensitive or potentially dangerous waypoints should be marked with signs to simplify following this route.

It should be considered to establish designated technical halt areas for ammunition transports in front of the

entrance of a tunnel or in front of a bridge, allowing special technical checks before continuing the transport or allowing to inform a bridge or tunnel warden about the intention to do so or to receive latest information or instructions from the responsible warden.

It should be forbidden to overtake ammunition transport while crossing a bridge or passing through a tunnel. Additionally a minimum distance to be kept between vehicles transporting ammunition should be prescribed.

### **2.11. Accident Response during the transportation of ammunition**

The greatest risk in the handling and transportation of ammunition and explosives is that of fire from a source external to the goods and it is vital that any fire should be detected and extinguished before it can reach the ammunition and explosives; consequently it is essential that fire precautions, fire-fighting measures and equipment should be of high standard and ready for immediate application and use.

Considering the robustness of the materiel and the packaging, emergency response to the situation should be scaled to the actual degree of danger. However, when a fire is present or is reasonably expected, all effort should be made to execute aggressive fire suppression and removal of non-involved personnel from the area.

Specific Instructions on appropriate conduct in case of accidents involving certain types of ammunition may be provided by means of “*accident instruction sheets*” or “*additional instruction sheets*” (cf. paragraph IV.1.4) applicable for the transportation of ammunition by road. Most of these instructions may be equally useful with respect to modes of transportation other than transportation by road.

In case of accident, standardized contingency plans should be at hand that include directives for traffic and safety regulation, instructions for medical care, as well as notification procedures in order to contact the authorities in charge, weapons experts, and medical and fire prevention personnel.

States may also consider installing and publishing a toll free telephone number for calling explosive ordnance disposal personnel, to be sent to the scene when an accident takes place during the transportation of ammunition. States may also consider installing tracking and monitoring systems connected with a positioning system (i.e. GPS or GALILEO) in their ammunition transport vehicles to allow a swift response to incidents.

## **3. Security**

National civilian ordinances and military regulations are an essential basis for the standardization of transport security. These should be combined with international agreements like the ADR and the RID.

Ammunition, and particularly ammunition for small arms and light weapons, is especially at risk of being stolen. For this reason, it must be protected at all times – and particularly during transportation – against theft. While stationary ammunition storage facilities can be comprehensively and adequately secured against illegal entry and theft of ammunition, it is more difficult to ensure this same level of security during transportation.

With regards to security measures, ammunition transportation should be planned and conducted as is customary for other precious items (e.g. currency, gold, diamonds, weapons etc).

When a shipment is planned, the risks and vulnerabilities should be analyzed first. This analysis will then serve

as the basis for the overall planning of the necessary Security measures. Routes and times of transportation should be selected randomly. Special vulnerabilities are breaks in the journey and low-speed routes as well as so-called “inevitable routes” that cannot be avoided during the transportation. The personnel tasked with the planning, preparation and conduct of ammunition transportation must be trustworthy, reliable and discreet. Information on the conduct of ammunition transportation should be classified.

As a rule, the personnel conducting the transportation should be armed when the transportation leaves the site. Depending on the risk analysis, it may even be necessary to employ an armed transportation escort team.

It may also be useful to have a single vehicle driving in advance of the ammunition transportation convoy covering the route to detect suspicious actions along the transportation route. Such an advance vehicle should be able to communicate with the convoy leader. In this way assaults on the ammunition transportation may be prevented.

Moreover, it should be ensured that the ammunition is continuously guarded not only during the actual transportation but also during the transfer.

Effective regulation for cargo verification and inspection mechanism can help prevent illicit transfers of SALW that are facilitated by falsified transport documentation.

As a rule, SALW and related ammunition should be transported in separate vehicles. Only in exceptional circumstances should they be transported together.

If civilian contractors are used to move ammunition by land, then procedures for authorization, security, monitoring and inspection of both the movements and the

contractors themselves should be in place beforehand. They should be equipped with specific protection measures (e.g. alarm systems on vehicles or electronic tracers in boxes), monitored by the military police, or guarded by military or security forces, depending on the quantity and type of ammunition transported and the respective risk assessment.

The measures for the Security of ammunition transportation should not interfere with the measures required for Safety.

#### 4. Stockpile management

For logistic reasons, and to prevent a theft of ammunition, the personnel responsible for stockpile management should know at all times – including during transportation – which and how much ammunition they have in their custody.

Errors and manipulations occur particularly in the transfer records of ammunition stocks. Such bookkeeping transfers are to be made for any addition to or removal from the inventory, which is to be transported. For this reason, simple but effective regulations concerning the stockpile management should be introduced that govern in particular the transfer of ammunition stocks from one responsible person to another.

The ammunition itself, as well as its packaging, generally show information on the ammunition designation, caliber, production batch number, producer and quantity and size; sometimes even serial numbers are shown. In most cases, this information ensures a definite identification and classification of the ammunition; hence, it can be very useful for stockpile management purposes – particularly for the comparison between nominal and actual quantities within the scope of book transfers (handing over/receipt of ammunition).

If ammunition is to be transferred from one responsible person to another, a formal handover and receipt procedure should be followed. This transfer procedure is based on a document that identifies type and quantity and, if applicable, other particulars of the ammunition to be transferred – i.e. the nominal data – that have to be compared. When the ammunition is handed over for transport, this document is generally referred to as a “transport document” (road transportation) or “waybill” (rail transportation). A sample “transport document” is provided at [Annex 10](#).

The personnel involved in the transfer procedure should jointly compare the nominal quantity of ammunition indicated in the transport document/waybill with the ammunition actually present during the transfer – i.e. with the actual numbers – to detect any deviations. This check should be performed for 100% of the ammunition; random checks do not suffice.

In order to keep the amount of time needed for this transfer procedure to a minimum despite the necessity for a 100% check, it is possible to leave ammunition packages unopened that were sealed by an authorized agency. The crosschecks are then conducted by means of the signs or inscriptions (see III.2.6) attached to the packages.

The personnel handing over and receiving the ammunition should confirm the correct transfer of the ammunition by their signatures on the transport document/waybill; both sides should receive a copy of the paper for documentary purposes. This document should be carried along during transportation, since it is not only a cargo certificate but also the basis for another comparison between nominal and actual numbers during a subsequent ammunition transfer.

## IV. Special aspects of external transportation of ammunition by road

This chapter and the associated annexes contain general recommendations and practical advice on transporting ammunition outside of stockpile facilities or other installations (“off-site”) by road. This chapter supplements the information in the Chapter *General Information on the Transportation of Ammunition by Land*.

### 1. Safety

#### 1.1. Vehicle crew

Whenever the situation allows doing so, a driver and a co-driver should man vehicles carrying ammunition. Both personnel should have the necessary driving li-

censes for the ammunition transportation vehicle. Prior to the ammunition transportation, the drivers should receive instructions on the rules to be applied to that particular transport.

Any physical or mental impairment which is due to, for example, alcohol consumption, the taking of tablets, indisposition, tiredness or the like and may have an impact on the driver’s fitness to steer the vehicle is to be reported to the responsible transportation officer immediately.

### 1.2. Safety equipment for the transportation of ammunition by road vehicles

Vehicles for the road transportation of ammunition should carry equipment designed for the special purpose of ammunition transportation so that the vehicle crew and/or the transportation escort personnel will be able to respond immediately and appropriately to a technical malfunction, a traffic accident or an ammunition accident. This equipment should include, but is not limited to, fire extinguishers, sets of individual protective equipment for self-protection of the vehicle crew and the escort team (i.e. NBC protective mask with an adequate filter), electrical warning lights designed in a way that their use will not cause the ammunition on board to ignite.

The equipment to be carried along for this purpose during ammunition transportation by road should be specifically approved for its intended use by a competent and qualified agency. This approval should be based on a specialized examination of the different items of equipment with respect to their necessity and suitability for use in ammunition transportation. The equipment should be carried along in the transportation vehicle; it should always be operational and ready to hand.

### 1.3. Marking of vehicles transporting ammunition by road

Vehicles transporting ammunition should be clearly identifiable as such from the outside so that, in the case of an incident or accident, the persons present at the scene by chance or emergency response personnel (i.e. police, fire brigade, explosive ordnance disposal) are able to correctly assess the situation without delay and take adequate measures.



The illustration above provides examples of how to mark vehicles transporting ammunition by road by means of *warning signs*, indicating the presence of hazardous goods, and *hazard labels* (cf. [Annex 6](#)), specifically indicating that the vehicle is transporting *Class 1* items or substances like ammunition.

Such *warning signs* and *hazard labels* should be made of flameproof material.

In order to avoid inappropriate action by the emergency response personnel, such markings should be removed or completely covered if the vehicle is not loaded with ammunition.

### 1.4. Accident instruction sheets and additional instruction sheets

*Accident instruction sheets* are written instructions for the vehicle crew and the escort personnel on the correct conduct in case of an accident. These measures can differ depending on the type of ammunition carried; for this reason, different *accident instruction sheets* (a sample is provided cf. [Annex 8](#)) should be issued for the different *hazard divisions* of ammunition (cf. III.2.3 and [Annex 4](#)).

If the transported ammunition contains one or more “other hazardous substances” in addition to the actual explosive, separate *additional instruction sheets* should be issued which address these other hazardous substances (sample cf. [Annex 9](#)).

*Accident instruction sheets* and *additional instruction sheets* should be carried along ready to hand in the cab of the ammunition transportation vehicle. In order to avoid inappropriate actions by the emergency response personnel in case of an incident or accident, only the *accident instruction sheets* and *additional instruction sheets* applicable to the specific ammunition transportation should be carried along in the transportation vehicle.

### **1.5. Loading of ammunition on road vehicles**

A number of safety hazards are connected with the loading of ammunition on road vehicles that may lead to an ammunition accident. This risks may be decreased significantly by following some simple procedural guidelines in addition to those already mentioned in paragraph III.2.8 (ammunition transshipment sites):

- Before it is loaded, the vehicle should be refueled and checked for technical defects. Refueling is prohibited during loading/unloading of ammunition.
- During loading and unloading, engines should be switched off unless they are required for the loading process. External heaters should be turned off as well.
- When transported in vehicles, or trailers, the ammunition can be loaded both along and across the movement line. The ammunition should preferably be loaded to evenly cover all the space of the loading space of the vehicle, with the line of symmetry of the boxes across the vehicle. Even if the vehicle is just partially loaded, efforts should be made to ensure an even distribution of weight so that each axle carries about the same load. Any point loading on the vehicle floor or any unbalanced loading of the cargo bed should be avoided.
- The ammunition boxes should be stowed in a way that prevents them from sliding or falling during transportation. The vehicle's side panels should be used as a stabilizing element for the fixation of the cargo only if the relevant vehicle-specific technical regula-

tions indicate for up to what cargo mass and under which conditions (e.g. bracing of the side panels with specific chains) the vehicle's side panels are approved for such a purpose.

- A vehicle (with the exception of container vehicles) should be loaded only up to the height of its side panels (including insertable boards). Bulky packages and cargo units consisting of fixed packages of ammunition may sometimes exceed the vehicle's side panels (including insertable boards) by approximately one third of their own height. The loading rates of the vehicles or trailer cannot be exceeded.
- Whenever a vehicle is transporting ammunition, its side panels and rear panel should be up.
- Ammunition should be covered with a waterproof and non-inflammable tarpaulin. The tarpaulin should be large enough to be pulled over and lashed to the vehicle's side panels.

### **1.6. Conduct of transportation by road**

Within the scope of their responsibilities and irrespective of the quantity of the ammunition which is going to be transported, the persons involved in the transportation process are to take the precautions which, according to the nature and extent of foreseeable hazards, are required to prevent damage or, in the event of an accident, to keep the extent of the damage as limited as possible.

Ammunition transportation vehicles should be driven very carefully and with foresight in road traffic. In particular, the mode of driving and the driving speed should conform to local traffic laws and be consistent with road and weather conditions.

The stipulated driving and rest periods should be observed. Additionally, it should be considered to order special speed limits and/or minimum distances to be kept between the vehicles when driving in a convoy.

Ammunition should be transported without making unnecessary stops. During a planned stop, the following minimum distances are to be kept:

- 300 m to inhabited built-up areas or crowds;
- 50 m between vehicles loaded with hazardous goods.

Vehicles loaded with ammunition must not be parked and left unattended and built-up areas are to be bypassed when there is a beltway. During the journey, there should not be any persons on the cargo bed.

If a disabled vehicle, which is loaded with ammunition, cannot be repaired on the spot, it is, if possible, to be towed to the nearest site where the cargo can be transshipped without obstructing the other traffic. This site should be at least 300 m from inhabited built-up areas or crowds. In the event that towing is not possible, the ammunition is to be transshipped on site.

## V. Special aspects of external transportation of ammunition by rail

This chapter and the associated annexes contain general recommendations and practical advice to be observed particularly when transporting ammunition off-site by rail. This chapter supplements the information in the Chapter *General Information on the Transportation of Ammunition by Land*.

### 1. Safety

Within the scope of ammunition transportation by rail, the same recommendations should be observed as in the ammunition transportation by road as regards the marking of freight cars and bulk containers as well as the car-

### 2. Security

As detailed in the chapter *General Information on the Transportation of Ammunition by Land*.

### 3. Stockpile management

As detailed in the chapter *General Information on the Transportation of Ammunition by Land*.

rying along of *accident instruction sheets and additional instruction sheets* (cf. paragraphs IV.1.3 and IV.1.4).

When ammunition is transported in freight cars, the doors of the cars should be closed when the car is moved. During the process of physically composing a train consisting of several freight cars or bulk containers, the freight cars or containers containing ammunition should be moved carefully. Bumping into other freight cars or bulk containers cars should be avoided.



When being transported by rail, the ammunition should be loaded only into roofed cars or closed bulk containers. If this is not possible, the ammunition should be protected by alternative means against weather effects, e.g. by a non-flammable, waterproof tarpaulin.

During rail transportation, stress is exerted upon the ammunition mainly through shunting shocks when the trains are assembled. The forces exerted in the freight car's longitudinal axis should especially be taken into account when the cargo is secured. Moreover, the cars or bulk containers should be so loaded that they can be unloaded later from both sides more easily.

Depending on the type and quantity of ammunition, it may be useful to add empty cars or cars not loaded with ammunition at certain intervals in order to minimize the danger of a mass explosion of the entire train in the case of an ammunition accident.

Damaged freight cars and bulk containers or cars and bulk containers in which the cargo is no longer tied down properly should be examined and unloaded only after the neighbouring cars or bulk containers have been unloaded.

## 2. Security

It is more difficult to guard the ammunition during rail transportation than during road transportation because of the usually large number of freight cars and the resulting difficulties in monitoring them. Moreover, it is generally not possible to stop a train at short notice in between stations to immediately examine, for example, a suspected illegal entry. These particular difficulties should be taken into consideration when planning Security measures for rail transportation. As a rule, the freight cars and bulk containers should be locked and padlocked during transportation.

## 3. Stockpile management

In many cases, large quantities are involved if ammunition is transported by rail. In order to enable the stockpile manager to check that the cargo is complete, ammunition earmarked for rail transportation should be delivered as a complete carload to the railroad loading facility.

Furthermore, the ammunition should be loaded in a way that the ammunition batches are kept together. Chalk lines on the inner walls of the freight car or the bulk container should mark the separation line between the individual batches.

Car doors and windows and hatches that cannot be locked from the inside, should be sealed. Prior to opening cars and bulk containers, the seals and, if applicable, the padlocks as well as the car floor, the car walls, doors, windows (hatches, ventilation lids) and the car roof should be checked to determine that they are still intact.

## VI. Special aspects of internal transportation of ammunition

This chapter and the associated annexes contain general recommendations and practical advice to be observed particularly when transporting ammunition on site. This chapter supplements the information in the Chapter *General Information on the Transportation of Ammunition by Land*.

### 1. Safety

A peculiarity of the internal transportation of ammunition is the fact that, besides the usual means of transportation like motor vehicles and trains, the handling equipment normally used for storage operations is employed as well. In addition, the ammunition is sometimes transported and stored at storage sites without packaging. Moreover, the quantity of explosives at an ammunition storage site is generally much higher than in rail or road transportation. Mistakes in ammunition handling could thus have much more severe consequences.

As a rule, ammunition that is transported internally should also be packed in proper shipping packaging or in similar alternate packaging. Unpacked ammunition should be transported and handled only in *ammunition workshops* in appropriate containers (e.g. transport skids) by specifically approved vehicles and handling systems. The responsible personnel with the help of an ammunition specialist should designate the *ammunition workshops* in writing.

Vehicles or equipment for handling or transporting ammunition within the site do not have to be equipped with *warning signs* and *hazard labels* or carry *accident instruction sheets* and *additional instruction sheets* if the personnel working on site has an adequate level of training.

