NATO STANDARD

AASTP-5

NATO GUIDELINES FOR THE STORAGE, MAINTENANCE AND TRANSPORT OF AMMUNITION ON DEPLOYED MISSIONS OR OPERATIONS

Edition 1 Version 3

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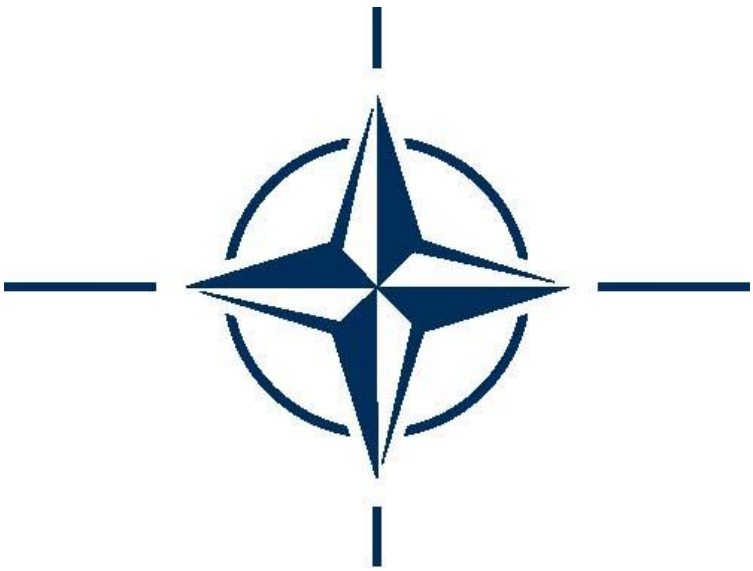

NORTH ATLANTIC TREATY ORGANIZATION
ALLIED AMMUNITION STORAGE AND TRANSPORT PUBLICATION

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AASTP-5

NATO GUIDELINES FOR THE STORAGE, MAINTENANCE AND TRANSPORT OF AMMUNITION ON DEPLOYED MISSIONS OR OPERATIONS

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The guidelines and techniques given in this document, in the opinion of the Group of Experts, among the best available at the time of publication.

Adherence to these guidelines should provide an acceptable level of safety of ammunition and explosives operations. It does not ensure or guarantee a risk-free situation; neither can the guidelines cater for every possible situation, which could be encountered. Because of the inherent danger in handling ammunition and explosives, the Group of Experts cannot be held responsible for any mishap or accident resulting from the use of this document.

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

20 June 2016

1. The enclosed Allied Ammunition Storage and Transport Publication AASTP-5, Edition 1, Version 3, NATO GUIDELINES FOR THE STORAGE, MAINTENANCE AND TRANSPORT OF AMMUNITION ON DEPLOYED MISSIONS OR OPERATIONS, has been approved by the nations in the CNAD AMMUNITION SAFETY GROUP (CASG - AC/326), is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4657.

2. AASTP-5, Edition 1, Version 3 is effective upon receipt and supersedes AASTP-5, Edition 1, Version 2, which should be destroyed in accordance with local procedures for the destruction of documents.

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4. This publication shall be handled in accordance with C-M(2002)60.

for Dieter Schmaglowski
Deputy Director NSO
Branch Head P&C

Edvardas MAŽEIKIS
Major General, LTUAF
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS

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RECORD OF SPECIFIC RESERVATIONS

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CHAPTER 1 AWARENESS GUIDE FOR THE OPERATIONAL COMMANDER

1.0 NATO EXPLOSIVES SAFETY AND MUNITIONS RISK MANAGEMENT (ESMRM) POLICY

a. NATO commanders and NATO nations participating in NATO operations shall comply with NATO explosives safety requirements of AASTP-1 or AASTP-5, as applicable.

b. When NATO explosives safety requirements cannot be met, the risk management process given in Allied Logistics Publication – 16 (ALP-16) shall be followed.

c. Munitions and munitions-related risk decisions by appropriate senior decision makers are both NATO commander and national responsibilities.

(1) For risk assessments with high and medium risk levels within operational plans, a general or flag officer within the NATO chain of command is responsible for making the risk decision.

(2) For risk assessments with high and medium risk levels at an MN base requiring a risk decision at a higher level within the chain of command, operational NATO commanders shall endorse and forward to the appropriate NATO commander with risk decision authority.

(3) Risk assessments with a low risk level do not require approval delegation and can be approved by operational commanders.

(4) Risk decisions affecting other nations' personnel, assets, or missions, as well as any unrelated personnel to the munitions operation, shall always be made by a general or flag officer within the NATO operational chain of command.

1.1 GENERAL

1. AASTP-5 will assist the planning, transport, reconnaissance, establishment and management of ammunition in the deployed environment.

2. AASTP-5, Chapter 1, is intended to serve as an awareness guideline for Operational Commanders. Chapter 2 of this publication is intended for use by the Operational Commander's Specialist.

3. AASTP-5 establishes minimum Field Distances (FD) for Net Explosive Quantity (NEQ) not to exceed 4,000 kg beyond which AASTP-1 Quantity Distances (QD) shall apply.

4. AASTP-5 is effective upon receipt. AASTP-5, like other AC/326 AASTPs and AOPs, will be revised periodically. Comments from users of this publication are invited. Comments should be directed to the Secretary of the AC/326 at NATO HQ; Brussels, Belgium.

5. Annex H is a list of technical documents that were significant in the development of version 2 of AASTP-5.

1.2 MANAGEMENT

1. The Operational Commander has overall responsibility for munitions safety.

2. Commanders are accountable for striking a balance between safety and operational requirements using the information available. They must be informed when minimum explosives safety standards cannot be met and must understand the hazards and consequences, and accept the risk of any deviation from those standards.

3. The risk and consequences of an accidental explosion of ammunition stockpiles must be considered as part of the force protection assessment. Analysing the risk can be very complex, particularly when multiple nations are occupying the base camp/airfield. Therefore, it is recommended that during the operational planning process, provision should be made to involve those personnel responsible for the storage and management of ammunition.

4. The requirement to establish an Explosives Safety Board (ESB) on a MN installation shall be formally addressed in NATO planning and operational documentation. The ESB Chair position should periodically be rotated among Nations to spread management responsibilities.

5. A competent person(s) of an appropriate rank/grade shall be appointed as the Explosives Safety Officer (ESO), to be responsible for advising on all explosives matters. In a MN setting, and for the safety of all participants, it is especially important that nations co-located on a MN installation select a Lead ESO to coordinate the execution of critical explosives safety elements on that installation. The Lead ESO shall also address matters that threaten the force if an explosive storage facility or operation is not properly managed and provide explosive safety input to the G3/J3 Force Protection Assessment. Critical explosives safety elements are further discussed in AASTP-5, paragraph 2.2.3.

6. If deviations to explosives safety requirements are necessary implement the risk management process given in paragraph 2.7.

7. In a MN environment, risk decisions must be coordinated and communicated with other nations impacted by such decisions, as one nations risk acceptance cannot

be assumed to reflect other nations' acceptance. (See paragraph 2.1.2.3)

Item Checked ☐

1.3. EXPLOSIVES SAFETY PROGRAM

1. The Operational Commander is responsible for initiating and maintaining an Explosives Safety Program (ESP). ESP is a functional program combining occupational safety training with operational and support activities of the Force. The aim of the program is to prevent accidental bodily harm, and damage or loss of materiel or facilities (i.e. military and civilian) from the hazardous effects of accidental explosions.

2. The primary effects to be considered are blast overpressure, ammunition fragments, debris from the storage facility, crater ejecta, ground shock, and thermal effects. Each of the explosion effects can cause injuries to personnel and damage to assets. The level of injuries or damage is dependent on the Potential Explosion Site (PES), the location of all ammunition activities (storage and operations).

3. The PES shall clearly identified on a map. The map shall include the safety arcs associated with each PES in order to define hazardous areas and land restricted from use.

4. Generally the NEQ, type of storage facility and its orientation towards the Exposed Site (ES) and the stand-off distance of the ES has a direct effect on the consequences, and therefore the risk(s) of an explosive accident.

Item Checked ☐

1.4. RECONNAISSANCE

1. Site selection should be based on a reconnaissance which examines all relevant ammunition safety factors. Annex A of Chapter 1 provides a Reconnaissance checklist for the Operational Commander.

2. The aim of the reconnaissance is to find an appropriate site for the storage of the unit’s ammunition. Main factors include:

    a. The size of the storage area;
    b. Safety distances to accommodation and maintenance area of the camp and neighbouring camps;
    c. Safety distances to civilian buildings, roads, airfields, railroads;
    d. General suitability (ground quality, topography, etc.);

e. Availability of technical utilities.

See also Chapter 2 Annex C for more details.

3. The results of the reconnaissance process is to be documented, checked for compliance with the provisions in this document and submitted to the appropriate channels, such as G3, G4 of the operating nation as well as the host nation. The appropriate authority must approve the reconnaissance report.

Item Checked ☐

1.5. OPERATIONAL GUIDELINES

1. The principle objective of the Field Storage concept is the dispersion of ammunition to minimize the loss in the event of fire, accidental explosion, or enemy action. Separate areas must be established for storing, marshalling and examining ammunition, for parking ammunition vehicles and for storing returned/found/captured ammunition.

2. An ammunition storage site may be used to store containers, flat racks or stacks separately or in combination. The minimum distance requirements specified in AASTP-5 must be met for both internal (inside the storage site) and external (off-post).

3. Ammunition shall be stored in accordance with the FD's outlined in paragraph 2.6. The use of barricades will reduce the amount of space needed for storing ammunition.

4. Captured ammunition shall be stored separately from own ammunition (see paragraph 2.4.3 for details).

5. Roads in, and leading to, explosive facilities are to be maintained in a good state to reduce the risk of vehicle accidents.

Item Checked ☐

1.6. IMPLEMENTATION

1. Personnel controlling or supervising the handling of munitions at field depots must be appointed by the Commander. The person designated must be thoroughly familiar with the operation, and clearly understand the hazards and risks.

2. Any relaxation in safety standards requires a risk management process. This process is a systematic procedure that will determine if an acceptable level of protection is provided. Acceptance of risk is to be made by the appropriate

authority (see paragraph 1.0.c).

Item Checked ☐

1.7. THREATS AND PROTECTION

1.7.1 FIRE PROTECTION

1. Fire represents a significant threat to a munition storage area and every effort shall be taken to reduce the threat of fire.

2. Fire protection plans must be prepared for each facility used to store munitions.

3. An emergency water supply must be provided for fire fighting purposes.

4. Fires in the vicinity of munitions should be fought until munitions stacks become involved in the fire.

Caution: Fires of munitions Hazard Divisions (HD 1.1, 1.2, 1.3, and 1.6) shall not be fought!

5. Each PES shall be identified by the prescribed fire division symbol of the most hazardous material present. However, an updated and central key plan of the PESs contents is the preferred method to posting symbols in a tactical environment.

6. Munitions which have been exposed to fire are considered unsafe to handle and transport. Qualified personnel must be consulted in deciding on future action.

Item Checked ☐

1.7.2 DISTANCE TO TRANSMITTING STATIONS

1. Minimum distances must be maintained from transmitting stations, dependent on the transmission power, see paragraph 2.6.

Item Checked ☐

1.7.3 SECURITY

1. The presence/movement of the stocks should be advertised as little as possible (by signing, placarding etc), whilst safety practices, and the expectations of the host nation and visiting troops. The number of personnel with access to the storage, both in the physical sense and to the stock register should be limited to the minimum.

2. Possible security measures:

a. A personnel access list;
b. Surveillance system;
c. Intrusion barricades;
d. Physical and electronic security measures;
e. Security response plans.

Item Checked ☐

1.7.4 BARRICADES AND APPROVED STRUCTURES

1. Barricades function by stopping ammunition fragments, and protecting stored ammunition against external threats, such as enemy fire.

2. Effective barricades between ammunition modules prevent sympathetic detonations. Barricades around PESs protect personnel and material from horizontal high velocity fragments.

3. Barricades can be provided by sloped terrain, sandbags, gabion mounds for earth-covered buildings and elevations (see paragraph 2.3.5 for more details).

Item Checked ☐

1.7.5 WEATHER AND LIGHTNING PROTECTION

1. Ammunition should not be exposed unnecessarily to inclement weather or direct sunlight and should be protected from sand, mud and water which can all have a serious impact on reliability as well as safety. Ammunition should not be unpacked except for operational necessity.

2. Storage of ammunition under cover is preferred. Ammunition must not touch the walls or ceiling of a structure in order to allow proper ventilation.

3. If ammunition is stored in closed and properly grounded ISO containers it can be considered protected from lightning (see paragraph 2.5.3.3).

Item Checked ☐

1.8. TRANSPORT

1. STANAG 4441 and requirements of Allied Movement Publication -6 (AMovP-6) shall be followed.

Item Checked ☐

1.9. RESERVED

1.10. ACCIDENT REPORTING AND INVESTIGATION

1. A national accident reporting and investigation process shall be established for reporting, investigating and analyzing explosives accidents with the aim to prevent a like occurrence thus improving safety, and not to allocate blame (not a criminal investigation). A report shall be prepared and communicated that includes recommendations for corrective action(s) and lessons learned.(See paragraph 2.9).

Item Checked ☐

1.11. AMNESTY PROGRAM

1. Sole nation on a NATO base shall implement an Munitions Amnesty program.

2. Two or more nations on a NATO base, as an integral part of a NATO Base's explosives safety and munitions risk management (ESMRM) program, support the NATO base´s Munitions Amnesty Program.

3. Further details can be found in paragraph 2.10.

Item Checked ☐

1.12. MISSILE INSTALLATIONS

1. Mobile missile systems (e.g., Patriot) positioned around or in the vicinity of a NATO base and which are being used in a static, defensive role shall be treated as PES and require additional special consideration due to inherent hazards they present to their surrounding environment.

2. When determining locations for missile systems, the threats posed by such systems to its surroundings need to be understood, considered, and coordinated with the Lead ESO before missile locations are selected (See paragraph 2.11).

Item Checked ☐

1.13. CONCLUDING A MILITARY OPERATION OR MISSION

1. Support and implement the activities associated with concluding a military operation or mission (see paragraph 2.12.)

Item Checked ☐

ANNEX A CHECKLIST FOR THE OPERATIONAL COMMANDER

1. What are the explosives safety threats for the mission.

2. Is there an up-to-date reconnaissance report available?

3. Is there sufficient knowledge available in the reconnaissance party concerning ammunition safety and ammunition risk management (storage, handling & maintenance)?

4. Is there an officer responsible for ammunition safety and risk management during this operation?

5. Are there enough qualified personnel for the safe handling of ammunition?

6. Is there enough space for the safe storage, handling and maintenance of the ammunition i.a.w. the recommendations of AASTP-5? If not what are the effects and the risks for the own troops and material?

7 Are the explosive risks known and communicated?

8. Are the effects/consequences known if a PES explodes?

9. Has risk decision been made where FD / QD distances can not be met?

10. Is it necessary to store ammunition in climatized containers/storage locations?

11. Is there a location available for the storage of damaged/enemy ammunition?

12. If it's necessary to have ammunition directly available for use on the camp:
    a. Where is this ammunition stored?
    b. How is this ammunition stored?
    c. What are the risks of this kind of storage for the own troops?
    d. Is there a lightning protection system applied for the explosive storage and operating location?

13. What firefighting arrangements are in place?

14. Is there a surveillance plan available (condition of the ammunition). Is there a response plan for security issues?

15. Has an Amnesty Program been established? **Item Checked** ☐

CHAPTER 2 GUIDELINES FOR THE SPECIALISTS

2.1. GENERAL

2.1.1 SCOPE

1. AASTP-5 Chapter 2, establishes NATO guidelines for the storage, maintenance and transport of ammunition during deployed missions and operations. It assists in the planning, reconnaissance, and establishment of an Ammunition Area in a deployed environment and then for the management of the ammunition. It is intended for use by the Operational Commander's specialist.

2. AASTP-5 Chapter 2 establishes minimum requirements that are based on reducing the Maximum Credible Event (MCE) to no greater than 4,000 kg Net Explosive Quantity (NEQ), to avoid/reduce loss of personnel and material, minimize the effects of unintended detonations/reactions during storage, transportation and handling or as a result of enemy action. If the 4,000 kg MCE is exceeded, then requirements of AASTP-1 shall apply.

3. The Field Distances (FD) provided in AASTP-5, Chapter 2, provide the same level of protection to non-related personnel and the public as that found in AASTP-1. With regards to the protection of in-camp personnel and structures, the FD consider the hazards associated with blast, fragments, debris, and building collapse, as well as the PES and ES construction, to provide a level of protection to ensure personnel will still be capable of continuing their mission. However, it should be emphasized that even with adherence to Field Distances (FD) tables provided herein, damages to structures and injuries (even lethality) to personnel could still occur. It is important to note that this would also be the case with AASTP-1 QD. Field Distances (FD) within AASTP-5, Chapter 2 do not consider asset protection.

2.1.2 DEVIATIONS

1. Before the Operational Commander makes any decision to deviate from AASTP-1 or AASTP-5 as applicable, it is advisable that specialists are consulted (for example fire fighting, ammunition safety, security, transport) and asked to highlight any possible consequence of relaxation of certain rules. Any advice provided to the Operational Commander must be documented and properly recorded.

2. Where the requirements of this document cannot be met, a consequence and/or risk analysis must be conducted before making a decision to deviate from these guidelines. This analysis is a systematic procedure that will determine if an

acceptable level of protection is provided. Acceptance of risk must be made only after considered judgment of the balance of risk after development, implementation and enforcement of control measures to mitigate negative effects whilst maintaining operational effectiveness. Any request for deviation must be approved by the appropriate authority.

3. Coordination

   (1) Coordinate with National Representatives.

   Coordinate all risk decisions with affected nations and obtain their concurrence with the ESMRM assessment, thereby informing affected nations of the associated munitions-related risks and encouraging their participation in the risk mitigation process.

   (2) Lack of Response from National Authorities.

   In the event that a nation chooses not to engage in the ESMRM process, NATO ESMRM requirements shall still apply and the ESMRM risk-decision shall be made by a general or flag officer delegated risk-decision authority within the NATO chain of command. The risk decision package shall document that a particular nation chose not to participate in the ESMRM process and their reason for doing so.

4. Prior to an Operational Commander authorizing a deviation to this manual, it must be recognized that it may have a follow on effect to other nations in the event that they take over the compound. Further, prior to endorsing or approving a deviation , the Operational Commander must recognize that they may not only be putting own nation's personnel at risk but potentially also other nations personnel (See 1.0).

2.1.3 RESPONSIBILITIES

1. The ESO is responsible for managing the Operational Commander ESMRM Program. The Operational Commander is accountable for striking a balance between safety and operational requirements using the information available and must therefore be made aware of the consequences of any deviation from safety criteria.

2. It is recommended that during the planning, reconnaissance and construction processes, provision should be made to involve those personnel responsible for the storage and management of ammunition. During the operational phase, an Explosives Safety Officer (ESO) shall be appointed. The ESO is responsible for advising the Operational Commander on all explosives safety matters. The competencies required by an ESO are detailed at Annex B together with a checklist for inspections by an ESO.

3. Access to an Ammunition Area is the Operational Commander’s responsibility. Access decisions should be based upon J2/J3 advice.

4. It is a responsibility of the Commander to ensure that an adequate Munitions Surveillance Program is being carried out, and any deviations that affect safety or operational capability must be immediately reported to the Commander.

5. Assume responsibility for the management of the the Commander's Munitions Amnesty Program and supports the NATO Base's Munition Amnesty Program as applicable.