In the case of rooms holding ammunition appropriately packaged for transportation, preferably vehicles with diesel or electric engines or other vehicles especially approved for ammunition transportation by a competent and qualified national agency should enter.

In the case of rooms holding ammunition that is not properly packaged, only explosion-proof vehicles should enter, and only if there is no ammunition with open hazardous material placed near the traffic lines. Vehicles not meeting these requirements should only be permitted to approach rooms holding ammunition in proper shipping packaging. Other vehicles should approach rooms holding ammunition without packaging or without proper packaging to a distance of no less than 20 m.

With the assistance of an ammunition specialist, the responsible personnel should designate in writing and mark trans-shipment and refueling locations in ammunition storage sites.

### 2. Security

Generally, stationary ammunition storage sites can be secured quite effectively and comprehensively against entry by unauthorized personnel. For this reason, the Security against the illegal abstraction of ammunition by storage site personnel is of special importance. The following useful measures may be taken: Subdivision of the storage site into zones with different access rights; securing of ammunition stocks by storing them in locked rooms with access control procedures; and personal checks of staff when they leave the storage site (e.g. by searching bags and vehicles at the gate).

### 3. Stockpile management

For the management of ammunition stocks that are internally transported, please refer to the recommendations in the OSCE Best Practice Guide on the *Management of Stockpiles of Conventional Ammunition* (prepared by the United States of America).

## VII. General information on the transportation of ammunition by air

Aim and scope of this OSCE Best Practice Guide are focused on ammunition transportation by land. The transportation of ammunition and other dangerous goods by air is regulated by the norms of the International Civil Aviation Organization Technical Instructions (ICAO-TI) and the International Air Transport Association Dangerous Goods Regulations (IATA).

ICAO<sup>6</sup> produces Standards and Recommended Practices in various areas of aviation to facilitate the international movement of civil aircraft. These are contained in annexes to the Convention on International Civil Aviation (usually referred to as the “Chicago Convention”). Most countries of the world are already party to this convention. Annex 18 to this convention deals with the „Safe Transport of Dangerous Goods by Air“. This annex contains broad principles to be adhered to and a list of responsibilities of „Contracting States“. These are, *inter alia*,

- to consider applications for the grant of exemptions to allow the carriage of dangerous goods forbidden by the normal requirements of the Technical Instructions.

- to ensure compliance with the Technical Instructions.
- to establish inspection, surveillance and enforcement procedures.
- to co-operate with other countries in exchanging information concerning suspected contraventions.
- to have penalties for proven contraventions of national legislation.
- to establish procedures for investigating and recording dangerous goods accidents and incidents.

The Technical Instructions contain detailed provisions, which include requiring that the training programs for operators (airlines) be approved by the State where the aircraft of an operator are registered.

The International Air Transport Association (IATA), has released its „Dangerous Goods Regulations“ (IATA-DGR) in form of a handbook, which is by almost 100% identical with the contents of the aforementioned ICAO-TI, but much more easy to use.

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<sup>6</sup> ICAO is a special organisation of the United Nations conducting the strategy of civilian aviation. ICAO was founded in 1944 by the Convention on International Civil Aviation (Chicago Convention) with domicile in Montréal (Canada). 188 countries of the world are already party to this convention.

# Annex 1

## Definitions

It cannot be ruled out that the following terms may have another meaning in other contexts.

**Ammunition:** In the context of this Best Practice guide the term ammunition covers all substances and items that have or may have explosive properties like

- a) Explosive substances and pyrotechnic mixtures and
- b) Items containing explosives and
- c) Agents and items not listed under a) nor b) that were produced to bring about a practical effect by means of an explosion or a pyrotechnic effect.

**Ammunition transportation safety** means the safety of ammunition as regards the unintended operation of its hazardous materials during regular transportation, taking into consideration the effects and influences inherent in normal transportation operations.

**Ammunition Specialists** are personnel authorized to carry out comprehensive measures and activities in the field of ammunition. They have comprehensive and fundamental knowledge of ammunition and of the handling of ammunition. Preconditions for such an authorization are the proof of the knowledge and certain skills as well as certain moral, mental and physical qualities.

**Ammunition transshipment** means all handling activities needed for loading ammunition on a means of transportation, for unloading ammunition from a means of transportation and for transferring ammunition from one means of transportation to another.

**Blasting agents** mean explosives that are used for demolition; an initiating device triggers their detonation. This kind of explosives may also be contained in initiators and initiating devices.

**Carrier** means the company that carries out the transportation with or without a transportation contract.

**Deflagration** means the chemical conversion of explosives with the generation of flames; this conversion is faster than burning, but still at subsonic speed. If the deflagrating material is being contained, gas pressure, temperature and conversion speed will increase, which may result in a detonation.

**Detonation** means the chemical conversion of explosives at supersonic speed with the generation of a shock wave (within the explosive).

**Dispatcher** means the company that dispatches goods on its own behalf or on behalf of a third party. If the transport is carried out on the grounds of a transportation contract, the dispatcher under this contract shall be deemed the dispatcher.

**Driver** means the person responsible for steering a vehicle in road traffic and for the operational and road safety of this vehicle.

**Explosion** means the mechanical effects of a sudden increase in pressure resulting from a rapid combustion under high gas pressure and the rapid generation of gas (deflagration or detonation of an explosive).

Explosive substances are solid or liquid substances or mixtures, which can, by chemical reaction, generate

gases of such a high temperature, pressure and speed that they can cause destruction in their vicinity.

**Explosives** mean blasting agents, propellants, initiating agents, igniting agents, and pyrotechnic mixtures.

**External transportation of ammunition** means the transportation of ammunition in public traffic. This, i.e., includes movements of ammunition:

- from provider (manufacturer or dealer) to an ultimate recipient (armed or security forces);
- from a governmental or supplier storage site to a military storage site;
- from one military storage site to another military storage site (including to reserve stocks and inventory of reserve organizations);
- from a military storage site to one or several units/formations;
- from a military storage site to a destruction facility; or,
- from a military storage site to a dealer or buyer (e.g. for elimination of surplus).

**Extraneous ammunition** means ammunition that is not under appropriate ownership and was taken over, seized or taken in custody by a third party.

**Handling of ammunition** means the internal and external transportation of ammunition with handling means or by hand.

**Hazardous goods** means material and items which, due to their nature, their characteristics or their condition, may pose a danger to public safety and order, particularly to the general public, essential public goods, life and limb of humans and animals and the integrity of other objects.

**Internal transportation of ammunition** means the transportation of ammunition in ammunition storage facilities or depots or other areas closed to public traffic by barriers, prohibitory signs or other appropriate means.

**Items containing explosives** are items containing one or more explosive substances or pyrotechnic mixtures.

**Materials handling equipment** are machines, equipment and devices used for the transportation of goods within a given workspace.

**Mixed Load** refers to loading Packages containing *class 1* items or substances – i.e. conventional ammunition – belonging to different *compatibility groups of class 1* (cf. [Annex 4](#)) together on one vehicle for the purpose of transport.

**Mixed Packaging** refers to packing items or substances belonging to different *compatibility groups* (cf. [Annex 4](#)) of *class 1* together into one package for the purpose of transport.

**Package** means a containment used to wrap and keep together the goods to be transported so that they can be stored and transported.

**Propellants** mean agents made of solid or liquid deflagrating explosives that are used for propulsion.

**Pyrotechnic mixtures** are substances or mixtures designed to generate an effect in the form of heat, light, sound, gas or smoke or a combination of these effects as a result of non-detonative, self-sustaining, exothermic chemical reactions.

**Recipient** means the recipient identified in the transportation contract. If the recipient authorizes a third

party to receive the shipment, this third party shall be deemed the recipient. If the shipment is carried out without transportation documents, the recipient shall be the company that receives the hazardous goods upon their arrival.

**Recovered ammunition** means ammunition or ammunition parts, which were found and have not been continuously stored, monitored or managed. Hence, recovered ammunition will occur when the former owner has lost or abandoned his property.

**Tie-down equipment** means equipment and material for securing and fastening cargo on a truck bed or interchangeable truck bodies to prevent the load from dropping off the truck bed and from sliding.

### *Transportation*

In the context of this Best practice guide, transport means any movement or carriage of conventional

ammunition. Transport can be conducted by land, air and sea. This best practice guide further differentiates between internal and external transportation of ammunition.

**Transportation safety** is achieved when the goods to be loaded are in a proper and secured condition. The cargo must be secured in the cargo area of the transportation means so as to ensure that it will not be damaged by normal, contract-covered, transportation-related effects (vibrations, stop and go operations, panic stop, centrifugal forces, sea motion, etc.).

**Transportation unit** means a motor vehicle or a unit comprising a motor vehicle with trailer or a semi-trailer truck.

## Annex 2

### Recommendation for the distribution of responsibilities of Personnel Involved in the Transportation of Ammunition

1. A qualified and competent agency should be appointed by the responsible national authority to be responsible for officially grouping substances or items into *class 1* (i.e. ammunition), into one of the *hazard divisions* and into one of the *compatibility groups of class 1*.
2. A qualified and competent agency should be appointed by the responsible national authority to be responsible for officially certifying that vessels (i.e.

trucks or railroad wagons) may be used for the purpose of ammunition transport.

3. A qualified and competent agency should be appointed by the responsible national authority to be responsible for officially certifying that packaging, handling and stowing materials may be used for the purpose of ammunition transport.
4. General safety obligations to be by all personnel involved in loading, unloading or in the execution of the transportation

Within the scope of their responsibilities and irrespective of the ammunition quantity, the personnel involved in the transportation and transshipment of

ammunition must make the arrangements necessary in accordance with the nature and extent of the predictable risks to prevent damages and, if an incident occurs, to keep the extent of the damage as limited as possible.

All personnel involved must observe fire precaution measures like prohibition to smoke and to handle fire and naked light.

In addition to the aforementioned general safety obligations the following obligation are to be observed depending on the specific function of the employed personnel:

a) An appointed ammunition specialist should be made responsible

- to once again determine and certify transportation safety, and
- to examine damaged cargo prior to unloading.

b) The party ordering the transportation should be made responsible

- to inform the dispatcher, the vehicle owner and the carrier about the type and quantity of dangerous goods to be transported, preferably in writing.

c) The owner of the transportation vehicle should be made responsible

- to observe the provisions of regulations on the transportation of ammunition;
- to employ only vehicles approved for ammunition transport;
- to ensure that the safety and loading equipment is in a proper condition and is provided to the driver.

d) The dispatcher should be made responsible

- to inform the owner and the carrier as well as the loading personnel and the driver about the dangerous goods to be transported, preferably in writing;
- for packing of the ammunition and marking of the packages;

- for filling in of the transport document and handing it over to the driver;
- for the provision of accident instruction sheets and additional instruction sheets;
- to attach the prescribed markings of the vehicle;
- to ensure transportation of exclusively certified approved ammunition.

e) The loader should be made responsible

- to instruct the driver on the dangerous goods;
- for observing the mixed loading requirements;
- for loading only approved vehicles and bulk containers;
- for loading only appropriately equipped vehicles;
- for marking containers with appropriate hazard labels;
- to make sure, that the load corresponds with the data on the transport document;
- to make sure, that no damaged packages are loaded;
- to make sure, that the vehicles are properly loaded.

f) The carrier (in case of road transportation) should be made responsible

- to consider whether the transportation can be carried out even if there are icy or snowy roads or if fog, rain or snowfall reduces the visibility to less than 50 m. If he conducts the transportation, he should consider to make sure that either breaks are made after short driving periods or that drivers can alternate;
- to ensure, that - under conditions with less than 50 m visibility - a vehicle equipped with adequately visible rear (fog) lights brings up the rear of the convoy, and
- if available – to ensure that a radio set for receiving the road traffic broadcasts is carried along.
- to ensure that the driver is provided with the transport document, and
- to assign a responsible chief transportation officer;

- to ensure, that only ammunition approved for transportation is transported;
  - to ensure, that only approved vehicles are employed;
  - to ensure, that the stipulated size of a transportation package is not exceeded;
  - to ensure, that only properly equipped vehicles are employed;
  - to ensure, that only reliable and trained personnel is employed as vehicle crew;
  - to ensure, that the vehicle crew and the escort team are briefed prior to loading;
  - to ensure, that accident instruction sheets and – if needed - additional instruction sheets are provided for the driver.
- g) The recipient of the load should be made responsible
- for the removal of hazard labels from empty packages and containers;
  - for proper unloading procedures.
- h) The appointed chief transportation officer should be made responsible
- to - if deemed to be necessary - either order to make a sufficient break or to order a rotation of drivers;
  - to give instructions on the carrying of matches and lighters;
  - to act according to the accident instruction sheet/ additional instruction sheet if an incident occurs;
  - to collect and return accident instruction sheets/ additional instruction sheets that are no longer required;
  - to ensure, that no unauthorized personnel is transported;
  - to ensure, that loaded vehicles are not parked and left unattended;
  - to ensure, that the provisions governing the conduct during breaks are observed;
  - to - if the cargo was damaged - request an ammunition specialist and, if applicable, inform police/ military police.
- i) The driver should be made responsible
- to report to the appointed transportation officer prior to the start of the journey or during a break if he feels unable to continue driving;
  - to bring along the appropriate equipment, the transport document and the accident instruction sheet/additional instruction sheet and present these papers upon request;
  - to observe the prohibition to carry unauthorized personnel and to transport personnel on the truck bed;
  - to compare, together with the loader, the cargo with the data on the transport document;
  - to make himself familiar with the contents of the accident instruction sheet/additional instruction sheet prior to the start of the transportation;
  - to observe the refueling provisions;
  - to ensure, that no empty packages or packages containing non-hazardous goods marked with hazard labels are loaded;
  - to ensure, that jerry cans with spare fuel are carried only in special brackets outside the truck bed;
  - to act according to the accident instruction sheet/ additional instruction sheet in case of an incident;
  - to interrupt the journey, request a specialist and inform, if applicable, police/military police if the cargo was damaged;
  - to observe the regulations governing the conduct during breaks, and
  - to ensure, that no damaged packages are loaded onto the vehicle;
  - for the installation, uncovering or covering of warning sign / hazard labels;
  - for conducting vehicle checks prior to loading and after unloading;
  - for the proper loading and unloading of the vehicle;



- for maintaining proper distances between vehicles in a convoy;
  - for adherence to regulations for the safe stowing of the load.
- j) The co-driver should be made responsible
- to observe the aforementioned general safety obligations;
  - to ensure, that the equipment is on the vehicle, and produce this equipment upon request;
  - to make himself familiar with the contents of the accident instruction sheet/additional instruction sheet prior to the start of the transportation;
  - to check the vehicle together with the driver prior to loading and after unloading;
  - to know how to act in incidents and during breaks;
  - to take the necessary measures when loaded vehicles are parked also in barracks.

## Annex 3

### Knowledge and Skills for Transportation of Ammunition

In order to cover all stages of the transportation process, this list also includes knowledge and skills, which are necessary for transporting non-hazardous goods. The list contains the minimum requirements.

#### *I. Knowledge and skills required of dispatchers, loaders and carriers*

##### **Dispatchers, loaders and carriers should**

- know the general health and safety regulations for handling ammunition;
- know the meaning of *hazard divisions*, *compatibility groups* and *ammunition fire divisions*;
- know which dangers ammunition can pose to humans, animals and the environment in case of accident or fire;
- be able to determine whether ammunition has been approved for transportation;
- be able to apply for an exemption permit for the transportation of ammunition;
- be able to determine whether a particular mode of transportation is required;
- be able to suggest a mode of transportation on the basis of an economic efficiency calculation;
- be able to determine the necessary number of specialist and auxiliary personnel;
- be able to properly employ specialists and auxiliary personnel;
- be able to determine the required transportation means;
- be able to order transportation capacity i.a.w. the relevant transportation request procedures;
- be able to determine whether the supplied vehicles and bulk containers are approved and suitable for transporting ammunition;
- be able to determine the required means of transshipment;
- be able to verify whether the means of transshipment may be used and are suited for the respective transportation;
- be able, among others, to determine the required tie-down equipment, tools, dunnage and consumable materials;
- be able to verify whether the equipment and/or material may be used for the respective transportation;
- know which fire prevention and first-aid measures are necessary;
- be able to determine the route, taking into account any prohibited or prescribed routes and possible traffic

- congestions, as well as the actual course of the journey, taking into account driving bans at certain times, prescribed breaks and possible weather conditions;
- know which regulations (e.g. compatibility requirements for mixed loading and storage) have to be observed when supplying the ammunition;
  - know the ammunition-related technical safety requirements (e.g. loading requirements and heights of fall);
  - be able to handle the loading procedures applicable within their field of activity;
  - know the load limit of the means of transportation;
  - know how to distribute the cargo on the cargo bed of the means of transportation;
  - know the criteria of ammunition transportation safety;
  - be able to assess whether any measures have to be taken in case of damaged packages, depending on the kind and extent of damage;
  - be able to determine for which kinds of transportation the packages have to be marked or labelled;
  - know how to mark vehicles and containers and which markings are to be used;
  - know how to mark packages containing duds;
  - know which accompanying documents are necessary for the transport, how to fill them in and use them;
  - know which general and special protection measures have to be taken (e.g. cordon off a transshipment site, employ an escort team);
  - know the occupational safety regulations for their respective field of activity;
  - be able to instruct the personnel involved in the transport with respect to the current health and safety regulations;
  - be able to set up and operate a transshipment site;
  - know what to do during the transfer of a shipment; e.g. know from which point on they are responsible for which kinds of protection and safety regulations and be able to arrange in due time for the ammuni-

tion to be guarded or unloaded;

- know which details to pay attention to and which measures to take before, during and after the unloading procedure (e.g. check for external damage, initiate measures in the case of damaged ammunition and/or packages or remove/cover markings).

## **II. Knowledge and skills required of drivers of ammunition transports**

### **The driver should**

- hold the necessary driver's license;
- have sufficient experience as a driver;
- be reliable and physically and mentally qualified for the job;
- know which vehicle and accompanying documents to carry, where they have to be carried and which data they should contain;
- know the meaning of the data in the *accident instruction sheet/additional instruction sheet*;
- know which kind of equipment has to be carried along in the vehicle any time ammunition is transported, what it has to look like and how to use it, including first-aid measures in case of burns;
- know how to prepare the vehicle for loading;
- know which engines and units to turn off during loading;
- know what to do when there are damaged packages;
- know how to distribute the cargo on the cargo bed;
- have knowledge on how to secure the cargo;
- be able to verify whether the transportation documents correspond with the cargo;
- be able to properly handle the packages;
- be able to use the tie-down equipment;
- be able to properly tie down the protective tarpaulin;
- know in which case and how to mark a transportation unit;
- know the requirements for the driving route and times;

- know which persons he may take along;
- know under which conditions he may drive without a co-driver;
- know what to do in various weather and road conditions;
- know which detour routes he may or must use in case of a traffic congestion;
- know what to do in case of a vehicle breakdown, an accident or a fire (he should have trained for these incidents);
- know which distances have to be maintained in a convoy;
- know which details to pay attention to when parking the vehicles (e.g. safety distance, guarding the vehicles);
- know what to do when the cargo is damaged;
- know when to remove or cover the markings;
- know when the *accident instruction sheets/additional instruction sheets* are to be removed by the record-keeping agencies;
- know the general health and safety regulations;
- observe the prohibition to smoke and handle fire and naked light during transshipment and road transportation;
- observe the prohibition to carry along fire-starting

devices to the transshipment site and into the vehicles and follow the respective instructions by the chief transportation officer.

#### **IV. Knowledge and skills required of co-drivers of ammunition transports**

##### **The co-driver should**

- know the general health and safety regulations (with respect to fire and smoking);
- understand the data in the *accident instruction sheet/additional instruction sheet*;
- be able to act according to the *accident instruction sheet/additional instruction sheet*;
- know what to do in case of a vehicle breakdown, an accident or fire (he should have trained for these incidents);
- be able to properly operate and employ the equipment (warning lights, emergency reflective triangles, fire extinguishers, first-aid equipment, etc.);
- be able to properly handle the packages;
- be able to properly handle the tie-down equipment on instruction by the driver.

## Annex 4

### Classification of Substances into Hazard Divisions / Compatibility Groups / Classification Codes

#### **1. Classification of Class 1**

Substances and items that have or may have explosive properties (ADR, Class 1) should be examined by a competent agency (e.g. government authority) using the required test procedures and test criteria in order to

determine whether they are to be classified into Hazard Divisions. Class 1 agents include:

##### **a) Explosive substances and pyrotechnic mixtures**

**Explosive substances** are solid or liquid substances or mixtures, which can, by chemical reaction, generate gases of such a high temperature, pressure and speed that they can cause destruction in their vicinity.

**Pyrotechnic mixtures** are substances or mixtures designed to generate an effect in the form of heat, light, sound, gas or smoke or a combination of these effects as a result of non-detonative, self-sustaining, exothermic chemical reactions.

**b) Items containing explosives**

Items containing one or more explosive substances or pyrotechnic mixtures.

**c) Agents and items** not listed under a) nor b) that were produced to bring about a practical effect by means of an explosion or a pyrotechnic effect.

## 2. Classification into Hazard Divisions

Due to the large number of different types of ammunition and explosives and corresponding hazard potentials, Class 1 is subdivided into six Hazard Divisions (1.1 to 1.6), with increasing numbers designating a decreasing hazard potential:

Class 1 hazardous goods should be classed into one of the following Hazard Divisions by a competent authority. The appropriate subdivision can be determined by tests and experiments, which will generally include a fire test.

### *Hazard Division 1.1*

Hazard Division 1.1 substances and items have a **mass explosion hazard**. A mass explosion is an explosion that affects almost the entire load instantaneously and results in severe devastation or destruction close to the detonation site. Within a wide radius, blasts, projected fragments and debris as well as ground waves pose a danger to the vicinity.

### *Hazard Division 1.2*

Hazard Division 1.2 substances and items do not have a **mass explosion hazard**. Subsequent single explosions (detonation, deflagration) occur in ever-shorter inter-

vals. Depending on the size of the items and the explosive mass, the hazard through projected fragments and debris covers a wide radius. The blast pressure affects only the immediate vicinity.

### *Hazard Division 1.3*

Hazard Division 1.3 substances and items do not have a **mass explosion hazard**. They have a **fire hazard** and a **minor hazard either because of the blast pressure** or projected **fragments and debris** or both. The burning process results either in a significant radiant heat (for instance in the case of propelling charges) or the agents and items subsequently burn or explode in such a way as to cause a minor blast pressure or projection of fragments and debris or both. In case of fire, the vicinity is exposed to the danger of radiant heat and projected burning parts and items (for instance pyrotechnic flares) or packaging, while the hazards of blast pressure and projected fragments and debris are relatively low. Apart from that, there will be heavy smoke when pyrotechnic agents and particularly smoke generating agents are burned. Smoke may have a caustic and/or toxic effect.

### *Hazard Division 1.4*

Hazard Division 1.4 substances and items only have a **minor explosion hazard** when the propelling charge or the explosive agent ignites during transport. The effects are basically confined to the package itself, and it is unlikely that larger fragments will be projected over longer distances. An external fire must not cause virtually instantaneous explosion of almost the whole content of the package. The closer vicinity is subject to the danger of radiant heat and fire (normal fire). Igniter caps, high explosive mixtures or components such as cartridge shells that are propelled from the origin of the fire may lead to eye injuries and minor burns.

### Hazard Division 1.5

Hazard Division 1.5 substances are **very insensitive** and **have a mass explosion hazard**. They are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal transportation conditions. The minimum requirement for these substances is that they must not explode in an external fire test.

### Hazard Division 1.6

Hazard Division 1.6 items are **extremely insensitive** and **do not have a mass explosion hazard**. These items contain only extremely insensitive detonating substances and demonstrate a negligible probability of accidental initiation or explosion propagation. The danger posed by subdivision 1.6 items is limited to the explosion of a single item.

### 3. Classification into a compatibility group

Since different **explosives and items containing explosives (for example ammunition)** can react very differently owing to their chemical characteristics, sensitivity, structure and composition, the ADR divides ammunition into altogether thirteen so-called *compatibility groups*. This classification is very significant when one has to determine the permissibility which of the different ammunition types may be combined in one transportation unit.

The classification of a certain type of ammunition into one of the following thirteen compatibility groups (**A** – **L**, **N** and **S**) should be determined by a competent agency (e.g. government authority) using the required test procedures and test criteria.

**A** Primary explosive substances, e.g. initial detonating agents.

**B** An item containing a primary explosive substance and less than two effective protective features. Some items such as detonators for blasting, detonator assemblies for blasting and cap-type primers are also included in this category, although they do not contain primary explosives.

**C** A propellant explosive substance or other deflagrating explosive substance or item containing such explosive substance.

**D** A secondary detonating explosive substance or black powder or an item containing a secondary, detonating explosive substance, in each case without means of initiation and without a propelling charge, or an item containing a primary explosive substance and at least two effective protective features.

**E** An item containing a secondary detonating explosive substance without means of initiation, with a propelling charge (other than one containing flammable liquid, gel or hypergolic liquid).

**F** An item containing a secondary detonating explosive substance with its means of initiation and a propelling charge (other than one containing flammable liquid, gel or hypergolic liquid), or without a propelling charge.

**G** A pyrotechnic substance or item containing a pyrotechnic substance or item containing both an explosive substance and an illuminating, incendiary, tear-producing or smokegenerating substance (other than a water-activated item or one containing white phosphorus, phosphide, a pyrophoric substance, a flammable liquid or gel or hypergolic liquid).

**H** An item containing both an explosive substance and white phosphorus.

**J** An item containing both an explosive substance and a flammable liquid or gel.

**K** An item containing both an explosive substance and a toxic chemical agent.

**L** An explosive substance or item containing an explosive substance and presenting a special risk (e.g. due to water-activation or presence of hypergolic liquids, phosphides or a pyrophoric substance) requiring isolation of each type.

**N** An item containing only extremely insensitive detonating substances.

**S** A substance or item packed or designed in such a way that any hazardous effects arising from accidental functioning will be confined to the package itself, unless the package has been damaged by fire. In the latter case, the blast and fragmentation effect will be limited to the extent that they do not significantly hinder or prohibit fire fighting or other necessary emergency response measures in the immediate vicinity of the package.

The compatibility group S is limited to Hazard Division 1.4.

#### 4. The classification code

**Hazard Division** and **compatibility group** in combination make up the *classification code*, which provides information about the hazard potential and the composition of Class 1 goods.

##### Example:

An explosive is classed into *classification code 1.1D*:

- *Hazard Division 1.1* (explosive substance with mass explosion hazard) and
- *Compatibility Group D* (secondary detonating explosive substance without means of initiation and propelling charge).

## Annex 5

### Mixed Loads of class 1 Substances or Items

Class 1 substances or items – i.e. conventional ammunition – should not be transported together on one vehicle<sup>7</sup>, with items or substances belonging to classes other than class 1<sup>8</sup>.

Class 1 substances or items belonging to different compatibility groups (cf. Annex 4) should not be transported together onto one vehicle<sup>9</sup>, unless the following table permits this “mixed loading”. Restraints indicated in the table should be observed.

<sup>7</sup> If a transport unit consists of a truck plus a trailer, both, truck and trailer are considered to be separate vehicles.

<sup>8</sup> Fuel for the purpose of refueling the ammunition transport vehicle should be transported in jerry cans located in racks outside the loading space of the vehicle

<sup>9</sup> If a transport unit consists of a truck plus a trailer, both, truck and trailer are considered to be separate vehicles.

Compatibility Group	A	B	C	D	E	F	G	H	J	K	L	N	S
A										(5)			
B				(1)						(5)			
C										(5)		(2), (3)	
D										(5)		(2), (3)	
E										(5)		(2), (3)	
F										(5)			
G										(5)			
H										(5)			
J										(5)			
K	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
L										(5)	(4)		
N			(2), (3)	(2), (3)	(2), (3)					(5)		(2)	
S										(5)			

 = "mixed loading" is permitted

- (1) = Packages of substances and articles in compatibility group B and D may be loaded in the same vehicle, providing that they should be transported in container or in a separate compartment approved by competent authority, to prevent any transmission of detonation from articles in compatibility group B to substances or articles in compatibility group D.
- (2) = Different types of articles of division 1.6, compatibility group B, may only be transported together when is proven that there is no additional risk of sympathetic detonation between the articles. Otherwise they should be treated as division 1.1.
- (3) = Articles of compatibility group N transported together with substances or articles of compatibility group C, D or E, should be considered as having the characteristics of compatibility group D.
- (4) = Packages containing substances and articles in compatibility group L, should only be stowed with packages containing the same substances and articles type within compatibility group L.
- (5) = Admissibility to the road transport of goods in compatibility group K should be authorized by an appointed and competent authority.

## Annex 6

### Hazard Labels

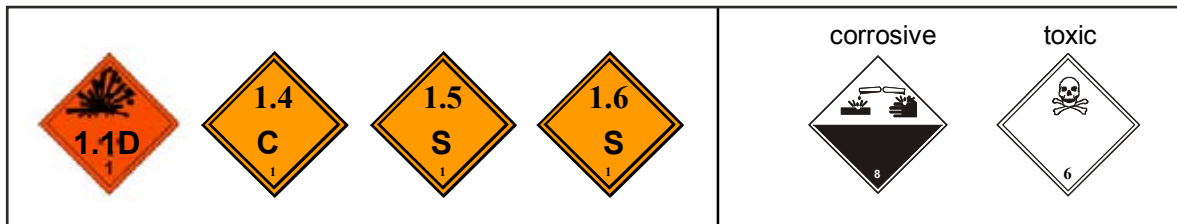
The *hazard labels* listed below serve as markings for packages (sets of packaging), containers and transportation units (vehicles) that are used for transporting ammunition.

*Hazard labels* provide information on the hazard/combination of hazards, which is posed by the ammunition they mark. *Hazard labels* for *class 1* goods indicate the *hazard division* (from 1.1 to 1.6) and the *compatibility group* (from A to S) of the ammunition that is being transported. For “*hazard division* “ and “*compatibility group*“ see [Annex 4](#).

As ammunition may contain several hazardous substances, two other *hazard labels* are of importance for the transportation of ammunition in addition to the above-mentioned *class 1* labels (“explosives”). These labels are primarily intended to mark hazardous goods falling into *division 6* (“toxic substances“) or *division 8* (“corrosives“).

Depending on the type of ammunition, it may be necessary to attach *hazard label(s)* no. 8 and/or 6.1, which are shown below, to the package, container or vehicle in addition to a *division 1 hazard label* (no. 1.x) in order to specify the hazards posed by the cargo as accurately as possible.

#### Hazard Labels



#### Indication of hazard division and compatibility group

The size of a *hazard label* should be commensurate with the label’s intended use and, if possible, be weatherproof. On packages, stickers are often used for *hazard labels*; on transportation units they mostly have the form of plastic signs.







# Annex 7

## Fire Placards for Class 1 Hazardous Goods

The classification of ammunition into the four fire divisions listed below is based on the classification of ammunition into one of the hazard divisions of class 1 (cf. Annex 4). Fire division placards furnish emergency

response personnel (fire brigade/police) with the following information:

- reaction of the ammunition in the event of fire or explosion (= reaction of the ammunition);
- resultant hazards to the objects that are to be protected (= hazard to objects).

Hazard Division	Fire Division	Reaction of the Ammunition	Hazard to Objects
1.1		<b>Mass explosion of the ammunition!</b> The detonation generates a large number of fragments and debris. In case of fire, an increase in temperature and pressure may cause a detonation. A detonation most often leads to a mass explosion.	Severe devastation is to be expected in the vicinity of the explosion site! Objects in the wide proximity are endangered by fragments and debris as well as by shock and ground waves. The pressure has a crushing impact on the surrounding objects.
1.2		<b>The ammunition explodes!</b> In the initial stages of the fire, there are only occasional explosions of ammunition. As the fire progresses, more and more ammunition reacts at increasingly small intervals but there is no mass explosion.	Shock waves and projected fragments cause moderate to severe damage in the surrounding area. Some burning and non-exploding ammunition is catapulted from the cargo bed and may cause new fires or explosions upon impact.
1.3		<b>The ammunition deflagrates, generating a blaze and intense heat. There is a danger that a mass fire will develop!</b> It does not come to a mass explosion. The deflagration spreads at an increasing speed.	The close vicinity of the explosion site is endangered by intense heat and fire as well as by thick smoke! The surrounding area is endangered by flames, heat, flying sparks, firebrand and flying, usually burning parts of the ammunition or packaging.
1.4		<b>Above all, the ammunition poses a moderate fire hazard!</b> The effect of the fire is basically confined to the stowage container and its contents. An external fire will not lead to a simultaneous explosion of a package's entire contents.	The immediate surroundings are endangered by heat and fire! As a rule, ammunition burns down. Flying sparks or firebrand is a rare occurrence. Occasionally, parts and fragments of the ammunition and its packaging are catapulted from the cargo bed. The distance they cover is small, though.

## Annex 8

### Accident Information Sheets (AIS) “Ammunition and Explosives Class 1” for Transportation of Ammunition by Road

This Annex includes 6(six) AIS covering the Hazard Divisions 1.1 to 1.6.

Adherence to these principles should enhance the safety of ammunition and explosives operations. It does not ensure or guarantee a risk-free situation, neither can the principles cater for every possible situation which could be encountered.

The shipper of class 1 hazardous goods is responsible for the contents of these instructions.

For each transport the AIS are to be filled out by the persons responsible with related data.

All class 1 hazardous goods are assigned a ,UN number‘ which identifies the hazard presented.