2.1.4 ACRONYMS AND DEFINITIONS

1. Key Terminology

MUST	Indicates a technical requirement which is vital for the safety of a depot and the avoidance of a catastrophe.
SHOULD	Indicates a safety requirement which is important but not essential.
MAY/CAN	Indicates optional courses of action and possibilities.
IS/ARE	Indicates a fact or a valid technique. (from AASTP-1)

2. Acronyms

AASTP	Allied Ammunition Storage and Transport Publication
ADR	European Agreement on the International Carriage of Dangerous Goods
AE	Ammunition and Explosives
AIS	Accident Information Sheet
AMOVP	Allied Movement Procedure
AOP	Allied Ordnance Publication
BLAHA	Basic Load Ammunition Holding Area
BLSA	Basic Load Storage Area
CALA	Combat Aircraft Loading Area
CAPA	Combat Aircraft Parking Area
CEA	Captured Enemy Ammunition
CG	Compatibility Group
ECM	Earth Covered Magazine
EM	Electro-Magnetic
EOD	Explosive Ordnance Disposal
ES	Exposed Site(s)
ESMRM	Explosive Safety and Munitions Risk Management
ESO	Explosives Safety Officer
ESP	Explosives Safety Program
EWD	Emergency Withdrawal Distances
FARP	Forward Ammunition and Refueling Point
FD	Field Distance
FEP	Fire and Emergency Plan
FPO	Fire Protection Officer
HD	Hazard Division
IATA	International Air Transport Association

IBD	Inhabited Building Distance
IMDG	International Maritime Dangerous Goods Code
ISO	International Standardization Organization
MAB	Munitions Amnesty Box
MOU	Memorandum of Understanding
MCE	Maximum Credible Event
NEQ	Net Explosive Quantity
OHP	Overhead Protection
PES	Potential Explosion Site
POD	Point of Debarkation
POE	Point of Embarkation
QD	Quantity Distance
RID	Regulations on the Carriage of Dangerous Goods by Rail
RP	Rearming Pads
SG	Sensitivity Groups
SsD	Storage sub-Division
SOP	Standard Operating Procedure
WP	White Phosphorus

3. Definitions

Ammunition Area	A group of PES at a minimum of FD from each other.
Cargo Aircraft	An aircraft, other than a passenger or a passenger/cargo carrying aircraft, carrying freight or cargo. (from the guidance document to STANAG 4441)
Combat Aircraft	A military aircraft designated to carry combat-configured munitions.
Combat Aircraft Parking Area	Any area specifically designated for: a. Aircraft loading or unloading of combat-configured munitions. b. Parking aircraft loaded with combat-configured munitions.
Compound	An area that incorporates functions, facilities, and operations necessary for the accomplishment of a mission.
ESMRM	ESMRM is a systematic approach that integrates risk assessment into operations planning, military training exercises, and contingency operations with the goal of identifying potential consequences associated with munitions operations, risk reduction alternatives, and risk decision criteria for key decision makers. ESMRM permits NATO commanders to deliver

	operational effect at tolerable levels of risk, and must be done on a recurring basis to be effective.
External Safety Distance	Distance applied from PES in a compound to ES located outside the compound.
Field Distance	Distances applied from a PES to other PES or ES located within a compound.
Forward Arming and Refuel Point	A temporary arming and refueling location that is organized, equipped, and deployed by an aviation unit.
Gabion	A cage within which can be placed various fill materials (e.g. gravel, sand, rock), and which is used for building walls, barricades and protective barriers.
Heavy Armoured Combat Vehicles	Vehicles constructed so that they protect the crew against the hazards of the main guns, anti-tank weapons and artillery ammunition.
Hot Refuelling	Refuelling of an aircraft whilst engines are still running.
Light Armoured Combat Vehicles	Vehicles constructed so that they protect the crew against the hazards of small arm ammunition, machine guns and fragments.
Non-Armoured Combat Vehicles	Vehicles constructed without armour protection.
Non-Robust Munitions	A munition that does not meet criteria as a Robust Munition, see below.
Outside Compound	An object influenced by the explosive effects from a PES. An ES containing explosives, in this publication, is considered to be a PES.
Personnel	People within the compound.
Prompt Sympathetic Detonation	Propagation of an explosion (e.g. munition to munition or stack to stack), without sufficient time delay between reactions, with the result being coalescence (e.g. joining) of the two or more blast pressure waves into a single pressure wave similar to one that would have been generated by a single explosion involving the combined NEQ at all the reacting munitions. FD in such situations is based on the combined NEQ.
Sympathetic Detonation	Propagation of an explosion (e.g. munition to munition or stack to stack), with sufficient time delay between reactions, with the result being that coalescence (e.g.

	joining) of blast pressure waves does not occur. The result is that each explosion is viewed as a separate event, with its own FD. Using appropriate FD should assure that prompt sympathetic detonation does not occur, though use of FD cannot rule out that subsequent sympathetic reactions might occur.
Rearming Pads	Element of the FARP.
Robust Munitions	AE that meet two of the following criteria: 1. Have a ratio of the explosive weight to empty case weight less than 1. 2. Have a nominal wall thickness of at least 10 mm. 3. Have a case thickness/$NEQ^{1/3}$ >0.165 cm/$kg^{1/3}$. Examples of Robust Munitions include 20 mm, 25 mm, and 30 mm cartridges, GP bombs, artillery projectiles, and penetrator warheads

2.2. MULTINATIONAL (MN) INSTALLATION OPERATIONS

2.2.1 INTRODUCTION

1. This Section outlines the principles that should be used to properly integrate ammunition safety guidelines into Multi-National (MN) operations. The critical explosives safety elements that must be accomplished and managed are identified. Addressing those elements provides coalition forces the ability to conduct operations and manage storage areas involving coalition and/or multinational AE in a safe manner and gives Commanders the flexibility to share AE resources and capabilities with co-located coalition and/or multi-national partners

2.2.2 EXPLOSIVES SAFETY BOARD (ESB)

1. It is necessary in a MN environment to collectively address ESMRM. This is best accomplished by establishing a safety committee/board. The ESB forms a framework for managing all explosives safety related Elements. The ESB provides a platform on which to address issues and concerns and to ensure critical explosives safety matters are not ignored. The ESB should be chaired by a senior officer on the Base Camp/Airfield HQ Staff, managed by the Lead ESO and attended by an appropriate AE representative from every Nation/Unit/Organization. The roles and responsibilities of the Chair, the ESB Manager plus the Board Members shall be recorded.

2. All Nations/Units/Organizations co-located on the MN Base must be represented at the Explosive Safety Board Meetings. The frequency of the board meetings is dependent on the Operational Tempo, but should occur no less than once per month. Minutes of the meetings should be recorded and distributed to all ESB Members. It may be necessary at times to bring in specialists from other related fields such as engineering, medical, security and emergency response

2.2.3 CRITICAL EXPLOSIVES SAFETY ELEMENTS

1. Lead Explosives Safety Officer

Ideally one nation should be assigned as the Lead Nation, and the ESO from that Nation would serve as the principal explosive safety advisor for the base camp/airfield Commander and manage the ESB. However the formal assignment of a Lead Nation does not always occur; therefore, in the common interest of all, a Lead ESO must be appointed amongst the co-located nations in order to manage the overall Explosive Safety Program.

2. Explosives Safety Criteria

The first order of business for the ESB should be to agree on what explosives safety criteria will be used by Nations co-located at the MN base/airfield. It is expected that all participating Nations would agree to use NATO explosives safety criteria found in AASTP-5.

3. Current National Points of Contact (POC)

It is vital that all Nations/Units/Organizations co-located on a base maintain a current communication network of contacts for their Nation and provide contact details to the Nation assuming Command and Control and to the Lead ESO. Nations should also provide up to date listings of their installation command staff and key explosives-safety related personnel to the ESB.

4. Land Use and Construction Management

The Nation responsible for land use and construction management should manage installation real estate/facility use, to ensure compliance with explosives safety requirements. Because of the consequences associated with an accidental explosion of munitions, mapping correct safety arcs, based on the Nations' listings must be annotated on the installation map, and all planned construction within and on the periphery of safety arcs must be closely managed and coordinated. The ESB should serve as the final decision-making authority for land use/construction requests and it must ensure that appropriate consideration is given to construction standards and AE siting.

5. Safety Arcs for FDs/Mapping

Safety arcs define the AE hazardous areas on an installation and the land restricted from use. Therefore all AE activities (storage, maintenance and operations) with their

safety arcs must be consolidated onto one master FD map. The map must identify the available land for use and identify activities at risk that are located within the safety arcs, i.e. Exposed Sites (ES). Each Nation should maintain current listings of structures/locations that contain their AE, and the hazard classification (e.g., 1.1D, 1.2.1E) and NEQ present (kg) at each of those facilities/locations.

6. Explosive Site Planning/Licensing

   a. All facilities/activities inside the safety arcs must be covered by an approved explosives site plan, license, or deviation.
   b. NATO does not have an explosives safety/licensing organization, so these matters shall be carried out at the National level.
   c. Even if issued through a Nation's process, coordination for explosive site planning /licensing and any planned construction has to be centralized and coordinated with the Lead ESO.

7. Risk Management

When explosive safety standards cannot be met, a risk management process must be carried out (see paragraph 2.7).

8. Surveys of the AE Stocks

Conducting inventories of ammunition stock on hand should be routine and an inventory of ammunition by Hazard Classification, quantity and Net Explosive Quantity (NEQ) are to be submitted to the ESB on a periodic basis, but not less than once per month. Knowledge of types and quantities of AE located on the base/airfield is necessary to respond to requests of users, but also necessary to plan and to license every AE storage and processing facility and to keep the installation safety arc map current.

9. AE Hazard Classification

AE brought together in a MN environment may raise concerns regarding its classification. The UN hazard classification system should be used to resolve any conflicts. Nations that have not classified their AE using the UN System may be required to apply a more conservative approach (e.g. greater separation distances).