The UN publishes a list of all UN numbers for all classes of hazardous goods in their *Recommendations on the Transport of Dangerous Goods*, better known as the ,Orange Book‘.

## Accident Information Sheet ROAD

CLASS 1, DIVISION 1.1, ADR

<b>UN – Number(s):</b>



**LOAD** • Ammunition and explosives

**NATURE OF DANGER**

- Mass Explosion
- Blast
- High velocity fragments and debris
- Potential additional environmental hazards – see Supplementary Hazard Warning Sheet, if attached

**PERSONAL PROTECTION**

- Two self-standing warning devices
- Warning vest or warning clothes for each crewmember
- Hand lamp for each crewmember
- See also supplemental hazard warning sheet, if attached

**GENERAL DRIVER ACTIONS**

- **KEEP CALM**
- Notify police with reference to ammunition.
- Notify fire brigade (via police) if necessary
- Stop engine. No naked lights; no smoking
- Secure accident area. Mark road hazard with warning devices
- Warn road users and passers-by about hazards. Advise to keep upwind if necessary.
- Provide first aid
- Guard cargo and keep unauthorized persons at least 25 meters away
- Do not touch dropped or projected ammunition
- Notify own agency/activity

**ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER** • Supplementary hazard warning sheet attached: YES NO

**FIRE**

**DEVELOPING FIRE – (cargo not yet on fire)**

- Fight fire with all available means

**ESTABLISHED FIRE – (cargo on fire)**

- DO NOT fight fire
- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- Always seek significant cover (such as strongly built structure). Avoid glass surfaces

**FIRST AID** • Standard unless supplemental hazard warning sheet specifies, if attached.

**ADDITIONAL INFORMATION**

- Emergency Service fire withdrawal distance recommendations on reverse.
- Brief description of material:
- For further information call:

<b>EMERGENCY</b>			
Austria	133	Italy	112
Belgium	112	Ireland	999
Canada	911	Netherlands	112
Croatia	112	Norway	112
Czech Rep.	112	Poland	112
Denmark	112	Slovenia	112
Finland	112	Sweden	112
France	112	Switzerland	117
Germany	110	Turkey	155
Hungary	112	UK	999

## Accident Information Sheet ROAD

### CLASS 1, DIVISION 1.1, ADR

- Emergency Service fire withdrawal distance recommendations

#### FIRE

##### ESTABLISHED FIRE – (cargo on fire)

- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- **Keep all persons (except rescue personnel) away from fire area**  
**Minimum distance to personnel - 1000 meters**
- Always seek significant cover (such as strongly built structure); avoid glass surfaces
- **rescue personnel – 500 meters**
- Fight ambient fires from covered position

# Accident Information Sheet ROAD

CLASS 1, DIVISION 1.2, ADR

<b>UN – Number(s):</b>



**LOAD** • Ammunition and explosives

**NATURE OF DANGER**

- Progressive Explosions
- Fragments and debris
- Potential additional environmental hazards – see Supplementary Hazard Warning Sheet, if attached

**PERSONAL PROTECTION**

- Two self standing warning devices
- Warning vest or warning clothes for each crewmember
- Hand lamp for each crewmember
- See also supplemental hazard warning sheet, if attached

**GENERAL DRIVER ACTIONS**

- **KEEP CALM**
- Notify police with reference to ammunition.
- Notify fire brigade (via police) if necessary
- Stop engine. No naked lights; no smoking
- Secure accident area. Mark road hazard with warning devices
- Warn road users and passers-by about hazards. Advise to keep upwind if necessary.
- Provide first aid
- Guard cargo and keep unauthorized persons at least 25 meters away
- Do not touch dropped or projected ammunition
- Notify own agency/activity

**ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER** • Supplementary hazard warning sheet attached: YES NO

**FIRE**

**DEVELOPING FIRE – (cargo not yet on fire)**

- Fight fire with all available means

**ESTABLISHED FIRE – (cargo on fire)**

- DO NOT fight fire
- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- Always seek significant cover (such as strongly built structure) Avoid glass surfaces

**FIRST AID** • Standard unless supplemental hazard warning sheet specifies, if attached.

**ADDITIONAL INFORMATION**

- Emergency Service fire withdrawal distance recommendations on reverse.
- *Brief description of material:*
- For further information call:

<b>EMERGENCY</b>			
Austria	133	Italy	112
Belgium	112	Ireland	999
Canada	911	Netherlands	112
Croatia	112	Norway	112
Czech Rep.	112	Poland	112
Denmark	112	Slovenia	112
Finland	112	Sweden	112
France	112	Switzerland	117
Germany	110	Turkey	155
Hungary	112	UK	999

## Accident Information Sheet ROAD

### CLASS 1, DIVISION 1.2, ADR

- Emergency Service fire withdrawal distance recommendations

#### **FIRE ESTABLISHED FIRE – (cargo on fire)**

- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- **Keep all persons (except rescue personnel) away from fire area**  
**Minimum distance - at least 1000 meters**
- Always seek significant cover (such as strongly built structure); avoid glass surfaces
- **rescue personnel – 500 meters**
- Fight ambient fires from covered position

## Accident Information Sheet ROAD

CLASS 1, DIVISION 1.3, ADR

<b>UN – Number(s):</b>



- LOAD**
- Ammunition and explosives
- NATURE OF DANGER**
- Explosions
  - Fire; possibility of mass fire
  - Firebrands may be projected
  - Potential additional environmental hazards – see Supplementary Hazard Warning Sheet, if attached
- PERSONAL PROTECTION**
- Two self standing warning devices
  - Warning vest or warning clothes for each crewmember
  - Hand lamp for each crewmember
  - See also supplemental hazard warning sheet, if attached
- GENERAL DRIVER ACTIONS**
- **KEEP CALM**
  - Notify police with reference to ammunition.
  - Notify fire brigade (via police) if necessary
  - Stop engine. No naked lights; no smoking
  - Secure accident area. Mark road hazard with warning devices
  - Warn road users and passers-by about hazards. Advise to keep upwind if necessary.
  - Provide first aid
  - Guard cargo and keep unauthorized persons at least 25 meters away
  - Do not touch dropped or projected ammunition
  - Notify own agency/activity
- ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER**
- Supplementary hazard warning sheet attached: YES NO
- FIRE**
- DEVELOPING FIRE – (cargo not yet on fire)**
- Fight fire with all available means
- ESTABLISHED FIRE – (cargo on fire)**
- DO NOT fight fire
  - Evacuate casualties as quickly as possible from hazard area
  - Leave area of fire immediately
- FIRST AID**
- Always seek significant cover (such as strongly built structure) Avoid glass surfaces
  - Standard unless supplemental hazard warning sheet specifies, if attached.
- ADDITIONAL INFORMATION**
- Emergency Service fire withdrawal distance recommendations on reverse.
  - *Brief description of material:*
  - For further information call:

<b>EMERGENCY</b>			
Austria	133	Italy	112
Belgium	112	Ireland	999
Canada	911	Netherlands	112
Croatia	112	Norway	112
Czech Rep.	112	Poland	112
Denmark	112	Slovenia	112
Finland	112	Sweden	112
France	112	Switzerland	117
Germany	110	Turkey	155
Hungary	112	UK	999

## Accident Information Sheet ROAD

### CLASS 1, DIVISION 1.3, ADR

- Emergency Service fire withdrawal distance recommendations

#### **FIRE ESTABLISHED FIRE – (cargo on fire)**

- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- **Keep all persons (except rescue personnel) away from fire area**  
**Minimum distance to personnel - 500 meters**
- Always seek significant cover (such as strongly built structure); avoid glass surfaces
- **rescue personnel – 60 meters**
- Fight ambient fires from covered position



## Accident Information Sheet ROAD

CLASS 1, DIVISION 1.4, ADR

<b>UN – Number(s):</b>



**LOAD  
NATURE OF  
DANGER**

- Ammunition and explosives
- Moderate fire
- Effects largely confined to package
- Limited flight distance of fragments
- Potential additional environmental hazards – see Supplementary Hazard Warning Sheet, if attached

**PERSONAL  
PROTECTION**

- Two self standing warning devices
- Warning vest or warning clothes for each crewmember
- Hand lamp for each crewmember
- See also supplemental hazard warning sheet, if attached

**GENERAL  
DRIVER ACTIONS**

- **KEEP CALM**
- Notify police with reference to ammunition.
- Notify fire brigade (via police) if necessary
- Stop engine. No naked lights; no smoking
- Secure accident area. Mark road hazard with warning devices
- Warn road users and passers-by about hazards. Advise to keep upwind if necessary.
- Provide first aid
- Guard cargo and keep unauthorized persons at least 25 meters away
- Do not touch dropped or projected ammunition
- Notify own agency/activity

**ADDITIONAL AND/  
OR SPECIAL ACTIONS  
BY DRIVER**

- Supplementary hazard warning sheet attached: YES NO

**FIRE**

**DEVELOPING FIRE – (cargo not yet on fire)**

- Fight fire with all available means

**ESTABLISHED FIRE – (cargo on fire)**

- Fight fire
- Evacuate casualties as quickly as possible from hazard area
- Keep all persons except firefighters well away from the area for the fire
- Standard unless supplemental hazard warning sheet specifies, if attached.

**FIRST AID**

**ADDITIONAL  
INFORMATION**

- Emergency Service fire withdrawal distance recommendations on reverse.
- Brief description of material:
- For further information call:

<b>EMERGENCY</b>			
Austria	133	Italy	112
Belgium	112	Ireland	999
Canada	911	Netherlands	112
Croatia	112	Norway	112
Czech Rep.	112	Poland	112
Denmark	112	Slovenia	112
Finland	112	Sweden	112
France	112	Switzerland	117
Germany	110	Turkey	155
Hungary	112	UK	999

## Accident Information Sheet ROAD

### **CLASS 1, DIVISION 1.4, ADR**

- Emergency Service fire withdrawal distance recommendations

#### **FIRE**

#### **ESTABLISHED FIRE – (cargo on fire)**

- **Keep all persons (except rescue personnel) away from fire area**  
**Minimum distance - at least 100 meters**
- **rescue personnel – 25 meters**

## Accident Information Sheet ROAD

CLASS 1, DIVISION 1.5, ADR

UN – Number(s):



- LOAD**
- Ammunition and explosives
- NATURE OF DANGER**
- Mass Explosion
  - Blast
  - High velocity fragments and debris
  - Potential additional environmental hazards – see Supplementary Hazard Warning Sheet, if attached
- PERSONAL PROTECTION**
- Two self standing warning devices
  - Warning vest or warning clothes for each crewmember
  - Hand lamp for each crewmember
  - See also supplemental hazard warning sheet, if attached
- GENERAL DRIVER ACTIONS**
- **KEEP CALM**
  - Notify police with reference to ammunition.
  - Notify fire brigade (via police) if necessary
  - Stop engine. No naked lights; no smoking
  - Secure accident area. Mark road hazard with warning devices
  - Warn road users and passers-by about hazards. Advise to keep upwind if necessary.
  - Provide first aid
  - Guard cargo and keep unauthorized persons at least 25 meters away
  - Do not touch dropped or projected ammunition
  - Notify own agency/activity
- ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER**
- Supplementary hazard warning sheet attached: YES NO
- FIRE**
- DEVELOPING FIRE – (cargo not yet on fire)**
- Fight fire with all available means
- ESTABLISHED FIRE – (cargo on fire)**
- DO NOT fight fire
  - Evacuate casualties as quickly as possible from hazard area
  - Leave area of fire immediately
  - Always seek significant cover (such as strongly built structure) Avoid glass surfaces
- FIRST AID**
- Standard unless supplemental hazard warning sheet specifies, if attached.
- ADDITIONAL INFORMATION**
- Emergency Service fire withdrawal distance recommendations on reverse.
  - *Brief description of material*
  - For further information call:

EMERGENCY			
Austria	133	Italy	112
Belgium	112	Ireland	999
Canada	911	Netherlands	112
Croatia	112	Norway	112
Czech Rep.	112	Poland	112
Denmark	112	Slovenia	112
Finland	112	Sweden	112
France	112	Switzerland	117
Germany	110	Turkey	155
Hungary	112	UK	999

## Accident Information Sheet ROAD

### CLASS 1, DIVISION 1.5, ADR

- Emergency Service fire withdrawal distance recommendations

#### **FIRE**

##### **ESTABLISHED FIRE – (cargo on fire)**

- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- **Keep all persons (except rescue personnel) away from fire area**  
**Minimum distance to personnel - 1000 meters**
- Always seek significant cover (such as strongly built structure); avoid glass surfaces
- **rescue personnel – 500 meters**
- Fight ambient fires from covered position

# Accident Information Sheet ROAD

CLASS 1, DIVISION 1.6, ADR

<b>UN – Number(s):</b>



- LOAD**
- Ammunition and explosives
- NATURE OF DANGER**
- Fire and heat
  - Potential additional environmental hazards – see Supplementary Hazard Warning Sheet, if attached
- PERSONAL PROTECTION**
- Two self standing warning devices
  - Warning vest or warning clothes for each crewmember
  - Hand lamp for each crewmember
  - See also supplemental hazard warning sheet, if attached
- GENERAL DRIVER ACTIONS**
- **KEEP CALM**
  - Notify police with reference to ammunition.
  - Notify fire brigade (via police) if necessary
  - Stop engine. No naked lights; no smoking
  - Secure accident area. Mark road hazard with warning devices
  - Warn road users and passers-by about hazards. Advise to keep upwind if necessary.
  - Provide first aid
  - Guard cargo and keep unauthorized persons at least 25 meters away
  - Do not touch dropped or projected ammunition
  - Notify own agency/activity
- ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER**
- Supplementary hazard warning sheet attached: YES NO

- FIRE**
- DEVELOPING FIRE – (cargo not yet on fire)**
- Fight fire with all available means
- ESTABLISHED FIRE – (cargo on fire)**
- Fight fire
  - Evacuate casualties as quickly as possible from hazard area
  - Keep all persons except firefighters well away from the area for the fire

- FIRST AID**
- Standard unless supplemental hazard warning sheet specifies, if attached.

- ADDITIONAL INFORMATION**
- Emergency Service fire withdrawal distance recommendations on reverse.
  - Brief description of material:
  - For further information call:

<b>EMERGENCY</b>			
Austria	133	Italy	112
Belgium	112	Ireland	999
Canada	911	Netherlands	112
Croatia	112	Norway	112
Czech Rep.	112	Poland	112
Denmark	112	Slovenia	112
Finland	112	Sweden	112
France	112	Switzerland	117
Germany	110	Turkey	155
Hungary	112	UK	999

## Accident Information Sheet ROAD

### CLASS 1, DIVISION 1.6, ADR

- Emergency Service fire withdrawal distance recommendations

#### **FIRE**

##### **ESTABLISHED FIRE – (cargo on fire)**

- Evacuate casualties as quickly as possible from hazard area
- Leave area of fire immediately
- **Keep all persons (except rescue personnel) away from fire area**  
**Minimum distance - at least 1000 meters**
- Always seek significant cover (such as strongly built structure); avoid glass surfaces
- **rescue personnel – 250 meters**

# ANNEX 9

## Accident Information Sheet ROAD

### *Supplementary Hazard Warning Sheets*

The following list displays hazardous substances which may be contained in ammunition in addition to or instead of explosives and for which a specific *Supplementary Hazard Warning Sheet* may be required (find related samples attached to this annex):

Hazardous Substance	Code Designation
White Phosphorus	WP
Chlorobenzylidene Malonic Acid Dinitrile, also termed Ortho-Chlorobenzalmalononitrile	CS
Chloroacetophenone	CN
Titanium Tetrachloride	FM
Hexachloroethane	HC
Red Phosphorus	RP
Thermite	TH
Pyrotechnic Charges	PT
Calcium Phosphide	CP
Unsymmetrical Dimethyl Hydrazine	UDMH
Inhibited Red Fuming Nitric Acid	IRFNA
Depleted Uranium	DU
Otto Fuel	OF

# CN

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Chloroacetophenone (CN) or

### Chlorobenzylidene Malonic Acid Dinitrile (CS), also termed Ortho-Chlorobenzalmalononitrile

<b>LOAD</b>	<p>(CN) Ammunition containing Chloroacetophenone, which is:</p> <ul style="list-style-type: none"> <li>• Colourless to white or slightly yellowish crystals or powder.</li> <li>• Nasty smell.</li> <li>• Heavier than water; <b>or</b></li> </ul> <p>(CS) Ammunition containing Chlorobenzylidene Malonic Acid Dinitrile which is:</p> <ul style="list-style-type: none"> <li>• White to slightly yellowish substance.</li> <li>• Slightly pepper-like to pungent smell.</li> </ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"> <li>• Irritation of eyes, skin and respiratory tract.</li> <li>• Nausea, vomiting and cauterization. High concentrations will cause severe noxious effects. Detrimental to health when inhaled and swallowed.</li> <li>• Potential hazard to waters and sewage treatment plants.</li> <li>• Substances hazardous to water may be produced in the event of fire.</li> <li>• CN -- Slow reaction with water producing a caustic mixture.</li> </ul>
<b>PERSONAL PROTECTION</b>	<ul style="list-style-type: none"> <li>• Appropriate respiratory protection equipment.</li> <li>• One 500 ml eye-flushing bottle with fresh tap water for each individual.</li> <li>• One container with 20 liters fresh tap water</li> </ul>
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes: Throughout area affected by smoke and fumes:</p> <ul style="list-style-type: none"> <li>• Short stay: wear appropriate respiratory protection equipment</li> </ul> <p><b>EMERGENCY SERVICES advice:</b> In event of longer stay:</p> <ul style="list-style-type: none"> <li>• Wear self contained breathing apparatus</li> <li>• Cover all parts of the body</li> </ul>
<b>FIRST AID</b>	<ul style="list-style-type: none"> <li>• Remove affected clothing.</li> <li>• In the event of skin irritations, thoroughly rinse and wash affected skin areas.</li> <li>• In case of eye contact, hold eyelids open and rinse with tap water 10 to 15 minutes while rolling eyes in all directions. Refer to ophthalmologist if necessary.</li> <li>• In event of vomiting, place head in lateral position. Call physician to accident site.</li> </ul> <p><b>EMERGENCY SERVICES advice:</b></p> <ul style="list-style-type: none"> <li>• In the event of a respiratory arrest immediately apply expired-air ventilation or breathing apparatus and provide oxygen feed, if indicated</li> </ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>



# CP

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Calcium Phosphide (CP)

<b>LOAD</b>	Ammunition containing Calcium Phosphide (CP), which is: <ul style="list-style-type: none"><li>• Solid substance.</li></ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"><li>• Smell of rotten fish, carbide or garlic.</li><li>• Easily combustible.</li><li>• Reacts strongly with water (self-igniting) by forming highly toxic and explosive hydrogen phosphide.</li><li>• Irritation of skin, eyes and respiratory tract.</li><li>• Danger of poisoning by inhalation (notably near ground level), swallowing or skin contact.</li><li>• Substance hazardous to water.</li></ul>
<b>PERSONAL PROTECTION</b>	<ul style="list-style-type: none"><li>• Appropriate respiratory protection equipment.</li><li>• One 500 ml eye-flushing bottle with fresh tap water for each individual.</li><li>• One container with 20 liters fresh tap water</li></ul>
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes: Throughout area affected by smoke and fumes:</p> <ul style="list-style-type: none"><li>• Short stay: wear appropriate respiratory protection equipment</li></ul> <p><b>EMERGENCY SERVICES advice:</b> In event of longer stay:</p> <ul style="list-style-type: none"><li>• Wear self contained breathing apparatus</li><li>• Wear protective clothing impermeable against toxic agents and flame resistant.</li></ul>
<b>FIRST AID</b>	<p>Symptoms of poisoning:</p> <ul style="list-style-type: none"><li>• Irritation of the eyes, nasal/pharyngeal mucosa and skin.</li><li>• Coughing, feeling of tightness, shortness of breath.</li><li>• Headache, dizziness, ringing in the ears.</li><li>• Nausea, vomiting and diarrhoea.</li><li>• Rise in pulse rate, tendency to collapse. Unconsciousness, spasm</li></ul> <p>Action to be taken:</p> <ul style="list-style-type: none"><li>• In the event of a respiratory arrest apply immediately expired-air ventilation.</li><li>• Rush affected persons to hospital. Transport only in a lying position. Halfsitting position is permissible in case of breathing difficulties.</li><li>• In case of eye contact, hold eyelids open and rinse with tap water 10 to 15 minutes while rolling eyes in all directions.</li><li>• In the event of skin contact with calcium phosphide rinse with plenty of water and subsequently cover with sterile dressing material</li></ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>

# DU

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Depleted Uranium (DU)

<b>LOAD</b>	<p>Ammunition containing Depleted Uranium (DU), which is:</p> <ul style="list-style-type: none"> <li>• Dull silver to blue-black metal.</li> <li>• Very heavy.</li> </ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"> <li>• Low specific activity. No radiation hazard involved under transport conditions.</li> <li>• Combustible metal at approximately 300 degrees Celsius.</li> <li>• Forms toxic (heavy metal) oxide dust of low specific activity when burning. Smoke and resulting dust may include Uranium Oxide.</li> <li>• Impairment of health caused by inhalation, swallowing, or when oxide dust gets into wounds.</li> <li>• Possible hazard to water and sewage treatment plants.</li> </ul>
<b>PERSONAL PROTECTION</b>	<ul style="list-style-type: none"> <li>• Appropriate respiratory protection equipment.</li> <li>• Protective gloves</li> </ul>
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes:</p> <ul style="list-style-type: none"> <li>• Keep up-wind, out of area affected by smoke.</li> <li>• Warn residents of populated areas to close doors and windows in smoke movement direction for several hundred meters.</li> </ul> <p>For short stay:</p> <ul style="list-style-type: none"> <li>• Wear respiratory protective equipment</li> <li>• Wear protective gloves</li> </ul> <p><b>EMERGENCY SERVICES advice:</b></p> <ul style="list-style-type: none"> <li>• Wear self contained breathing apparatus</li> <li>• Cover all parts of the body.</li> <li>• Put down smoke with water spray, containing water runoff.</li> <li>• Fight fire as if magnesium; <b>DO NOT</b> use halons.</li> <li>• To prevent Uranium Oxide spread, survey equipment and personnel before departing the scene.</li> </ul>
<b>FIRST AID</b>	<ul style="list-style-type: none"> <li>• If a person is affected by smoke or breathes dust, remove to hospital.</li> <li>• Inform medical personnel that victim may be contaminated with Uranium Oxide.</li> </ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Titanium Tetrachloride (FM)

# FM

<b>LOAD</b>	Ammunition containing Titanium Tetrachloride (FM), which is: <ul style="list-style-type: none"><li>• Colorless or yellowish fluid.</li></ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"><li>• Extremely caustic.</li><li>• Reacts strongly with moisture or water, developing heat and forming hydrochloric acid during reaction.</li></ul>
<b>PERSONAL PROTECTION</b>	<ul style="list-style-type: none"><li>• Appropriate respiratory protection equipment.</li><li>• One 500 ml eye-flushing bottle with fresh tap water for each individual.</li><li>• One container with 20 liters of fresh tap water</li></ul>
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes: Throughout area affected by smoke and fumes:</p> <ul style="list-style-type: none"><li>• Short stay: wear appropriate respiratory protection equipment</li></ul> <p><b>EMERGENCY SERVICES advice:</b> In event of longer stay:</p> <ul style="list-style-type: none"><li>• Wear self contained breathing apparatus</li><li>• Wear protective clothing or a heat protection suit affording heat protection comparable to asbestos</li><li>• Cover non-burning exposed FM with ground limestone to neutralize</li></ul>
<b>FIRST AID</b>	<p>Action to be taken:</p> <ul style="list-style-type: none"><li>• Remove immediately contaminated clothing.</li><li>• Rinse affected body parts with plenty of water and cover with sterile dressing (no treated burn dressing)</li><li>• If eyes are affected, hold open eyelids and rinse immediately with water for 10 to 15 minutes, rolling eyeballs in all directions.</li><li>• Call physician to accident site.</li><li>• Protect from body heat loss.</li><li>• Transport casualties preferably in a lying position.</li></ul> <p><b>EMERGENCY SERVICES advice:</b></p> <ul style="list-style-type: none"><li>• In the event of respiratory arrest apply immediately expired-air ventilation or breathing apparatus</li></ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Hexachloroethane (HC)

# HC

<b>LOAD</b>	Ammunition containing Hexachloroethane (HC), which is: <ul style="list-style-type: none"> <li>• Solid substance.</li> <li>• Insoluble in water.</li> </ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"> <li>• Zinc chloride fume poisoning.</li> <li>• After ignition, high concentration of fumes with caustic effects is produced, particularly in cold and dry air.</li> <li>• Irritation of eyes and respiratory tract.</li> <li>• Substances hazardous to water may be produced in the event of fire.</li> </ul>
<b>PERSONAL PROTECTION</b>	Appropriate respiratory protective equipment.
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes: Throughout area affected by smoke or fumes:</p> <ul style="list-style-type: none"> <li>• Short stay: wear appropriate respiratory protective equipment.</li> </ul> <p><b>EMERGENCY SERVICES advice:</b> In the event of a longer stay,</p> <ul style="list-style-type: none"> <li>• wear self-contained breathing apparatus;</li> <li>• cover all parts of the body.</li> </ul>
<b>FIRST AID</b>	<p>Symptoms of zinc chloride fume poisoning:</p> <ul style="list-style-type: none"> <li>• Irritation of the eyes.</li> <li>• Irritation of the upper respiratory tract and hoarseness.</li> <li>• Pains in the chest, especially behind the sternum.</li> <li>• Severe coughing, breathing difficulties and feeling of suffocation.</li> </ul> <p>Action to be taken:</p> <ul style="list-style-type: none"> <li>• Rush affected persons to nearest physician.</li> <li>• Transport casualties preferable in a lying position.</li> </ul> <p><b>EMERGENCY SERVICES advice:</b></p> <ul style="list-style-type: none"> <li>• If possible, apply oxygen douche (set equipment to 8 liters Oxygen/min).</li> </ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>

SUPPLEMENTARY HAZARD WARNING SHEET  
Ammunition containing Inhibited Red Fuming  
Nitric Acid (IRFNA)

# IRFNA

**LOAD**

Ammunition containing Inhibited Red Fuming Nitric Acid (IRFNA), which is:

- Brown liquid
- Red-brown to yellow vapours with pungent, acrid odour when exposed to air
- Completely water miscible.

**NATURE OF  
DANGER**

- Fire-conductive, caustic, and toxic.
- Ignites flammable solids (e.g. wood, cotton) upon contact.
- Violent reactions upon contact with flammable liquid (explosion hazard).
- Vapours cause acid burns on skin, eyes, and respiratory organs (pulmonary edema).
- Substance hazardous to water.

**PERSONAL  
PROTECTION**

- Appropriate respiratory protection equipment.
- Protective clothing
- One 500 ml eye-flushing bottle with fresh tap water for each individual.
- One container with 20 liters of fresh tap water

**ADDITIONAL AND/  
OR SPECIAL ACTIONS  
BY DRIVER**

**Evacuation immediately of the hazard area.**  
**Hazard area description on reverse**

Throughout area affected by smoke and fumes:

- Short stay: wear appropriate respiratory protection equipment

**INTERVENTION PERSONNEL advice:**

- In event of longer stay: wear self contained breathing apparatus and protective clothing
- Capture runoff from leak or fire fighting operation

**FIRST AID**

Symptoms of intoxication/acid burn:

- Skin, eyes, nasal and pharyngeal mucous membranes, respiratory tract smart.
- Slight tussive irritation causing slight cough, which subsides after approximately 20 to 30 minutes.
- Dyspnoea, vomiting, shock.

Action to be taken:

- Remove immediately contaminated clothing.
- Rinse affected body parts with plenty of water and cover with sterile dressing (no ointment, cream or oily solutions)
- If eyes are affected, hold open eyelids and rinse immediately with water for 10 to 15 minutes, rolling eyeballs in all directions.
- Transport promptly casualties for medical treatment in a lying position.

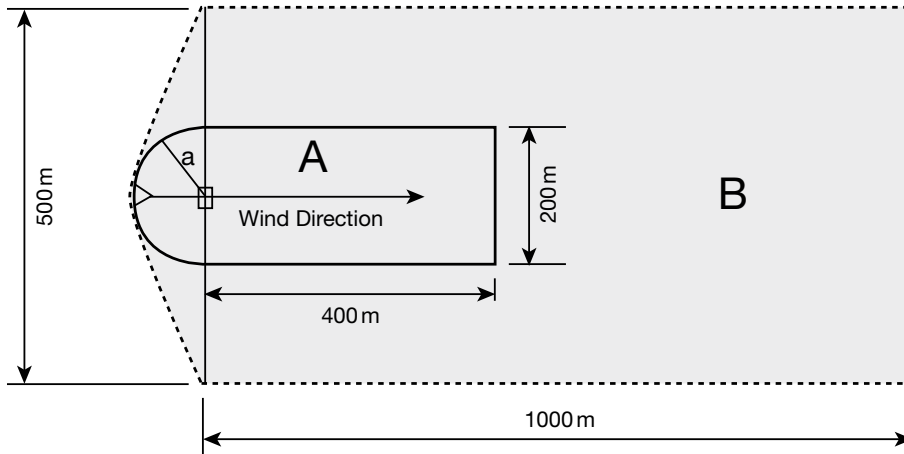
**INTERVENTION SERVICE advice:**

- In the event of respiratory arrest apply immediately expired-air ventilation or breathing apparatus
- If swallowed, and if conscious, make victim sip large quantity of water, possibly with milk added. DO NOT make victim vomit.
- In case of victim dyspnoea, half sitting position is permitted.

For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.

SUPPLEMENTARY HAZARD WARNING SHEET  
Ammunition containing Inhibited Red Fuming  
Nitric Acid (IRFNA)

# IRFNA



Explanations: a = 100 m Radius

**1. LEAK:**

Hazard Area **A** must be evacuated.

Hazard Area **B** applies if the danger to the environment cannot be cleared away within one hour.

**2. FIRE:**

Hazard Area **A and B** must be evacuated.

# OF

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Otto Fuel II (OF)

### LOAD

Ammunition containing Otto Fuel II (OF), which is:

- Oily liquid.
- Not miscible in water.
- Heavier than water.

### NATURE OF DANGER

- Heating of closed containers may cause bursting due to pressure.
- Detrimental to health when inhaled and swallowed. High concentrations will cause severe noxious effects.
- Potential Hazard to waters and sewage treatment plants

### PERSONAL PROTECTION

- Appropriate respiratory protection equipment.
- One 500 ml eye-flushing bottle with fresh tap water for each individual.
- One container with 20 liters of fresh tap water
- Protective gloves for each individual

### ADDITIONAL AND/ OR SPECIAL ACTIONS BY DRIVER

In event of moderate fire or development of fumes:

Throughout area affected by smoke and fumes:

- Short stay: wear appropriate respiratory protection equipment.
- Wear protective gloves to discover leakage

**EMERGENCY SERVICES** advice: In event of longer stay:

- Wear self contained breathing apparatus
- Wear chemical protective clothing outfit

### FIRST AID

Symptoms of intoxication:

- Irritation of nasal mucosa and rhinostenosis.
- Splitting headache.
- Dizziness, disorientation and disorder of balance.
- Irritation of the eyes.
- Contact with skin leads to a yellow skin hue.

Action to be taken:

- Move casualties into fresh air, put them on the ground in a comfortable position, loosen tight clothing, prevent chilling
- In case of respiratory arrest, start artificial respiration (mouth to mouth or breathing apparatus) immediately.
- Remove affected clothing (usually identifiable by yellow colour).
- Rinse affected parts of the body with lots of water.
- If eyes are affected, hold open eyelids and rinse immediately with water for 10 to 15 minutes, rolling eyeballs in all directions.
- If Otto Fuel has been swallowed, provoke vomiting.
- Call physician to accident site. Transport casualties preferably in a lying position.
- In case of danger of loosing consciousness handle and transport casualties in a stable lateral position

For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Pyrotechnic Charges (PT)

# PT

<b>LOAD</b>	Ammunition containing Pyrotechnic Charges (PT), which are: <ul style="list-style-type: none"><li>• Solid substances.</li><li>• Fairly soluble in water.</li></ul>
<b>NATURE OF DANGER</b>	In fire: <ul style="list-style-type: none"><li>• Ammunition may cause intense burning or explosions.</li><li>• Caustic or poisonous gases may be produced.</li></ul> Hazardous to water
<b>PERSONAL PROTECTION</b>	<ul style="list-style-type: none"><li>• Appropriate respiratory protection equipment.</li><li>• One 500 ml eye-flushing bottle with fresh tap water for each individual.</li><li>• One container with 20 liters of fresh tap water</li></ul>
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	In event of moderate fire or development of fumes: Throughout area affected by smoke and fumes: <ul style="list-style-type: none"><li>• Short stay: wear appropriate respiratory protection equipment</li></ul> <b>EMERGENCY SERVICES advice:</b> In event of longer stay: <ul style="list-style-type: none"><li>• Wear self contained breathing apparatus</li><li>• Cover all parts of body</li></ul> <b>DO NOT</b> use water to fight fire
<b>FIRST AID</b>	Action to be taken: <ul style="list-style-type: none"><li>• If eyes are affected, hold open eyelids and rinse immediately with water for 10 to 15 minutes, rolling eyeballs in all directions.</li></ul> <b>EMERGENCY SERVICES advice:</b> <ul style="list-style-type: none"><li>• In the event of respiratory arrest apply immediately expired-air ventilation or breathing apparatus</li></ul> For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.