10. Explosives Safety Continuity

The rotation of personnel presents many issues. With regards to explosives safety elements, it is particularly important that continuity be maintained. For that reason, Commands should try and arrange turnovers/rotations in a manner that allows a handover of some sort. This will greatly minimize the amount of time needed to learn the status of critical explosives safety elements.

11. Surveillance/Serviceability (See also Par 2.4.6 - Surveillance)

It must not be assumed that all Nations participating in MN operations will have well

managed stockpile surveillance and/or propellant stability test programs that monitor the safety of their ammunition stocks. If a Nation does not have those programs, then there may be an increased likelihood of an accidental detonation/reaction (e.g., auto-ignition of propellant) occurring due to the "unknown condition" of their ammunition stockpile. This increases the risk to surrounding ammunition stocks, personnel, facilities, and other resources.

2.3. PLANNING RECONNAISSANCE AND PLANNING DESIGN FOR A COMPOUND

2.3.1 INTRODUCTION

1. Consideration shall be given to different functions needed within a compound to accomplish a mission (e.g. administrative buildings, fuel storage, sleeping accommodation, ammunition storage, maintenance facilities, ammunition truck holding locations, inspection stations, airfield, port, demolition grounds and other similar areas/operations). Each PES within a compound must be defined considering that different ammunition Hazard Division (HD) and Storage sub-Divisions (SsD) react differently when initiated.

2. FD are provided for the separation of ES from PES and between different PES.

3. An output from the planning, reconnaissance and design phase will be a site plan document, which must be approved by the appropriate authority. This document forms the basis for the compound layout and design and will be transferred as the user of the compound changes.

2.3.2 PLANNING

1. The aim of the planning phase is to find an appropriate area of the right size for the storage of the unit's ammunition. The following information is necessary before starting the reconnaissance operation:
    a. Maps of the area
    b. Environmental and weather information of the area. It must be remembered that high temperatures and high humidity can effect the lifetime, quality and safety of some kinds of ammunition, such as rocket systems, flares, White Phosphorus (WP), etc. Further details can be found in paragraph 2.4.2.
    c. Type of mission and operation (e.g. peace keeping, peace enforcing), both present and future, and acceptable losses of materiel.
    d. Ammunition type, NEQ and HD.

e. For flexibility in the use of the storage, all planning should be based upon HD 1.1 material only.
f. Required activities in the Ammunition Area such as maintenance, handling of captured ammunition, package, etc.
g. Any Memorandum of Understanding (MOU) between partners and the host nation.
h. Designation of the lead nation. The lead nation may change during different phases.
i. People in the area and possible threats.
j. Important infrastructure including military structures.
k. General suitability of terrain (e.g. flood-prone, swampy, vegetation, ground quality, gradient)
l. Requirement for specialized buildings (i.e. workshops, receipt & issues, salvage and office buildings)
m. Availability of utilities (e.g. power, water).
n. Any Ammunition Area should be at least 100 meters from a switching station i.e., Power station, RF station or large transformer station since these stations can introduce high uncontrollable currents. Electrical Supply Lines such as service lines that provide power to an explosives facility must be run underground for at least 15 meters to the facility. Aboveground service lines not serving power to an AE facility or to an open PES will not be closer than 15 meters.

NOTE: Given the information above, the main considerations for defining the layout of an Ammunition Area will be the required FD and Inhabited Building Distance (IBD).

2. During the planning of operational ammunition storage facilities, decisions are made that may be difficult to rectify at a later date. It is therefore of prime importance that the planning is focused and conducted by highly qualified personnel. It is recommended that during the planning process, provision should be made to involve those personnel responsible for the storage and management of the ammunition that will be stored in the site. The ESO, engineers and troops from other arms and services should cooperate closely in the planning phase.

3. High priority must always be given to the safety associated with the storage, maintenance and transport of munitions during deployment. During deployment, allowance must be made for varying logistic procedures in the planning process (pallets, containers). The planning should also include the handling equipment required.

4. It is important to remember that the IBDs applicable in the country of deployment must be observed whenever they are more stringent than the IBDs applicable in the country of origin.

5. The total NEQ of ammunition in each PES should be determined by adding the sum of the NEQ of all energetic compositions contained in all the ammunition excluding HD 1.4 which may be disregarded, see paragraph 2.6. The NEQ in any PES should never exceed a loading capacity of 4,000 kg.

6. Since building debris can contribute to additional hazards in case of an accident, building type must be taken into consideration prior to use as a storage building. Ammunition may only be stored on the lowest floor of a building and only if no personnel occupy floors above the designated storage floor.

7. The following should be considered for ammunition storage:
    a. Total gross weight
    b. Total NEQ
    c. HD and Compatibility Group (CG)
    d. Sensitivity Group (SG)
    e. Storage limitations of the individual items to be stored (e.g. temperature limitations for missiles, WP)
    f. Size of the package(s)
    g. Security Classification

With this information the number of PES can be calculated. The required footprint for the Ammunition Area can then be determined by taking into account the required separation distances, as provided in paragraph 2.6, from all PES to all ES.

2.3.3 RECONNAISSANCE

1. A well performed reconnaissance mission is the basis of a successful layout of an Ammunition Area. Missing or inaccurate information may lead to an unsafe situation. In the reconnaissance phase, technical specialists (e.g. engineers, ESO) should visit the area to determine if it meets mission requirements. Annex C, the Site Survey Check List, lists subjects and topics that should be evaluated to help determine the size of an Ammunition Area and compound. Some key points to consider when evaluating the Ammunition Area are:
    a. The adequacy of existing roads and bridges. These may need to be upgraded.
    b. Distances to infrastructure from the planned Ammunition Area must be calculated. Considerations of infrastructure must also take into account civilian use of facilities such as hospitals, schools, airfields, etc.
    c. Cultural facilities: An awareness of cultural sites such as graveyards, religious buildings or other cultural sites must be maintained.
    d. Public facilities/utilities: Exposing AE hazards to public facilities and utilities such as Radio Towers, Chemical/Oil Storage Tanks should be

avoided.

e. Availability of local materials (e.g. fill for barricades and Overhead Protection (OHP)).
f. Availability and capacity of existing utilities.
g. Weather patterns and Lightning protection (see paragraph 2.5.3).

2. The results of the reconnaissance process must be documented, checked for compliance with the provisions in this document and submitted to the appropriate authority. The approved reconnaissance report will become the basis for the preparation and establishment of the planned compound.

2.3.4 DESIGN PHASE

1. A number of factors should be assessed as part of the design phase, including:
   a. The number of ammunition containers to be stored at the Ammunition Area.
   b. The types and numbers of PES needed (e.g. ammunition process buildings, ammunition truck holding locations, limited quantity storage locations, inspection stations, ammunition loading and unloading sites, disposal and detonation grounds, and other area/operations).
   c. The NEQ for each PES.
   d. The configuration lay-outs for the various HD and CG in the Ammunition Area.
   e. The requirements for and types of OHP construction needed.
   f. The types/thicknesses, to include fill material, of barricades and OHP.
   g. The required FD between different PES.
   h. The effects of a PES MCE and implication on construction inside the compound.
   i. When applicable, the orientation of an Ammunition Area and individual PES with respect to ES (e.g. adjacent Ammunition Areas, mission critical assets, the public, hospitals, schools) and from external threats.
   j. The required FD of PES to ES (e.g. Ammunition Areas, mission critical assets, etc.).
   k. The required IBD of PES to ES (e.g. the public, hospitals, schools).
   l. Window use.
      (1) In Ammunition Area. Windows must not be used in the Ammunition Area because of the dangers from glass shards injury/lethality in the event of an explosion.
      (2) In the compound but outside of the Ammunition Area. Windows use is not encouraged, but if used should be limited. To minimize injuries/lethality due to glass breakage, windows should face away

from PES and protective measures (internal curtains and wire mesh) taken to stop glass shards from entering the facility.

(3) Taping of and placement of specially designed plastic film on windows can improve their performance when exposed to explosive effects and should be used when possible. Special attachment techniques may also be required to keep the window glazing from presenting a blunt trauma risk to occupants of the building.

2.3.5 BARRICADES

1. The proper use of barricades can decrease the magnitude of a detonation event and increase the explosives capacity of limited areas. A barricade at a PES will stop low angle high velocity fragments, which are the primary mechanism for prompt detonation propagation. They also may protect the PES from enemy fire. The use of proper barricades at PES and/or ES is necessary for the implementation of the FD contained in this document.

2. The barricade should be thick enough and the material must have enough penetration resistance to stop high-velocity fragments. The barricade must be stable over time and should not be susceptible to environmental factors.

3. The fill material of a barricade should not be hazardous to personnel or other ammunition modules when it is launched by an explosion. The preferred type of fill material is free of organic and hazardous materials and should consist of sand or gravel with a maximum diameter of 20 mm.
    a. A proper barricade between PES will allow the use of reduced FD. Gabion configurations of 1, 2+1, 2+2 or 2+2+1 (see Figure 2-1) (or equivalent) between adjacent storage containers should be used as the standard for Ammunition Areas in theatres of operations. Note that in the event of an explosion, the barricade may impact on an adjacent PES. Gabion configurations of 3+2 or 3+2+1 do not provide more protection than the 2+2 or 2+2+1 mentioned previously, but can produce more mass movement onto the adjacent storage container, which may not be necessarily advantageous. For this reason, these larger barricades are not recommended between PES located at FD but are more suitable in front of the container opening.