# RP

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Red Phosphorus (RP)

<b>LOAD</b>	Ammunition containing Red Phosphorus, which is: <ul style="list-style-type: none"><li>• Solid substance.</li><li>• Insoluble in water.</li></ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"><li>• Combustion produces fumes, which are detrimental to health. Irritation of eyes and respiratory tract, cauterization is possible.</li><li>• In the event of fire substances are produced that are hazardous to water.</li></ul>
<b>PERSONAL PROTECTION</b>	<ul style="list-style-type: none"><li>• Appropriate respiratory protection equipment.</li><li>• One 500 ml eye-flushing bottle with fresh tap water for each individual.</li><li>• One container with 20 liters of fresh tap water</li></ul>
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes: Throughout area affected by smoke and fumes:</p> <ul style="list-style-type: none"><li>• Short stay: wear appropriate respiratory protection equipment</li></ul> <p><b>EMERGENCY SERVICES advice:</b> In event of longer stay:</p> <ul style="list-style-type: none"><li>• Wear self contained breathing apparatus</li></ul>
<b>FIRST AID</b>	<p>Action to be taken:</p> <ul style="list-style-type: none"><li>• Remove immediately contaminated clothing.</li><li>• If eyes are affected, hold open eyelids and rinse immediately with water for 10 to 15 minutes, rolling eyeballs in all directions.</li><li>• Have victim lie down even if feeling healthy.</li><li>• Transport casualties preferably in a lying position.</li><li>• Ensure medical care</li></ul> <p><b>EMERGENCY SERVICES advice:</b></p> <ul style="list-style-type: none"><li>• In the event of respiratory arrest apply immediately expired-air ventilation or breathing apparatus</li><li>• If possible, provide oxygen feed.</li></ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>

TH

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing Thermite (TH)

<b>LOAD</b>	Ammunition containing Thermite, which is: <ul style="list-style-type: none"><li>• Solid substance, metal mixture.</li><li>• Insoluble in water.</li></ul>
<b>NATURE OF DANGER</b>	<ul style="list-style-type: none"><li>• Develops high temperatures in the event of fire.</li><li>• Generation of explosive gases in connection with water.</li></ul>
<b>PERSONAL PROTECTION</b>	Appropriate respiratory protection equipment.
<b>ADDITIONAL AND/OR SPECIAL ACTIONS BY DRIVER</b>	<p>In event of moderate fire or development of fumes: <b>DO NOT USE WATER</b> for fire fighting.</p> <p>Throughout area affected by smoke and fumes:<ul style="list-style-type: none"><li>• Short stay: wear appropriate respiratory protection equipment</li></ul></p> <p><b>EMERGENCY SERVICES advice:</b> In event of longer stay:<ul style="list-style-type: none"><li>• Wear self contained breathing apparatus</li><li>• Wear protective clothing or heat protection suit affording heat protection comparable to asbestos</li></ul></p>
<b>FIRST AID</b>	<ul style="list-style-type: none"><li>• Move affected persons to fresh air.</li></ul> <p>For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.</p>

SUPPLEMENTARY HAZARD WARNING SHEET  
Ammunition containing Unsymmetrical  
Dimethyl Hydrazine (UDMH)

# UDMH

**LOAD**

Ammunition containing Unsymmetrical Dimethyl Hydrazine (UDMH), which is:

- Colorless liquid with pungent ammonia-like odor
- Completely water miscible.

**NATURE OF  
DANGER**

- Nonpersistent and highly flammable, caustic and toxic.
- Spontaneous reaction upon contact with oxygen-rich substances (e.g. acid, rust).
- Vapours are heavier than air and combined with air from explosive mixtures.
- Acid burns on eyes and respiratory organs are possible (pulmonary edema).
- Substance hazardous to water.

**PERSONAL  
PROTECTION**

- Appropriate respiratory protection equipment.
- Protective clothing
- One 500 ml eye-flushing bottle with fresh tap water for each individual.
- One container with 20 liters of fresh tap water

**ADDITIONAL AND/  
OR SPECIAL ACTIONS  
BY DRIVER**

**Evacuate immediately the hazard area.**  
**Hazard area description on reverse**

Throughout area affected by smoke and fumes:

- Short stay: wear appropriate respiratory protection equipment

**INTERVENTION PERSONNEL advice:**

- In event of longer stay: wear self contained breathing apparatus and protective clothing
- Capture runoff from leak or firefighting operation

**FIRST AID**

Symptoms of intoxication/acid burn:

- Eyes, nasal and pharyngeal mucous membranes, respiratory tract smart.
- Slight tussive irritation causing slight cough, which subsides after approximately 20 to 30 minutes.
- Trembling, dizziness, possibly convulsion, unconsciousness.
- Skin smarts, blisters appear.

Action to be taken:

- Remove immediately contaminated clothing.
- Rinse affected body parts with plenty of water and cover with sterile dressing (no ointment, cream or oily solutions)
- If eyes are affected, hold open eyelids and rinse immediately with water for 10 to 15 minutes, rolling eyeballs in all directions.
- Call physician to accident site.
- Transport promptly casualties for medical treatment in a lying position.

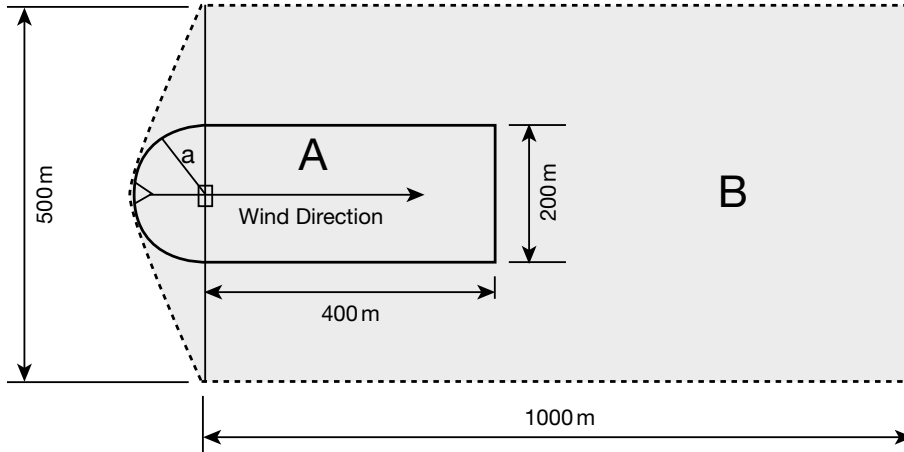
**INTERVENTION SERVICE advice:**

- In the event of respiratory arrest apply immediately expired-air ventilation or breathing apparatus
- In case of victim dyspnoea, half sitting position is permitted

For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.

SUPPLEMENTARY HAZARD WARNING SHEET  
Ammunition containing Unsymmetrical  
Dimethyl Hydrazine (UDMH)

# UDMH



Explanations: a = 100 m Radius

**3. LEAK:**

Hazard Area **A** must be evacuated.

Hazard Area **B** applies if the danger to the environment cannot be cleared away within one hour.

**4. FIRE:**

Hazard Area **A and B** must be evacuated.

# WP

## SUPPLEMENTARY HAZARD WARNING SHEET Ammunition containing White Phosphorus (WP)

### LOAD

Ammunition containing white phosphorus, which is:

- Colorless to yellow wax-like substance
- Pungent, garlic-like smell

### NATURE OF DANGER

- Phosphorus poisoning.
- Ignites upon contact with atmospheric oxygen producing thick fumes that are detrimental to health.
- On contact with water, caustic phosphoric acid is produced.
- Irritation of skin, eyes and respiratory tract; cauterization is possible.
- Substance hazardous to water

### PERSONAL PROTECTION

- Appropriate respiratory protective equipment.
- One 500 ml eye-flushing bottle with fresh tap water for each individual.
- One container with 20 liters fresh tap water.
- Three liters of 5% sodium bicarbonate solution.

### ADDITIONAL AND/ OR SPECIAL ACTIONS BY DRIVER

In event of moderate fire or development of fumes:

Throughout area affected by smoke and fumes:

- Short stay: wear appropriate respiratory protection equipment

**EMERGENCY SERVICES advice:** In event of longer stay:

- Wear self contained breathing apparatus
- Wear protective clothing or a heat protection suit (affording heat protection comparable to asbestos)
- Spray water continuously on extinguished phosphorus fires or cover with moist sand/soil

### FIRST AID

- Remove quickly all clothing affected by phosphorus to prevent phosphorus burning through to skin. If this is impossible:
- Plunge skin or clothing affected by phosphorus in cold water or moisten strongly to extinguish or prevent fire.  
Then immediately remove affected clothing and rinse affected skin areas with cold sodium bicarbonate solution or with cold water.
- Moisten skin and remove visible phosphorus (preferably under water) with squared object (knife-back etc.) or tweezers. Do not touch phosphorus with fingers!
- Throw removed phosphorus or clothing affected by phosphorus into water or allow to bum in suitable location
- Cover phosphorus burns with moist dressing and keep moist to prevent renewed inflammation.
- In case of eye contact, prop eyelids open and rinse eyes with water for 10 to 15 minutes.

For urgent information regarding assessment and treatment of noxious effects, contact poison control or medical treatment center.

# Annex 10

## Transport Document

Delivery note no(s). / Dispatch note no(s).	
<b>Dispatcher</b>	<b>Carrier</b> Person picking up consignment himself
<b>Recipient</b>	<b>Remarks</b>

*Freight clause*

*Dispatcher's remarks / Special instructions*

Number / Type	Contents / Designation	Gross weight (in kg)

Cargo / Documentation handed over Date:	Cargo / Documentation received	Receipt of consignment confirmed
	Driver's signature	Recipient's signature

## Annex 11

### Further information on “ammunition transport”

Further information on the topic “ammunition transport” may also be sought from the following sources:

1. The Intergovernmental Organisation for International Carriage by Rail  
*www.otif.org*
2. Convention concerning International Carriage by Rail of 9 May 1980 version applicable as from 1st November 1996 (Convention relative aux transports internationaux ferroviaires du 9 mai 1980 dans sa version applicable à partir du 1er novembre 1996 (**COTIF**))
3. Convention on Uniform Rules concerning the Contract for International Carriage of Goods by Rail (Règles uniformes concernant le contrat de transport international ferroviaire des marchandises (**CIM**))
4. NATO STANAG 4441/AASTP-2 “Manual of NATO Safety Principles for the Transport of Military Ammunition and Explosives” (Edition 1)
5. NATO STANAG 4123/AASTP-3 “Manual of NATO Principles for the Hazard Classifications of Military Ammunition and Explosives” (Edition 1)
6. United Nations Group of Experts on the Transport of Dangerous Goods / United Nations Committee on the Transport of Dangerous Goods  
*http://www.unece.org/trans.*
7. Report of the UN Group of Experts on the problem of ammunition and explosives (A/54/155) 1999
8. IATA Dangerous Goods Board (DGB)  
*http://www.iata.org*
9. IMO Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC) / **International Maritime Dangerous Goods (IMDG) Code**  
*http://www.imo.org*
10. OECD and PIARC (1997), Transport of Dangerous Goods through Road Tunnels: Current National and International Regulations (Report 2)  
*http://www.oecd.org/dsti/sti/transport/road/index.htm*



# Best Practice Guide on the Destruction of Conventional Ammunition



# Table of Contents

I. Introduction	145
1. Objectives	145
2. Scope	145
3. General process for demilitarization activities	145
4. Environmental impact	147
5. Economics of demilitarization	147
6. Monitor of demilitarization process	147
7. Destruction process	147
II. Dumping of Ammunition	148
1. Sea dumping	148
2. Landfill	148
III. Open Burning/Open Detonation	149
1. Open Detonation	149
2. Open Burning	149
IV. Closed burning	150
1. Rotary Kiln	150
2. Fluidized Bed incinerator	151
3. Car Bottom Furnace	152
4. Hot Gas Decontamination Facility	152
5. Contained or Controlled Detonation Chamber	153
V. Additional Techniques for Ammunition Disposal	154
1. Reverse Assembly	154
2. Mechanical downsizing	154
3. Cryogenic Fracturing	155
VI. Separation Techniques	156
1. Melt out techniques	156
2. Water jet washout	157
3. Solvent Washout	157
VII. Experimental Conversion Techniques	158
1. Super Critical Water Oxidation	158
2. Plasma Arc Pyrolysis	158
3. Electro-Chemical Oxidation	159
4. Biodegradation	159
VIII. Discussion	160
IX. Conclusions	162
X. List of abbreviations	162
XI. References	163

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2 June 2008

# I. Introduction

As stated in the *OSCE document on stockpiles of conventional ammunition, FSC.DOC/1/03, 19 November 2003*, the presence of ammunition always poses certain risks to human security. The ultimate solution to this problem is the destruction of all surplus ammunition. This document will discuss the best practice methods for the destruction of conventional ammunition.

## 1. Objectives

The objectives of this best practice guide are to provide guidance for the effective destruction of surplus ammunition that remains, for instance after conflicts, or is identified as a result of armed forces restructuring during defence reform.

It is anticipated that this guide will contribute to and facilitate the development and application of high common standards in this field. For the recommendation, planning and conduct of specific destruction projects, further detailed guidelines should be developed within the boundaries of national regulations and procedures. Such additional guidelines might take into account best practices available.

## 2. Scope

This best practice guide limits itself to the destruction of conventional ammunition. The neutralization of Nuclear weapons as well as of Chemical and Biological Weapons is excluded; however some references are made to chemical ammunition. Also excluded are the destruction of UXO (unexploded ordnance) and range clearing.

The physical destruction techniques available range from open burning and open detonation techniques to highly sophisticated industrial processes.

The arguments in favour and against each process are discussed in this paper. Appropriate destruction techniques in a certain area will depend primarily on:

- 1)The resources available in the area,
- 2)The physical condition of the stockpile, in other words is the ammunition transportable,
- 3)The quantity of ammunition and explosives in terms of economies of scale,
- 4)National capacities, and
- 5)National explosive safety and environmental legislation.

In general, the greater the amounts of ammunition to be destroyed, the larger are the economies of scale and therefore the wider range of affordable and efficient technologies.

## 3. General process for demilitarization activities

The process of developing a demilitarization project plan starts with the ammunition and the responses to the following basic questions:

### 3.1 *Is it safe to move the ammunition?*

If no, then the ammunition is not suitable for demilitarization by other than controlled “on-site” demolitions.

### ***3.2 Can the ammunition be internationally transported in accordance with the United Nations Recommendations on the Transport of Dangerous Goods, and the associated inter model requirements, such as The European Agreements Concerning the International Carriage of Dangerous Goods by Rail (RID) and by Road (ADR), and the International Maritime Dangerous Goods (IMDG) Code?***

In order for ammunition to meet the fundamental requirements for international cross border movements it must have been classified as Dangerous Goods Class 1 and the packages Type Tested and approved in accordance with the UN requirements. To undertake this time consuming and potentially costly process for ammunition that is destined for disposal would normally only be appropriate for large quantities [1].

### ***3.3 What are the transport cost implications?***

For budgeting purpose any cross border transportation should be assessed at 30% to 40% of the total foreseen demilitarization cost.

### ***3.4 How much ammunition, by specific designation, is there?***

The quantity of ammunition to be demilitarized is a deciding factor when there is overriding budgetary constraints. Unless the owning organisation has ready access to an existing demilitarization facility that already has in place the required infrastructure, tooling and competent staff the unit cost per item will be disproportionately high. The answer to this question has to be considered in the light of the response to paragraph 1.3.2.

### ***3.5 Is there sufficient technical information?***

The significance of this requirement is best illustrated by the following example. A demilitarization project includes high explosive filled projectiles. Various op-

tions are available to demilitarize these projectiles. The preferred one is to melt out the explosive filling using hot water (above 81° Celsius) for subsequent re-use in the production of commercial blasting explosives. It represents the best re-use and recycling option, and has a minimum environmental impact. However it is not that simple. Of the potential explosives fillings only TNT has a low melting point. The most common alternative filling is RDX which cannot be melted at below 205.5° Celsius. At the same time RDX, wax and aluminium are added to TNT for various operational reasons. It still has a low melting point and is relatively simple to fill the projectile by melt pouring. It can also be melted and removed, but there is a significant potential hazard from any recrystallized RDX. The addition of the fine powdered aluminium further exacerbates to the problem. This kind of technical information is essential in order to define what demilitarization technique is the best option. For the abovementioned example without the information regarding the explosive filling it may not be possible to decide on the optimum demilitarization process which can lead to the choice of a process that is inherently hazardous.

### ***3.6 Will the work be awarded following a competitive bidding process or as a sole source allocation?***

If the latter it an independent cost appraisal may be required.