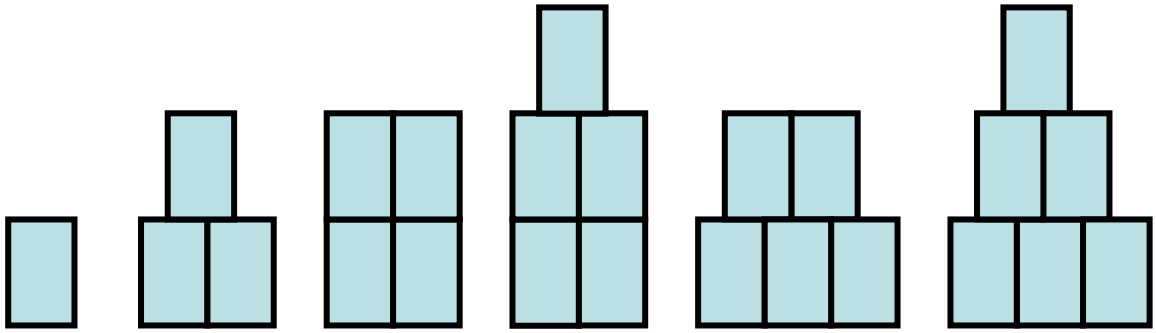


Figure 2-1 : Gabion (for each min width 1m) arrangements, 1 (up to 100 kg NEQ), 2+1 (up to 1000 kg NEQ) and 2+2, 2+2+1, 3+2, 3+2+1 (up to 4000 kg NEQ).

b. A proper barricade with a configuration of 2+2+1 or 3+2+1 (or equivalent) placed no more than 10 m in front of a PES opening should be used in theatres of operations. The closer the barricade is to the PES the better it will be for stopping/collecting fragments.

c. The barricade between PES should be made a minimum of 0.3 m higher than the tallest of the adjacent stacks, see Figure 2-2.

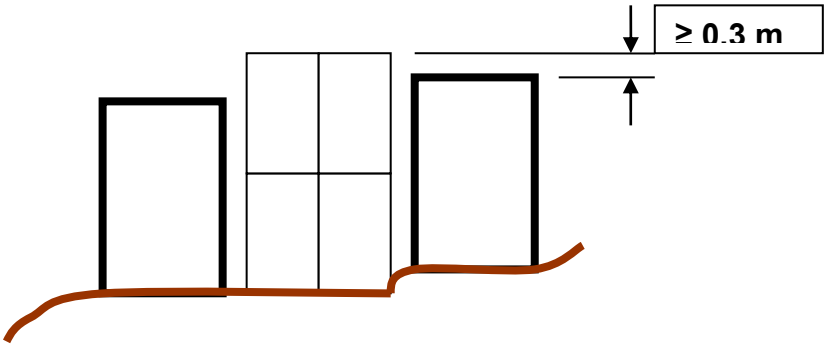


Figure 2-2: Determining minimum barricade height

d. It should be noted, however, that a barricade does not necessarily prevent subsequent propagation or damage caused by blast, lobbed items, debris or secondary fires.

4 OHP for barricaded PES construction can, under certain circumstances, be utilized to reduce explosion effects, protect the stocks from enemy fire and maintain a constant temperature. Suggestions for construction, and an example

design (see Figure 2-3) of a barricaded PES with OHP design follows:

a. In a row of PES separated by Gabion barricades with OHP, each PES should have its own independent roof.
b. Combustible materials should not be used to construct the OHP.
c. The fill material for OHP should not be hazardous to surrounding ES when it is launched. The preferred type of fill material is free of organic material and should consist of sand or gravel with a maximum diameter of 20 mm.
d. The fill material must be at least 60 cm deep and must cover the entire roof area of each PES.
e. Columns used as support for the sectional roof may be inserted within the Gabion. Also, a minimum 60 cm ventilation gap may be provided between the top of the Gabion and the OHP to allow for rapid venting of blast overpressure. A secondary benefit is ventilation.

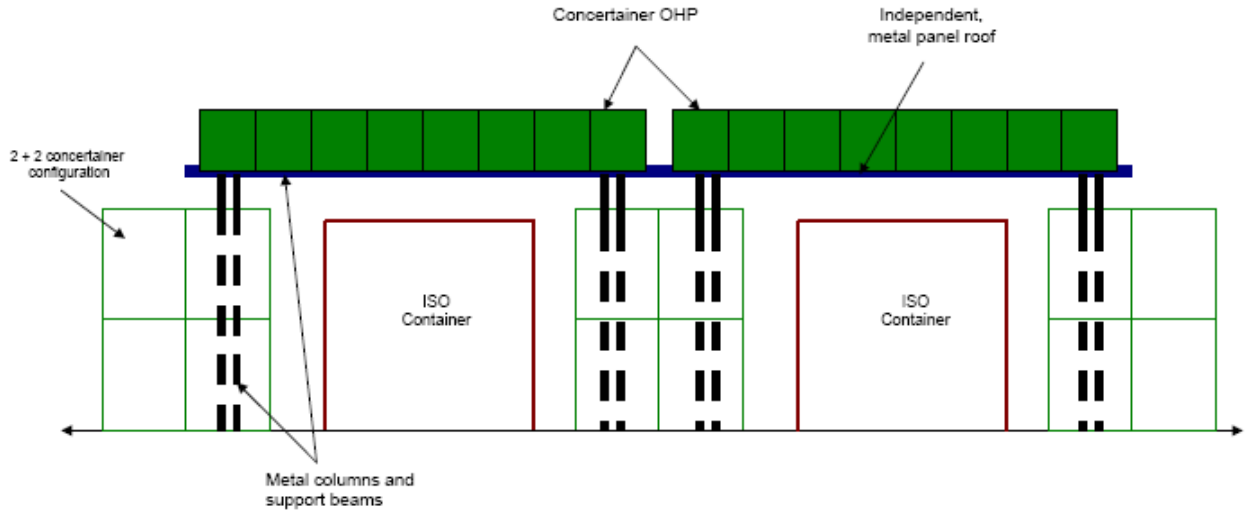


Figure 2-3: Example design of a barricaded PES with OHP

2.3.6 SITE PLAN DOCUMENT PREPARATION AND APPROVAL

1. A Site Plan is required prior to construction of the compound. The Site Plan document, which must be approved by the appropriate authority, should consist of:
    a. Layout drawings of the proposed compound.
    b. A description of use and occupancy of each facility within the compound.
    c. The NEQ and HD at each PES and its associated FD and IBD.
    d. Anticipated number of personnel in each facility on the compound.
    e. Approved construction drawings to include: materials used, barricades, structural hardening, OHP, lightning protection system, static grounding systems, windows.
    f. Standard Operating Procedures (SOP).
    g. A topography map, with contours (when terrain features are considered to provide natural barricading) or topography that otherwise influences the layout of facilities on the compound.
    h. Identified deviations from safety standards caused by local conditions.

2.4. OPERATIONAL AMMUNITION ON SAFETY PROCEDURES

2.4.1 DOCUMENTATION REQUIREMENTS

1. Once a site has been selected, the following documentation (where required) should be prepared and approved by the appropriate authority:
    a. MOU
    b. Site plan document
    c. Explosives licence. Annex G
    d. Deviations

2.4.2 STORAGE CG

1. Ammunition should be stored per Table 2-1 based on its assigned CG. To preserve operational capability and to reduce the risk of loss of the total stockpile of an item in the event of a fire or explosion, it is recommended that not more than 50% of any CG, and associated non-explosives components, are stored in any one PES. Where reasonably practicable, this stock is to be further dispersed.

Compatibility Group	A	B	C	D	E	F	G	H	J	K	L	N	S
A	X												
B		X	1	1	1	1	1						X
C		1	X	X	X	2	3					5	X
D		1	X	X	X	2	3					5	X
E		1	X	X	X	2	3					5	X
F		1	2	2	2	X	2, 3						X
G		1	3	3	3	2, 3	X						X
H								X					X
J									X				X
K										X			
L											4		
N			5	5	5							7	6
S		X	X	X	X	X	X	X	X			6	X

Table 2-1: Mixing of Compatibility Groups

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 F.
2. Storage in the same building is permitted if effectively segregated to prevent propagation.
3. Mixing of articles of Compatibility Group G with articles of other compatibility groups is at the discretion of the National Competent Authority.
4. 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.
5. Articles of compatibility N should not in general be stored with articles of other Compatibility Groups except S. However if such articles are stored with articles of Compatibility Groups C, D and E, the articles of Compatibility Group N should be considered as having the characteristics

of Compatibility Group D and the compatibility groups mixing rules apply accordingly.

6. A mixed set of munitions HD 1.6N and HD 1.4S may be considered as having the characteristics of Compatibility Group N.
7. It is allowed to mix HD l.6N ammunition. The Compatibility Group of the mixed set remains N if the ammunition belongs 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 ammunition should be considered as having the characteristics of Compatibility Group D and the compatibility groups mixing rules apply accordingly.

2. Determining NEQ at a PES

The NEQ of all ammunition (except HD 1.4) at a PES, regardless of HD, should be added together for determining the NEQ at a PES

2.4.3 TRANSPORT AND STORAGE OF CAPTURED ENEMY AMMUNITION (CEA)

1. The following rules apply to CEA:
   a. Before transporting CEA into the Ammunition Area, it must have been certified as safe for transport and storage by a qualified individual (e.g. Explosives Ordnance Disposal (EOD) specialist).
   b. Because of uncertainties of its safety status (i.e. increased risk of fire and accidents), CEA must be isolated from own ammunition by the greatest distance possible, but no less than FD.
   c. CEA storage in a PES should not exceed an NEQ greater than 500 kg.
   d. If positive identification is not possible, CEA must be treated as HD 1.1. When its NEQ is unknown the total weight of the CEA (less package) must be used.
   e. CEA should be stored by CG mixing rules.
   f. An inventory list, to include NEQ, should be kept of CEA in each PES. Copies of the list must be kept at the PES, with the EOD team on duty (if available), and the fire-fighting unit.

2.4.4 DESTRUCTION OF AMMUNITION (INCLUDING EMERGENCY DESTRUCTION)

1. A destruction ground may be required for disposing of ammunition that is in a dangerous and/or unserviceable condition. The location chosen must be a sufficient distance away from all surrounding ES so that it presents no additional danger. Destruction is to be carried out according to AASTP-1 Part IV chapter 7

and national regulations governing such operations. During operations, it is essential that any dangerous and/or un-serviceable ammunition is destroyed as soon as possible as accumulations of this ammunition presents an unnecessary and additional danger.