### ***3.7 Are there any time constraints?***

There may be operational, logistic or funding time constraints. These may well have an impact on the project budget and funding time-lines.

### ***3.8 Are there any security implications?***

With the growing increase of precision guided munitions and the use of electronic guidance systems muni-

tions may contain confidential embedded electronic data. Such components will require special handling and destruction verification.

### 3.9 Are there any environmental constraints?

The aim of any ammunition disposal should be to minimize, or even eradicate, any adverse environmental impact it. However such aims are expensive to achieve, and may not be justifiable, or even possible, for small quantities.

### 3.10 Are there any restraints on the re-use and re-formulation of recovered materials?

National legislation may prohibit or limit the re-use and re-formulation of recovered materials, especially explosives and propellants.

## 4. Environmental impact

Although there are no completely ecologically safe procedures in the destruction of ammunition and explosives; where ever possible steps must be taken to minimize the impact on the air, the soil and the water environment. Pollution control measures must always be considered in destruction planning. The collection of scrap and residues would assist in minimizing the impact on the environment [2]. Specific local environmental legislation must be taken into account.

## 5. Economics of demilitarization

Comparing the costs of different demilitarization methods is difficult and potentially misleading, because there are so many variable factors such as transportation, capital investments, labour, energy, waste disposal and the value of recyclable materials.

## 6. Monitor of demilitarization process

It is necessary that the demilitarization activities are monitored and verified during the course of the project. This is done to ensure that the task is undertaken in accordance with the agreed schedules and that proper and accurate records are maintained. Where scheduled payments on deliverables are being made the associated disposal certificates should be countersigned by the accredited Validation Authority. The extent and frequency of the validation will normally be dictated by the scope and complexity of the project. In the case of large scale projects over long time periods it is not uncommon to have a resident on-site verification presence.

## 7. Destruction process

This document uses the ammunition classification terminology as defined by the OSCE in the above mentioned reference. In this document, the following classifications are allocated:

- (i) *Ammunition for small arms and light weapons (SALW);*
- (ii) *Ammunition for major weapon and equipment systems, including missiles;*
- (iii) *Rockets;*
- (iv) *Landmines and other types of mines;*
- (v) *Other conventional ammunition, explosive material and detonating devices.*

The exact technologies used for ammunition destruction will further depend on the amount of ammunition that has to be destroyed and the local technologies that are readily available.

This handbook will give an overview of the most used technologies. Starting with the dumping of ammunition (Chapter 2), this book will give an historical overview or sequence of technologies used. Chapter 3 discusses open burning and detonation, and Chapter 4 the closed

burning and detonation of ammunition. In Chapter 5 the necessary reverse engineering technologies will be discussed, while Chapter 6 focuses on the separation of metal parts and explosives. Although this handbook focuses on the destruction of the ammunition, within Chapter 6 also the reuse and recycling of materials can be a major factor to be considered.

Special attention will be given in Chapter 7 to the destruction technologies of those chemicals originating from ammunition that might lead to problems during the incineration process.

The conditions in favour of the different technologies are discussed in Chapter 8, and the best practice methods are listed in a table. Finally, Chapter 9 summarizes the major conclusions of all methodologies that can be applied for the destruction of ammunition.

## II. Dumping of Ammunition

### 1. Sea dumping

The dumping of ammunition is forbidden by law, for those countries that have ratified the various agreements and conventions. (The London convention of 1972 and the 1996 Protocol [3], OSPAR 22 September 1992, [4]). Most Western European countries are signatories.

Beside this the dumping may lead to undesired situations, as the governments no longer have control over the ammunition.

### 2. Landfill

When ammunition is dumped in lakes or landfill sites, the toxic chemicals leaching from the ammunition over a long and unpredictable period of time will pollute the environment. A large number of the components used

in the ammunition are harmful for the environment.

These components will include heavy metals (e.g. Lead, Antimony, Zinc, Copper), explosives (e.g. 2,4,6-trinitrotoluene (TNT), nitro-glycerine (NG) and RDX), and components from propellants (e.g. dinitrotoluene (DNT), Diphenylamine (DPA) and dibutylphthalate (DBP)). Components of pyrotechnics like hexachloroethane and barium/strontium salts in tracers and compositions for illumination are also harmful to the environment.

Due to the uncontrolled migration of toxic chemicals leaching from dumped ammunition, mainly by the ground water, large areas will be polluted including the drinking water supplies for the people living in those areas.

## III. Open Burning/Open Detonation

### 1. Open Detonation

The destruction of ammunition by open detonation (OD) and open burning (OB) is still widely used, commonly referred to as OBOD.

In open detonation, ammunition is packed together and destroyed by sympathetic detonation, using donor charges of serviceable explosives. This is achieved by the explosion of demolition charges in close contact with the densely packed ammunition items. It is therefore only viable for ammunition with a relatively high explosive weight ratio.



Figure 3.1: Ammunition prepared for destruction

Due to the detonation shock wave generated by the donor charges, the ammunition will be detonated. The advantage of open detonation is the ability to destroy large quantities of ammunition efficiently. The demolition range must have sufficient area to ensure that the effects of blast, noise and fragmentation are limited to the site. In general most ranges in non-combat areas are significantly limited.

Open detonation also enables the destruction of ammunition without the need for special equipment.

The disadvantages of open detonation are:

- The risks of uncontrolled pollution of the soil, (ground) water and air [5];
- The risks originating from shock wave and fragments;
- The possibility that not all the ammunition articles will be destroyed properly, and that UXO will then result in the immediate area;
- Production dependant upon daylight hours and suitable weather conditions.

To prevent the uncontrolled migration of any potential pollution, the open detonation has to be performed preferably at locations that are not vulnerable towards leaching out of the pollutants to the ground water table.

The shockwave and fragments can be mitigated by the restriction of the total amount to be detonated at one time or by the proper shielding of the location. These additional safety measures will depend on the vulnerable infrastructure in the neighbourhood.

Because of the uncontrolled pollution, the open detonation of large stocks of ammunition is prohibited in most Western European countries.

Open detonation should however be performed with personal protective equipment, to prevent the exposure of EOD personal to the pollutants [6]. This can be achieved by simple skin and breathing protection by the use of (disposable) overalls, gloves and dust masks.

### 2. Open Burning

Open burning is mainly used for the destruction of surplus (bulk) propellants and pyrotechnic compositions. Also non-confined (bulk) explosives may be destroyed

by this technique preferably in small quantities, due to the risk that burning explosives and propellants might transfer into a full detonation.



Figure 3.2: Bags filled with propellant, ready for open burning

The open burning of ammunition containing smoke, flare, and dye or irritating agents is forbidden in the USA and many other countries, because of the high concentrations of hazardous products that are formed during the open burning [7].

## IV. Closed burning

### 1. Rotary Kiln

The rotary kiln is characterized by the controlled thermal destruction of ammunition or explosives during a pre-determine time, and the treatment of the exhaust gases.

The type of furnace that is most frequently used for the destruction of ammunition is the rotary kiln type.

The ammunition is transported by a feed hopper (at the left) that regulates the amount of ammunition (from a separated room) per unit of time to be introduced to the furnace.

Open burning is generally conducted on engineered structures such as concrete pads, or metal pans to avoid contact with the soil surface, and leaching out to the ground water table. OB pans should be made of a material sufficient to withstand the burning process, and should be of sufficient depth and size to contain treatment residues. The pans may be elevated slightly above the ground to enhance cooling and to allow inspections for leaks. The pans should be covered when they are not in use [8].

In conclusion it can be stated that the use of open burning and detonation should be limited to locations that are not vulnerable to the leaching out to the ground water table. In cases that leaching out (OB) might be a problem the use of a watertight construction is mandatory, such as concrete or metal pans. Those engaged in the destruction should be equipped with the proper protective means, like (disposable) protective clothing and breathing protection.



Figure 4.1: Outside view of a rotary kiln furnace (courtesy NAMSA)

This is an important safety issue that will prevent too high concentrations of ammunition in the kiln. The ammunition will react to the high temperature in the furnace which is achieved by burners at the end of the furnace. These burners can be heated by gas or oil burners. The rotary kiln incinerator is a thick walled rotating cylindrical steel drum with an internal Archimedean screw. The controlled rotation speed causes the ammunition to move through the heated drum. As different types of ammunition require different residence times the rotating speed of the kiln has to be adjusted. At a certain residence time the explosives will ignite. The reaction products are mixed with excess air to burn completely in the post combustion chamber (after burner), for a complete combustion. The solid reaction products are collected by the ash remover, the cyclones and filters, these may be bag or ceramic filters. The gaseous products are treated with water washers and denox installations. The latter is of special importance in the case of the burning of explosives like TNT, because of the high NO<sub>x</sub> concentrations that will be generated. In this way the emission of exhaust gases will be in compliance with the stringent demands from national environmental authorities [9].

According to their size and performance criteria rotary kilns can be used for the burning of bulk explosives and propellants; small calibre ammunition (up to 20.000 rounds an hour), fuzes, detonators and other igniting devices, especially in large quantities. If suitable large and medium calibre ammunition should undergo a pre-treatment step, to expose the explosive filling. Suitable pre-treatment methods are to be discussed in later chapters.

Rotary kiln furnaces have been extensively used on a commercial basis in USA, Germany, France, Italy, UK, Albania and Ukraine. In conclusion it can be stated that the rotary kiln is especially suitable for the destruction of a large variety of ammunition types and demilitarization arising.

In Bosnia UNDP is using a containerized Transportable Ammunition Destruction System (TADS). This system can be placed at any location, at 25 % of the costs of the full scale rotary kiln. Such mobile systems can be used to destroy small calibre ammunition up to larger quantities.



Figure 4.2: Containerized Ammunition Destruction System as used by Bosnia UNDP

## 2. Fluidized Bed incinerator

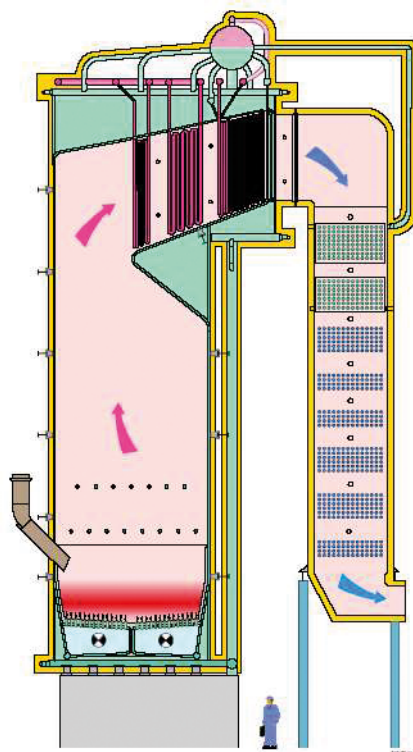


Figure 4.3: Fluidized Bed incinerator



The explosive waste is pumped as non detonable slurry [10 ] into the bed (the red area). The bed consists of sand (mainly silicon oxide) particles of a well defined particle size. Due to the action of the hot air flow the sand particles start to float and act as a liquid.

This is a very safe concept to incinerate explosive waste.

The fluidized bed can be realized in any size. Figure 4.4 shows a large industrial set up. For the incineration of explosive waste small installations with a diameter of 0.5 meter are sufficient.

The major advantage of the fluidized bed furnace is the low energy consumption. This makes it possible to extract the excess heat from the furnace to heat a separate cabinet / furnace for the heat treatment of medium sized ammunition parts in small quantities. (see also 4.3 Car Bottom Furnace)

The Fluidized bed incinerator is especially dedicated for the destruction of bulk explosives and propellants in the form of slurry, consisting of energetic materials and water.

The disposal of pyrotechnic compositions by fluidized bed incineration is not always possible due to the formation of products that will react with the sand particles of the bed. This may lead to the formation of lumps that will disturb the proper functioning of the fluidized bed.

### 3. Car Bottom Furnace

This type of furnace is used for the heat treatment of small calibre ammunition (parts) like igniters, detonators and fuzes. Characteristically the furnace is used for the treatment of small numbers; large amounts of these articles can be treated in the rotary kiln furnace. The CBF is also used for the heat treatment of metal

scrap contaminated with small amounts of explosives.

In general practice the furnace is used in combination with other installations, for example in combination with another furnace. The heat necessary to warm up the furnace comes from the excess heat generated by the large furnace.



Figure 4.4: Car bottom furnace with door half open

The ammunition is placed on the car (that can be rolled in the furnace on rails).

The ammunition or the metal scrap will typically be in the furnace with a residence time of 30 minutes. The gases coming from the furnace can be lead to the pollution control system (PCS) from the facility next by (e.g. the fluidized bed incinerator). After the heat treatment the metal parts that will remain on the car can be certified as Free From Explosives (FFE), packaged and transported to the scrap metal industry.

### 4. Hot Gas Decontamination Facility

The hot gas decontamination facility ( in fact the enlarged version of the CBF) can be applied to process items that contain trace quantities of energetic material to a condition such that the items are assured to have no significant quantities of energetic material (Chapter 5). Items to be treated are loaded in baskets, banded

to metal pallets, or secured directly to the surface of a specially designed railcar. The railcar is then moved into a decontamination chamber such that the railcar and the chamber form a sealed box. Hot air is supplied to hold the chamber at temperature of 300 degrees C for 1 - 2 hours.



Figure 4.5: Hot gas decontamination facility. The rail car is charged with metal baskets that are loaded with pre-treated ammunition.

The installation is especially suited to clean large amounts of contaminated scrap.

## 5. Contained or Controlled Detonation Chamber

This type of equipment is used for the destruction by sympathetic detonation. The principle uses the sympathetic detonation of a small explosive charge of explosives, mostly plastic explosive, in close contact with the ammunition to be destroyed. The chamber is designed to withhold the overpressure generated by the detonating explosives, but cannot withstand the brisance force of nearby detonations. The maximum load of explosives that can be detonated at the same time depends on the design and size of the detonation chamber. The deto-

nation chamber is ideally suited for the disposal of small amounts of medium sized ammunition, including hand grenades and anti personnel mines. Larger calibre ammunition (> 105 mm shell) may need to be down sized before they can be destroyed using the detonation chamber.

To avoid contamination of personal, simple protective measures have to be followed comparable to the open burning and detonation.



Figure 4.6: Mobile version of detonation chamber with expansion and air pollution control unit

## V. Additional Techniques for Ammunition Disposal

In Chapter 4 some of the closed burning and closed detonation techniques have been discussed. In most of these techniques it will be mandatory to limit the amount of ammunition, or to mitigate the worst possible effect of the ammunition. For larger items it may be necessary to disassemble the ammunition. This reverse engineering will provide:

- Complete discrete explosive items suitable for subsequent disposal.
- Explosive items requiring mechanical downsizing.

### 1. Reverse Assembly

This process may be able to be conducted in factories that have been producing the ammunition. In the reverse assembly the ammunition parts are separated using equipment that is sometimes also be applied for the production of the ammunition. The equipment has to be adapted for the reverse process and has to be handled by qualified personnel. The process may include several operations.

- The initiating devices – fuses and igniters are removed from the round.
- The fuzes are removed from the projectiles.
- The boosters are separated from the fuzes.
- The igniters and the centre core igniters are removed from the cartridge.
- The propellant cartridges are separated from the projectiles and the propellant is removed



Fig. 5.1: Manual disassembly of anti-personnel landmines (Donetsk, Ukraine)

Down-sizing can be done by the proper combination of equipment and qualified personal. For mechanical disassembly mechanically operated systems are used to dismantle ammunition. In contrast to manual disassembly, mechanical disassembly has the advantages of high production rates; it is an efficient system of work and has low staff requirements. There will be a need for a wide range of equipment necessary to cope with all down-sizing requirements.

### 2. Mechanical downsizing

Mechanical downsizing makes use of different equipment like lathe, saw (especially band saw) and hydro-abrasive cutting. The cutting tool is used to open the ammunition, to separate the fuze from the projectile, to separate the cartridges from the projectiles etc, without the need for the wide range of specialized equipment needed for the reverse assembly methodology. However, the amount of labour and the amount of ammunition that can be destroyed will be comparable to the reverse assembly process.

In addition to the use of a lathe, the downsizing can be achieved by sawing or cutting the ammunition into smaller parts if proper precautions will be taken. These techniques can be applied all over the world. The application of these techniques to the reverse assembly of ammunition may create dangerous situations, as most explosive fillings are sensitive to friction.



Figure 5.2: Lathe for the cutting of 81 mm mortar

This method of downsizing can be chosen if the safety of the personal is guaranteed. The use of remote controlled processes will be in most cases sufficient as well as mandatory for a safe process.

Ammunition can also be sectioned by high pressure hydro abrasive technology, provided that the water pressure will not exceed the limit of 2000 bar. Typical operating pressures are generally 200 bars.

This technology originates from the off-shore business and was used to cut pipelines or open storage tanks that contained vapours of hydrocarbons.