2.4.5 AMMUNITION PERSONNEL QUALIFICATIONS

1. Personnel controlling or supervising the handling of ammunition at an Ammunition Area must be identified/appointed by the Operational Commander. The designated personnel, normally the ESO, must be thoroughly familiar with ammunition operations being conducted and must clearly understand the hazards and risks involved. The competencies required by an ESO are detailed in Annex B.

2.4.6 SURVEILLANCE

1. Ammunition surveillance and serviceability programs are a national responsibility. Knowing the condition and the serviceability status of ammunition stocks is an important part of ensuring user safety and functional reliability. In Service Surveillance programs will help in the early detection of degradation in ammunition stocks, which could lead to an increased probability of an explosive accident or other unsafe reaction occurring with those stocks, as well as ensure the munitions will function properly when needed.

2. Both a propellant stability test program and an ammunition surveillance program are necessary to accomplish the above, and they must consider the conditions under which ammunition will be stored and used (e.g., high and low temperatures, high and low humidity), as environmental conditions can aggravate ammunition degradation issues and create serious safety and operational capabilities consequences.

3. Ammunition stored at the Ammunition Area requires a qualified AE expert to check and manage the serviceability of the assets. Determining the condition of AE should be made by type, model and lot number assigned at time of manufacture. Ammunition carried by soldiers and/or stored in vehicles are subject to extreme conditions and requires special attention. Screening by the user however is limited to the detection of damage/contamination.

4. Unfavourable storage conditions in an operational environment should be avoided. Servicing measures must be performed regularly to help ensure ammunition is kept clean, dry and complies with their respective unique requirements. For example it is recommended that White Phosphorus Ammunition is stored and transported in a nose up configuration because the filler may melt or change position in high temperatures, and can cause poor ballistics.

5. Unless necessary for operational reasons, “unknown condition” ammunition should not be stored in the same storage location (e.g., cell, magazine) as “known condition” ammunition from Nations that have surveillance and propellant stability test programs. Such stocks should be stored separately, at a minimum of the required FD given in the FD Table in paragraph 2.6, to prevent prompt propagation.

6. NATO guidelines for conducting in-service surveillance (ISS) of non-nuclear munitions can be found in STANAG 4675 and its AOPs.

2.4.7 STORAGE OF LIMITED QUANTITIES

1. For reasons of operational necessity, limited quantities not to exceed allowable NEQ of 45 kg NEQ of HD 1.3 or 1.4 or 23 kg NEQ of HD 1.2.2. may be stored without regard to FD.

2. Such storage shall meet NATO Base requirements, as well as nationally-defined procedures and are restricted to limited quantities of HD 1.2.2 (40 mm and below), HD 1.3 (e.g., document destroyers, signaling devices, riot control), and HD 1.4 (e.g., small arms, riot control) munitions may be stored at locations (e.g., hangars, arms rooms, security alert force rooms),. NATO base procedures shall address items such as allowable NEQ, documentation requirements, approval process, and LPS requirements, as necessary.

3. Each location to which this paragraph applies shall have a risk assessment conducted which assesses the operational necessity, the risk involved, and identifies proposed mitigation / limitations / conditions to minimize that risk. The risk assessment shall be prepared by the national ESO. As part of its development, the risk assessment shall be coordinated with the base ESO, as well as logistics, security, fire protection, and ammunition surveillance personnel.

4. The national commander, to which the munitions belong, shall make the risk decision, based on operational necessity, for such storage and/or operations.

5. Each approved limited quantity storage/operations location shall be licensed by the national ESO. The license shall specify the exact location, the HD and quantity of each permitted, NSN, any time restrictions (e.g., one year, 6 months), and any required mitigation / limitations / conditions associated with the commander’s risk decision.

6. Fragment barriers shall be provided when HD 1.2.2 is stored in inhabited buildings such as barracks or office buildings. Minimum acceptable fragment barriers are: 6 mm of mild steel plate, one layer of sand bags, 30 cm of loose sand or dirt, or equivalent protection.

7. Munitions must remain stored in their original container with original packaging, as the munition hazard classification process designation (e.g., HD 1.3) is based on testing of that munition in its packaged configuration. Removing the packaging potentially could result in a more significant reaction which could increase risk substantially. The only exception is for an arms rooms that supports guard forces or military police, which are permitted to have one outer pack of each caliber of small arms ammunition open for use.

8. The appropriate fire and/or chemical hazard symbols shall be properly posted on the door to the storage area. Appropriate symbols need not be posted on the exterior of the building if only storing HD 1.4 ammunition.

9. At least two fire extinguishers shall be available for immediate use at each location. Each fire extinguisher shall be:
    a. Kept in a fully charged, operable condition.
    b. Placed in a conspicuous and readily accessible location.

10. Approved locations shall meet all safety, security, and fire protection requirements; however, small amounts of flammable or combustible liquids necessary for weapons cleaning and maintenance can be stored in approved storage containers placed as far as possible from the munitions.

11. Training ammunition stored in the same room must be separated and distinguishable from operational ammunition and listed separately on the arms room inventory.

12. Munitions shall be stored in accordance with storage compatibility requirements given in paragraph 2.4.2.

2.4.8 PARKING OF UP-LOADED VEHICLES

1. All vehicles containing munitions (e.g., transport; armored, light-armored, non-armored vehicles preparing for / returning from missions or training), shall be parked in locations that meet the FD given in Table 2-2. Any deviation from this requirement requires the conduct of a risk assessment, as detailed in paragraph 2.7.2, by the national ESO to include any mitigation, restrictions, and limitations, and in coordination with the Base's Lead ESO. The risk assessment package will be presented to the NATO Base Commander for their risk decision

2.5. PROTECTION

2.5.1 FIRE PROTECTION

1. Protecting against fires involves three important principles:
    a. Prevention.
    b. Hazard identification.
    c. Fire fighting.

2. Responsibilities and Organization.
    a. The Operational Commander is responsible for the protection of ammunition against fire, as well as for the protection of personnel from fire hazards involving ammunition. The Operational Commander along with his designated specialists (i.e. ESO, Fire Protection Officer (FPO)) will develop necessary plans as described below. All personnel working at the Ammunition Area must be aware of their responsibilities/expected actions in the event of an emergency.
    b. A Fire and Emergency Plan (FEP) should be developed at each compound. Emergency response and evacuation provisions must be developed for each PES located in the Ammunition Area. An exercise of the FEP should occur at least once during each rotation of the operational commander or a minimum of once every six calendar months.
    c. The FEP shall require that the fire department knows the hazards associated with each ammunition fire division. In addition, the fire department must know what Fire Division is associated with every PES (see below). The fire department should be notified each time a Fire Division symbol is changed.
    d. Layout plans for the Ammunition Area including content/type/Fire Division plans and evacuation plans are to be prepared and kept accessible outside the Ammunition Area at all times.
    e. Emergency Withdrawal Distance (EWD) for non-essential personnel (those not directly involved in fire fighting) are intended for use in emergency situations only and are not to be used for facility siting purposes. In the event of a fire no personnel other than those directly involved in fire fighting shall be permitted entrance to the Ammunition Area.
    f. The same EWD applies to the local population.
    g. The EWD is governed by the HD involved in the fire. The EWD for essential personnel at accidents shall be determined by on-site emergency authorities. Emergency authorities shall also determine who are considered as essential personnel.
    h. At a minimum, FEP shall address the following:

(1) Specific sections and guidance that address emergency preparedness, contingency planning and safety. For safety, those plans shall limit access to trained and authorized personnel. These plans shall identify the number and location of specific locations (i.e. protective structure(s), or other safe location(s)), for personnel to take shelter.

(2) Procedures that minimize the possibility of an unintentional detonation, release, discharge or migration of military munitions or explosives out of any storage unit when such release, discharge or migration may endanger human health or the environment.

(3) Provisions for prompt notification to emergency response and environmental agencies and the potentially affected public for an actual or potential detonation or uncontrolled release, discharge or migration (that may endanger human health or the environment).

(4) First aid instruction and use of fire fighting equipment.

(5) Emergency map.

i. The Operational Commander along with the designated specialists (i.e. ESO, FPO) is responsible to produce the necessary plans. He/she also has to ensure that all plans and emergency plans are accessible to the Emergency Authorities and Rescue Forces.

3. Prevention

a. Fire prevention plans should be included in the SOP for the compound.

b. Fire prevention measures are to be organized within the scope of general fire prevention taking into account the following areas:

(1) Order and cleanliness as well as strict observance of safety precautions count among the most effective fire prevention measures, equal to the prohibition of smoking and the use of open flames, fire and naked lights.

(2) Handling of flammable substances.

(3) Prevention of the accumulation of additional fire hazards such as stacking material, packaging material and the like.

(4) Fire hazards associated with machines, equipment and tools used during ammunition operations or the overloading of electrical cables.

(5) The use of oil or gas filled lighting, heating or burning appliances and all flame, spark or fire producing appliances should be minimized.

(6) Remove flammable undergrowth and lay out fire lanes.

(7) Clear zones around PES, trimming of branches, etc.

4. Hazard Identification

a. The four Fire Divisions symbols are shown below. The number and shape of each symbol serves to identify its fire hazard for fire fighting personnel approaching a scene of a fire. These are:

(1) Fire Division 1 - Mass explosion

(2) Fire Division 2 - Explosion with fragment hazard

(3) Fire Division 3 - Mass fire

(4) Fire Division 4 - Moderate fire.

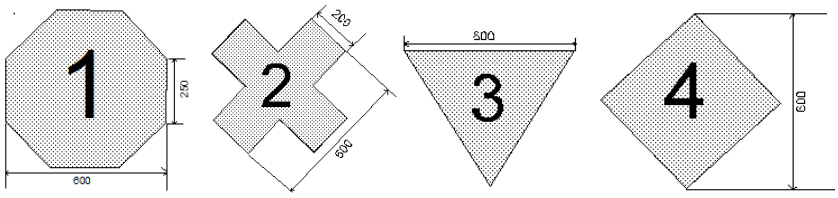
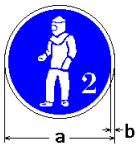


Figure 2-4: Fire Division Symbols. (From AASTP-1).

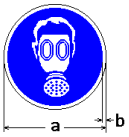
b. Supplementary symbols are used to identify which locations contain specific types of pyrotechnic material as these munitions give supplementary hazards. For this reason, the ESO should advise the FPO of any supplementary hazards and the specific emergency measures for such ammunition.

Supplementary symbols shown below can be displayed at a PES to indicate the following precautions that must be taken if fighting fires:

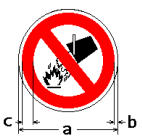
(1) Wear full protective suit.



(2) Wear respirator face piece.



(3) Apply no water.



c. The Operational Commander may, for security purposes, permit the removal of the Fire Division symbols or a change in the colors used. In these situations, the Operational Commander should give prompt and precise information to the fire department about the changes and condition of the ammunition.

5. Fire Fighting

a. Fire-fighting principles and procedures for field operations are the same as those given for permanent depots in AASTP 1.

b. All fires in the vicinity of the ammunition should be fought until stacks of ammunition or explosives become involved in the fire or the fire is extinguished. If ammunition becomes involved in a fire, it is critical to remove personnel immediately from the site to safe locations/distances.

c. **Ammunition fires involving other than Fire Division 4 must not be fought.** When fighting fire involving ammunition in Fire Division 4, the minimum distance should be 25 meters.

d. Personnel whose duties require them to fight secondary fires must not approach within 300 m of any fire involving explosives other than Fire Division 4.

e. All unprotected personnel not involved in the fire fighting activities should be ordered to withdraw to protected positions (inside protective shelters) and/or should be evacuated to at least 800 meters or to IBD, whichever is the greater.

f. After an ammunition fire has been extinguished, personnel must wait at least six hours before entering the area.

g. No one must touch ammunition involved in a fire or accidental explosion without being directed to do so by a qualified person.

h. The following additional provisions could be necessary:

(1) Fire Division 4 ammunition may be stored near the entrance to the Ammunition Area. (Note: If a fire does break out in this ammunition, it is possible to fight it and there is a realistic chance of saving ammunition in this Fire Division, while there is no chance of saving ammunition in the other Fire Divisions when fire breaks out.).

(2) The area in which ammunition from Fire Divisions 1, 2 and 3 is stored must be delineated very clearly.

(3) Empty packaging and combustible material are to be stored separately from the PES.

2.5.2 ELECTRO-MAGNETIC (EM) RADIATION PROTECTION

1. Transmitting devices (cellular phones, pagers, vehicle transmitters, etc.) must not be used within 20m from any PES unless specifically authorized. Use of transmitters within the Ammunition Area must be reviewed on a case-by-case basis and a license to operate such equipment at a specified safe distance should be provided by the National Technical Authority and approved by the ESO.

2. Care must be exercised to protect electrically initiated ordnance from stray electrical currents. STANAG 1380/AECP-2 provides a calculation methodology for determining safety distances and managing the effects of EMR on munitions and weapon systems containing electrically initiated devices (EIDs).

3. Rocket, Rocket Motors or Missiles in a propulsive state should be stored in the direction that least endangers personnel or equipment, preferably stored pointed down. They are not to be pointed upward or toward the door. If pointing down is not an option, or the propulsive state is unknown, point rockets or missiles in the direction of an earth berm or natural barrier.

2.5.3 WEATHER PROTECTION

1. Environmental Conditions
    a. Temperature
        (1) High temperatures (>40°C), and large variations in temperatures can degrade the performance and safety of a variety of munitions (in particular those containing WP) and propellants. Every effort should be made to reduce this effect, through the use of covered storage, correct stacking procedures for provision of adequate ventilation and, if possible, the use of an air-conditioned environment. Proper surveillance of munitions (see Paragraph 2.4.6) is necessary to maintain the operational capability of the munitions.
        (2) Ammunition stored in the open should be shaded with light coloured tarpaulins in order to reduce the effects of radiant heat. These coverings should not be in direct contact with the ammunition (or ammunition container) as this can lead to increased temperatures in the ammunition and containers. A minimum air gap of 30 cm should be maintained between the top of the explosives stack/container and any covering material to provide adequate ventilation.
        (3) Tarpaulins and camouflage nets should be erected so that ammunition can be removed rapidly at night without taking the covering down. This allows replacement ammunition to be inserted into the location with a minimum of work. However, the tarpaulins

and camouflage nets must be capable of being lowered quickly or be made secure against the possibility of high winds or tropical storms, where these are a threat.

(4) A light paint colour on a container may significantly reduce temperature inside the container.

b. Humidity

(1) The effects of moisture at higher temperatures are worse than the effects of moisture at low temperatures. These increased effects resulting from high moisture and high temperature can lead to failure of initiation systems, reduction in propellant efficiency, and degradation of various munitions fills. Alternatively, low humidity environments can result in an increased risk from electrostatic discharge hazards and may also dry out critical seals and other components.

2. Environmental Controls

a. Every effort is to be made to reduce the effects of high temperatures and moisture on explosives held by units and in Ammunition Areas. All excess vegetation and combustible material shall be removed from open storage sites and within a radius of 20 m of such sites when munitions are present. Ammunition shall not be located immediately adjacent to reservoirs or sewers.

(1) Storage on the Ground

Ammunition should not to be stored directly on the ground in any situation but should be placed on pallets that provide a minimum of 75 mm clear distance from the ground to ensure ventilation. It is important that sand, earth and vegetation should not be allowed to build up around the base of pallets preventing the free passage of air.

(2) Improvised Structures

Local improvised structures and shelters may prove useful for providing cover over ammunition. Alternatively, tents, galvanized iron shelters or ISO-containers can be used where available.

3. Lightning Protection

a. In order to mitigate the adverse effects of a lightning strike (accidental initiation, damage), all PES should be provided with lightning protection. In addition, PES should be located no less than 15 m from trees, telegraph poles, pylons in order to reduce side flash. The resistance to earth of any lightning protection system should be less than 10 Ohm or as low as possible given the existing soil conditions.

b. ISO containers used to store ammunition are to be considered a “Faraday cage” thereby not requiring additional lightning protection. However, they must be effectively grounded as described in AASTP-1.

2.5.4 ELECTRICAL SAFETY

1. In a multinational (MN) base, many Nations could be co-located, and each may be using a different electrical standard. This could present problems with regards to electrical safety. However, the threat will most likely be related to personnel safety (e.g., shocking, short-circuits, electrocution) rather than issues related to hazardous environments involving explosives dusts or vapours and munitions. The reason for this is that any explosives operations will very likely involve all-up weapons.
2. Some exceptions could result from long exposure or munitions to high temperatures/high humidity, which might cause certain munitions filled (e.g., TNT-based fills) to exude explosive content or off-gas which could present risk of a fire or explosion. If these conditions occur, such munitions should be moved to a location away from good ammunition stocks and disposed of as quickly as possible. Placing ammunition in a covered structure or covering munitions with non-static generating material and providing circulation around the munitions will keep temperatures lower and should prevent exudation and off-gassing from occurring.

2.5.5 SECURITY

1. Since enhanced security is a prerequisite to improved explosives safety, sufficient coordination between security specialists and the ESO must be maintained.

2.6. FIELD DISTANCES

2.6.1 GENERAL

FD are introduced to make a distinction between distances used in AASTP-1 and AASTP-5. A FD is a distance between two PES whereby prompt sympathetic detonations will be avoided or the distance between a PES and an ES where the FD are to maintain adequate protection levels

1. The use of FD
    a. FD depend on the PES, ES, NEQ, HD and the type of ammunition. The FD can be reduced by using appropriately designed barricades. When using FD all ammunition is calculated as HD 1.1, (HD 1.4 must not be included).

b. The FD also depends on the required protection level against prompt sympathetic propagation. By using the FD given below, a high level of protection against prompt sympathetic propagation is achieved. This implies that other types of reaction, such as mass-burning (HD 1.3), occasional explosions of single articles (HD 1.2) and delayed mass explosions, may occur.

c. For practical purposes (loading and unloading, inspection, fire fighting), a minimum distance of 0.5 m is required between the outside of the ammunition container/stack and an adjacent barricade.

d. FD, as a function of NEQ, are given in Table 2-2. These FD assume that barricades in use are designed according to paragraph 2.3.5.

2. Field Distances

a. The FD are based on the following explosion effects on personnel in the open and on structures:

(1) Blast

(2) Fragment impact.

The resulting FD are given below in Table 2-2 and Table 2-3.

b. For PES and ES different structures can be used. Figure 2-5 shows examples of hardened structures, Figure 2-6 shows examples of semi-hardened structures and Figure 2-7 shows examples of light structures. Different structures can also be used as PES and ES (see Annex F).

Figure 2-5. Examples of hardened structures.

Figure 2-6. Examples of semi-hardened structures.

Figure 2-7. Examples of light structures.