The advantage of the hydro abrasive cutting (HAC) technique is the flexibility that allows the cutting of all ammunition from 40 mm to large aircraft bombs and torpedoes. Another advantage is the proven safety of

the technique within its safe pressure limits. The HAC system is especially suited for the cutting of ammunition containing plastic bonded explosives.



Figure 5.3: Equipment for hydro abrasive cutting, insert picture 155 mm cutting result

In conclusion, mechanical downsizing is a suitable process, when it is performed remotely controlled.

### 3. Cryogenic Fracturing

This technique was developed for the demilitarization of chemical munitions. [10] The ammunition is cooled down in a container filled with liquid nitrogen. The steel of the projectiles becomes brittle due to the low temperature. Subsequently the projectiles are transported to a hydraulic press and fractured to recover the explosive or chemical agent, whilst converting the shells into smaller metal fragments.

Due to the low temperature the chemical warfare agent in the projectiles could not evaporate so the metal fragments and the chemical agent were treated in a special furnace with exhaust cleaning.

Cryo fracture is widely used in Europe for the commercial demilitarization of small contained explosive units and components. The freezing of the item desensitizes the explosives so enabling it to be safely crushed and subsequently processed in a kiln. Many tens of thousand of cluster munition bomblets have been disposed of using this technique.



Fig. 5.4: Cryofracture plant at Alsetex, France (courtesy NAMSA)

## VI. Separation Techniques

Techniques to separate the explosives content from the metal containers that are usually practiced include:

- melt out techniques;
- high pressure water washout;
- solvent washout.

### 1. Melt out techniques

Melt out techniques are widely used to remove the explosives and fillings from ammunition that is filled in the molten state. The most common example is TNT and TNT derivatives, such as TNT/RDX, that are melt poured at a temperature of 80,35° Celsius or above. Melt out techniques are suitable for all TNT based munitions. Due to its high melting point (205,5° Celsius) melt out is not suitable for RDX filled ammunition.

The ammunition is heated using hot water/steam or induction furnaces. The explosives will melt at temperatures above 80,35° Celsius, and will flow out of the casing. Subsequently, the molten explosives can be collected for further treatment or disposal. Commercially it is often used in the production of commercial blasting explosives.



Figure 6.1: Melt out of TNT with autoclaves at munition disposal factory Ankara (courtesy NAMSA)

- TNT vapour has to be removed by proper exhaust;
- Residual layer of explosive makes it necessary to give the ammunition an additional heat treatment (Car Bottom Furnace or hot gas decontamination (Chapter 4).

The melt out technique is also used for the demilitarization of ammunition containing white phosphorus (WP). This ammunition is immersed in a bath of warm (50°C)

water. The phosphorus melts at 42°C and can be collected under water. This procedure is necessary because of the violent reactivity of phosphorus towards the oxygen in the air. The recovered WP has a commercial value.; Small quantities of WP filled munitions can be disposed by OD but expert advice should be sought due to the problems of environmental contamination.



Figure 6.2: Recovery of white phosphorus using melt out

## 2. Water jet washout

The principle of water jet washout of explosive fillings is the use of a high pressure water jet. The water jet is focused on the explosive filling by means of a rotating nozzle. With high pressure water washout it is possible to remove all kinds of explosive fillings out of the metal casing of the ammunition. The wash out is especially suitable for the removal of plastic bonded compositions (PBX) and other non melt cast explosives.

The installation depicted in Figure 6.3 can washout 2 articles simultaneously. All 8 articles are washed out in this installation in half an hour.

Characteristics of water jet washout are:

- The water jet will completely remove all kind of explosives (not only the melt cast types/no thin layer of explosive material will remain);

- Less pollution in the buildings, less TNT vapour means better labour hygienic conditions;
- The water in the washout process is recycled (no waste water problem);
- The explosives can be separated from the water for reuse;
- The explosives can be transformed into slurry that can be classified as class 4.1 [11].



Figure 6.3: Water jet washout of 155 mm shells

The water jet washout installation can be very effectively combined with the hydro abrasive cutting system (Chapter 5.2).

## 3. Solvent Washout

This technique makes use of a solvent that readily will dissolve the explosives. Since most explosives, like TNT and RDX, are not (or at least very poor) soluble in water, other solvents have to be chosen. Most explosives will be dissolved in solvents like methylene chloride, methyl alcohol, acetone or toluene. It should be emphasized that large amounts of solvent will be needed; large recovery and storage facilities for the solvent will be mandatory. The solvent washout enables the recycling of the explosives. This technique will be preferable for the reuse of high valuable military

explosives. This technique is limited to small amounts of ammunition.

The solvent washout can also be used for the cleaning of contaminated metal parts, e.g. the shells after removing the explosive by melting out. The solvent will dissolve the thin layer of explosives that is left in the shells after the melt out step.

This type of processing has to be conducted under appropriate safety conditions; some solvents have high vapour pressure and could form explosive mixtures with air, while other solvent could be harmful to people because of the toxicity (toluene, methylene chloride).

## VII. Experimental Conversion Techniques

In Chapter 3 and 4 the combustion of explosive waste have been discussed as a conversion technique. During the last two decades new experimental technologies have been tested for the conversion of explosive waste.

These technologies include:

- Super Critical Water Oxidation
- Plasma Arc Pyrolysis
- Electrochemical Oxidation
- Chemical Reaction
- Biological Degradation

These small scale techniques are designed and used for very specific types of waste.

### 1. Super Critical Water Oxidation

Supercritical water oxidation (SCWO), also known as Hydrothermal Oxidation, destroys toxic and hazardous organic wastes in a compact, totally enclosed system.

This makes it an interesting technology for the destruction of pyrotechnic compositions containing chlorine (e.g. hexachloroethane, polyvinyl chloride), but also irritating agents and chemical warfare agents. It is a high tech process for the destruction of chlorine containing compositions, avoiding the formation of dioxins.

### 2. Plasma Arc Pyrolysis

The plasma reactor consists of an internal centrifuge in which the hazardous waste material is heated up by melting torches, producing a plasma arc with a temperature of about 20000°C. The waste water of the off-gas cleaning system will be treated in a water evaporation unit. Thus, no waste water will be released into the sewers. Due to its toxic contents (toxic metals) the dry residue from the evaporator has to be disposed of in a hazardous waste storage site.

The plasma arc technology was developed to destruct hazardous waste like chemical agents containing arsenic. As the product of the reactor will be a glazed composition in which the toxic compounds are captured, the final product has to be stored in a hazardous waste storage site.

Energetic compounds (explosives, propellants and pyrotechnics) in the presence of a small amount of oxygen are oxidized in a plasma reactor into gaseous products consisting principally of carbon monoxide, carbon dioxide, and small hydrocarbons such as methane, ethene, and ethane. Arc furnaces have very short start-up times (of about 5 minutes to stable operation) and shutdown

times. The process needs a high amount of energy, is very costly, but dedicated to the neutralization of certain types of chemical munitions. Furthermore, plasma arc pyrolysis is well suited for the decontamination of metal parts.

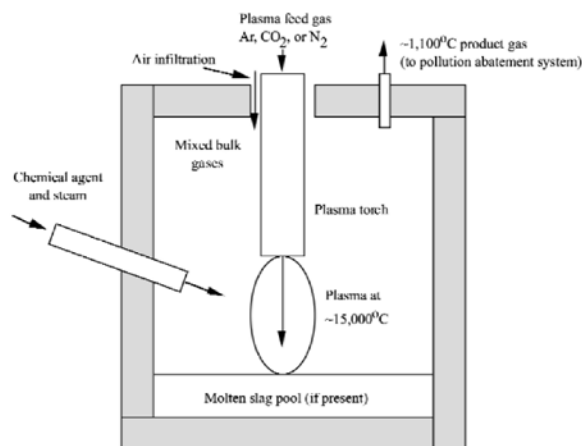


Figure 7.1: Schematic drawing of a plasma reactor.

### 3. Electro-Chemical Oxidation

The AEA Technology (AEA) SILVER II™ technology is based on the highly oxidizing nature of  $Ag_2^+$  ions, which are generated by passing an electric current through a solution of silver nitrate in nitric acid in an electrochemical cell similar to those used in commercial electrochemical processes. The electrochemical reactions used in the SILVER II™ technology belong to a class of chemical processes collectively known as mediated electrochemical oxidation (MEO). MEO processes have been offered as an alternative to conventional incineration for destroying hazardous wastes. Because they are also relatively new in development and application, experience with these processes is limited.

The process can be used for the neutralization of primary explosives such as lead azide and lead styphnate.

### 4. Biodegradation

Biodegradation makes use of the ability of micro-organisms to consume ammunition related chemicals such as TNT and other explosives or propellant components. Biodegradation can be practiced like a chemical process in reactor type equipment.



Figure 7.2: Biodegradation equipment

Because of the slow reaction rates, large storage facilities will be necessary; therefore it might be better to use the technology of land farming. A lot of micro-organisms that can convert chemicals are already present in the soil. The land farming will create the optimal conditions in the soil for the micro-organisms in order to convert the organic energetic compounds:

- Percentage of oxygen;
- pH of the soil;
- Percentage of water in soil;
- Extra nutrition for micro-organisms.

The reactor type is better suited for the treatment of explosive waste in large concentrations, whereas the land farming can be used for the in situ remediation of contaminated military sites (with low concentrations of energetic materials). Biodegradation is not recom-



mended for the treatment of propellant (waste) containing heavy metals (as additives for gun barrel erosion or burning rate inhibitor).

## VIII. Discussion

A large number of different technologies are in use for the destruction of ammunition. In order to be able to evaluate the best practice methods some criteria can be mentioned as a guideline.

- 1. The applied technology should lead to the irreversible destruction of the ammunition and its containing explosives, propellants and pyrotechnics.*
- 2. The applied technology should be environmentally benign and be safe for personnel to implement. The principles of complete environmental system analysis should be applied.*
- 3. The applied technology should be economically sound, with minimum energy requirements needed for destruction, leaving minimum of waste behind.*
- 4. The applied combination of technologies should be suitable to destroy most ammunition types.*

- 5. Sometimes the applied technology should render the ammunition safe at the location where the ammunition encountered. This holds for ammunition that is not safe to transport.*

The choice of the most suitable technology for the demilitarization of ammunition will strongly depend on the local situation. In general practice it will be not one technology but a combination of technologies. Therefore a list is given with the most frequently used demilitarization technologies and the conditions of application.

Technology	Technology Conditions of application
Open detonation	No other technology available or not financially viable Transport not possible High security risk with ammunition in area Large and medium calibre ammunition
Open burning	No other technology available or not financially viable Preferably limited amounts of explosives
Rotary kiln	Large amounts of small and medium calibre ammunition After down-sizing may be suitable for large calibre ammunition
Fluidized bed	Large amounts of bulk explosives and propellants Energy recovery possible Combination with CBF
Car Bottom Furnace (CBF)	Small amounts of igniters, detonators, fuzes, pyrotechnics
Hot gas Decontamination	Large amounts of contaminated metal scrap
Detonation Chamber	Limited amounts of ammunition
Downsizing technologies	Used in combination with reuse options As pre treatment for other technologies
Separation technologies	Recycle and reuse
Experimental conversion technologies	Specific applications for hazardous materials to prevent formation of highly toxic substances and protection of the environment

In practice the demilitarization of ammunition will always be a combination of the above listed technologies. The technologies have to be available at the local situation. More important is the availability of qualified personal.

If a large amount of ammunition has to be handled, it will be cost effective to build a fixed facility. If the amounts of ammunition are moderate it will be advisable to use a mobile facility. A promising issue can be the local transformation of ammunition into class 4.1 waste.

This can be realized by the separation of the explosives from the metal parts and the subsequent mixing of the explosives with water and additives [10]. This conversion, however requires sophisticated technologies, access to Hazardous Waste Disposal facilities – including HW from EWI etc.

For special application the use of experimental technologies can be recommended. This is the case when by using conventional incineration technologies highly toxic chemicals could be produced like dioxins.

## IX. Conclusions

Best practice methods can mitigate the risks of ammunition demilitarization with a minimum of costs and environmental impact. The applicability of the individual techniques strongly depends on the local situation and the economy of scale.

When explosives cannot be recycled, they have to be destroyed. A promising technology will be the transformation of the explosives in 4.1 waste products. This can be achieved by mixing the energetic material with water

and additives, the resulting class 4.1 wastes can be safely incinerated in commercial installations elsewhere.

A limited number of components in ammunition should be handled by specific methods as described in Chapter 6. This holds especially for chemical warfare agents and smoke compositions containing hexachloroethane or white phosphorus. These types of ammunition should be treated separately with additional safety measures.

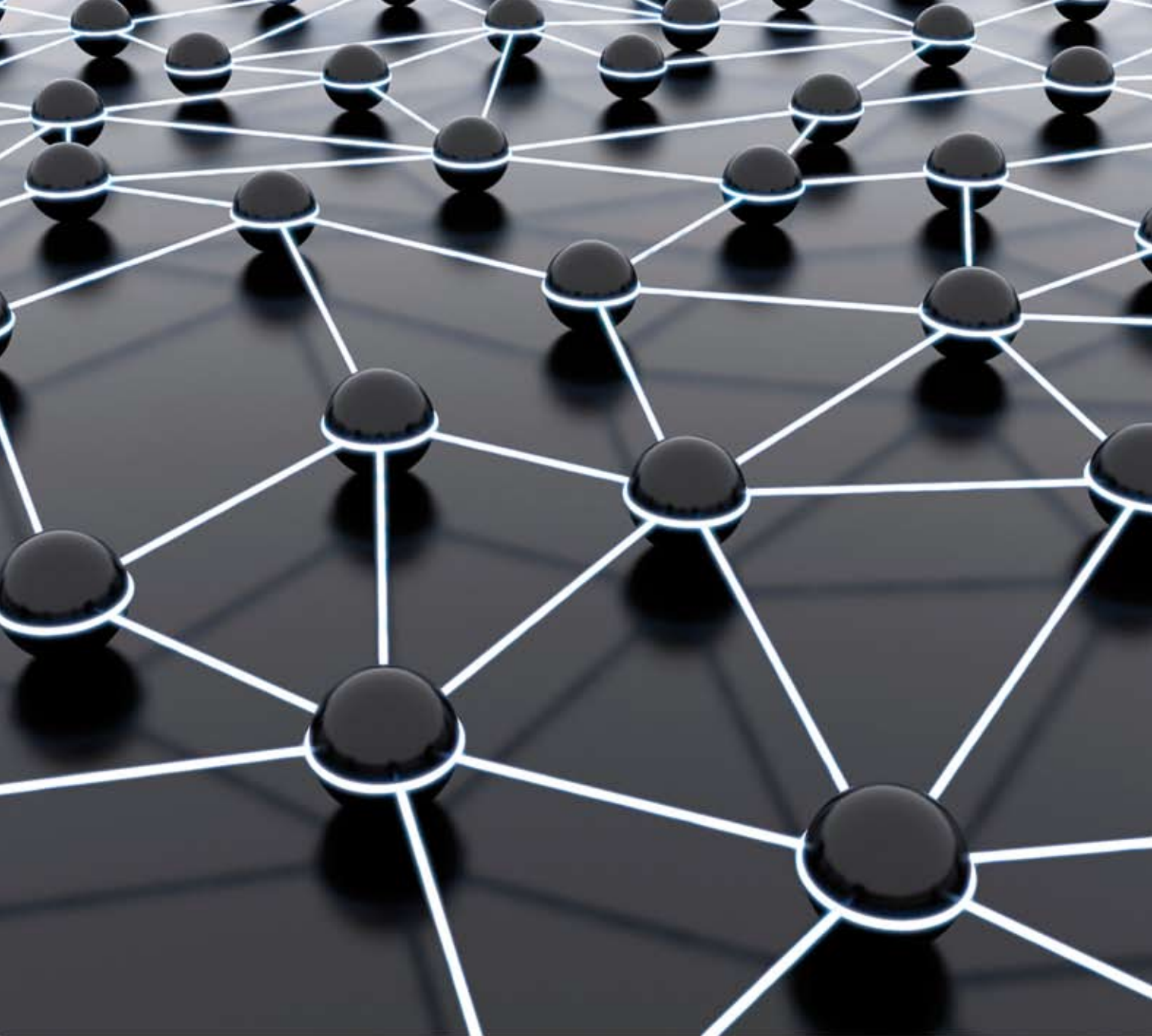
## X. List of abbreviations

CN	Chlooracetofenon	OB	Open Burning
CS	O-chloorbenzilydeenmalonitril	OD	Open Detonation
CW	Chemical Weapon	RDX	Hexogene (Research Department X)
DBP	Di Butyl Phtalate	SCWO	Super Critical Water Oxidation
DNT	Di NitroToluene	TNT	2,4,6-Tri NitroToluene
DPA	Di Phenyl Amine	UXO	UneXploded Ordnance
NG	Nitro-glycerine		

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# NOTES



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