AASTP-5
Table 2-2

Matrix for Ammo Field Storage Distances for Deployed Missions or Operations

ES		PES									
		VEHICLES					STRUCTURES (notes 11 & 12)				
		HEAVY ARMOURED (notes 1 & 5)	LIGHT ARMOURED		NON-ARMOURED		HARDENED (note 5)	SEMI-HARDENED		OPEN/LIGHT	
			BARRICADED	UN-BARRICADED	BARRICADED	UN-BARRICADED		BARRICADED	UN- BARRICADED	BARRICADED	UN-BARRICADED
		APPLICABLE FD's									
ES CONTAINING EXPLOSIVES (note 2 and 12)	HEAVY ARMOURED (note 5)		NO FD (note 6)	NO FD (note 6)	NO FD (note 6)	FD1	FD1	FD1	FD1	FD1	FD1	FD1
	LIGHT ARMOURED (note 5)		NO FD (note 6)	NO FD (note 6)	NO FD (note 6)	FD1	FD1	FD1	FD1	FD1	FD1	FD1
	NON ARMOURED	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UN-BARRICADED	FD1	FD1	FD3	FD1	FD3	FD1	FD1	FD3	FD1	FD3
	HARDENED (note 5)		FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
	SEMI-HARDENED	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UN-BARRICADED	FD1	FD1	FD2	FD1	FD2	FD1	FD1	FD2	FD1	FD2
	OPEN/LIGHT STRUCTURE	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UN-BARRICADED	FD1	FD1	FD3	FD1	FD3	FD1	FD1	FD3	FD1	FD3
	AMMO WORKSHOP (note 4)	BARRICADED	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1	FD1
		UN-BARRICADED	FD1	FD1	FD3	FD1	FD3	FD1	FD1	FD3	FD1	FD3
EXPOSED SITES WITHOUT EXPLOSIVES (notes 3, 9 and 12)	HARDENED (notes 5 and 10)		FD10	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4
	SEMI-HARDENED (note 10)	BARRICADED	FD10	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4	FD4
		UN-BARRICADED	FD10	FD5	FD6	FD5	FD6	FD5	FD5	FD6	FD5	FD6
	LIGHT STRUCTURE	BARRICADED	FD10	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD8/FD7 (note 7)
		UN-BARRICADED	FD10	FD8/FD7 (note 7)	FD9	FD8/FD7 (note 7)	FD9	FD8/FD7 (note 7)	FD8/FD7 (note 7)	FD9	FD8/FD7 (note 7)	FD9
	OPEN - PERSONNEL MISSION RELATED		FD10	FD8	FD9	FD8	FD9	FD8	FD8	FD9	FD8	FD9
	UNPROTECTED PEOPLE OUTSIDE COMPOUND		FD10	FD9	FD9	FD9/FD8 (note 08)	FD9	FD8	FD9/FD8 (note 08)	FD9	FD9/FD8 (note 08)	FD9

Notes (Table 2-2)

(01) It can be assumed that heavy armour will contain fragments and not generate debris for NEQ up to 150kg and is therefore an effective barricade. For NEQ < 150 kg, the FD10-distances are based on blast impulse only. For NEQ > 150kg, the generation of vehicle debris increases and FD10 address the sudden increase above 150 kg NEQ.

(02) For these ES the aim is to avoid prompt propagation - one barricade is considered sufficient.

(03) For these ES the aim is to ensure personnel protection and structural integrity (survivability).

(04) Only ammo related personnel. For Ammo workshop as PES use the relevant PES column . For personnel and facility protection, apply the FD given below for ES without explosives, for the type of structure housing the ammunition workshop.

(05) Hardened structures and Heavy Armoured Vehicles are by definition considered barricaded. Light Armoured Vehicles acting as an ES also are considered barricaded.

(06) No FD means 0 m; 2 m is recommended in order to allow space for maneuvering vehicles.

(07) If provided OHP or the structural integrity protects against free falling fragments then FD7 may be applied.

(08) FD9 is to be used except for robust artillery shells stored in a vertically position where FD8 may be applied.

(09) The FD do not address fatalities and injuries associated with flying glass.

(10) The FD are based on having structures that control blast ingress (through entrances and windows) to limit internal pressures.

(11) Non earth covered buildings that can generate debris like structures of concrete or bricks may not be used as PES.

(12) Reduced distances may be implemented if the nationally approved structures have been validated.

AASTP-5 Table 2-3	FIELD DISTANCES (FD's) (AASTP-5 Criteria)									
	PES to ADJACENT PES			PES to ES (NON PES)						
NEQ	FD1	FD2	FD3	FD4	FD5	FD6	FD7	FD8	FD9	FD10
25	4	7	14	12	18	23	23	100	130	13
50	4	9	18	15	22	30	33	100	212	21
75	4	10	20	17	25	34	40	100	260	27
100	4	11	22	19	28	37	46	100	294	32
150	4	13	26	21	32	43	56	100	342	42
250	4	15	30	25	38	51	73	100	400	400
500	4	19	38	32	48	64	103	155	400	400
750	4	22	44	37	55	73	118	203	400	400
1000	4	24	48	40	60	80	130	235	400	400
1500	7	28	55	46	69	92	149	283	400	400
2000	8	30	61	51	76	101	164	320	400	400
2500	8	33	65	54	82	109	177	352	400	400
3000	9	35	69	58	87	116	188	381	400	400
4000	10	38	76	64	95	127	207	400	400	400

2.6.2 THE STORAGE OF READINESS AMMUNITION

1. The following guidelines apply to locations where combat units hold their readiness basic load ammunition in shipping containers, armoured vehicles, trucks, trailers, structures, or on combat aircraft or re-arming pads. Provisions given can be used for the storage of ammunition in readiness in the theatre of operations or at home stations during training exercises.

2. Readiness ammunition explosives safety criteria do not apply to combat positions (such as artillery or mortar firing positions) or to ammunition needed at checkpoints.

3. Readiness ammunition storage criteria should not be used for the storage of training ammunition unless there is no other option available. When basic load ammunition and training ammunition are in the same storage, the training ammunition should be in a separate storage container if possible and where this is not possible the training ammunition must be clearly marked as such.

4. Readiness ammunition can be stored in a Basic Load Ammunition Holding Area (BLAHA) or in uploaded/combat vehicles, combat aircraft, etc. Any combination of BLAHA with combat loaded vehicle / combat aircraft or multiple BLAHA are called Basic Load Storage Areas (BLSA). An area with only multiple combat loaded aircraft is called a Combat Aircraft Loading / Parking Area (CALA /CAPA).

    a. For the purposes of BLAHA criteria combat vehicles can be heavy armoured, light armoured or non-armoured.
    b. Field Distances are given in Table 2-2 and Table 2-3. If total NEQ exceeds 4000 kgs, AASTP-1 distances apply.
    c. In a BLAHA, ammunition of all HD and all CG may be stored together without regard to the requirements of the mixing rules in Table 2-1.
    d. FD can be computed from individual vehicles or groups of vehicles. If the distance between two or more vehicles does not meet the distances required then the explosive quantity of all vehicles must be summed and this total value used for FD computations.

        (1) **Heavy Armoured Combat Vehicle**
        Heavy armoured combat vehicles are expected to contain most of the blast and fragments from an internal explosion and they are well protected against the effects of an external explosion.

        The hatches of heavy armoured combat vehicles must be kept closed and locked; otherwise, the vehicles are considered as light armoured combat vehicles.

(2) **Light Armoured combat Vehicles**

Light armoured combat vehicles are considered to be well protected from an external blast but will probably not contain the blast and fragments from an internal detonation of the stored ammunition.

Light armoured combat vehicles can be considered as being barricaded as an ES and un-barricaded as a PES.

(3) **Non-Armoured Vehicles and Stationary Storage Sites**

Non-Armoured Vehicles and stationary storage sites provide minimal to no protection from an external explosion.

5 POL separation. Small quantities (not exceeding 100 litres) of petroleum, oils, and lubricants (POL) held as immediate reserves for operational purposes, and that contained in vehicle fuel tanks and/or necessary equipment (i.e. climate control unit) requires no specific quantity distance from buildings or munition stacks. Bulk quantities of POL in steel tanks, drums or bladders should be sited at IBD with a minimum distance of 400 m separation.

6. Barracks, headquarters, maintenance facilities and other important facilities (e.g., water tower in a desert environment) within a military installation should be separated in all cases from the BLAHA.

7. Non-armoured vehicles, storage locations or administrative buildings can be protected by a combination of adequate barricades and OHP.

2.6.3 AIRFIELDS USED DURING DEPLOYED MISSIONS AND OPERATIONS

1. General

   a. Deployed missions and operations introduce unique safety issues as a result of the rapid movement of large amounts of munitions, generally a higher tempo of operations, and the necessary concentration of mission critical assets.

   b. With regards to the storage of munitions, the assumption is made that ECM will not be available and munitions will be stored in the open under cover, in light-weight structures, or in barricaded above ground structures with or without OHP.

2. Combat and Cargo Aircraft Loading, Unloading, and Parking

   a. Aircraft carrying explosives should be armed, loaded, unloaded and/or parked only in designated areas that meet required FD as indicated in

Table 2-2 and Table 2-3. This does not apply to aircraft containing only installed explosives and safety devices such as authorized signals in survival kits, egress systems components, engine starter cartridges, fire extinguisher cartridges and other such items necessary to flight operations.

b. FD can be computed from individual aircraft or groups of aircraft. If the distance between two or more aircraft does not meet the distances required in Table 2-2 and Table 2-3 then the explosive quantity of all aircraft must be summed and this total value used for FD computations. If an explosion should occur, aircraft within this group will be lost and aircraft in adjacent groups may be damaged by fragments; however, the explosion is unlikely to propagate simultaneously. Subsequent explosions may be caused by fragments, debris and/or secondary fires.

c. Combat-loaded aircraft should face the direction involving least exposure of personnel, equipment, facilities and civilian population to the line of fire of forward-firing armament.

d. Proper barricades placed between adjacent aircraft will prevent prompt sympathetic propagation due to high velocity, low angle fragments.

e. Lesser distances may be used for specific weapons where trials have shown that such distances are adequate to minimize the probability of propagation. For example, certain missile loads on fighter aircraft (i.e. F16, F15, Tornado) may use known, reduced FD that is based on testing.

f. Freefall munitions may be armed/de-armed on the aircraft parking ramp. Forward firing munitions should be armed/de-armed in an area specifically designated as a forward-firing area with a safe aircraft heading established by airfield operations.

g. Ammunition should be positioned in designated storage areas near the flight line in order to be readily available in adequate time for safe aircraft loading. Such areas should be barricaded to further reduce separation distances.

h. In most cases an existing airfield will be used for operations. The FD used will depend on the availability of infrastructure, their construction and their function in relation to the mission. For example:

   (1) Central airport support facilities
   (2) Aircraft-maintenance
   (3) Crew support
   (4) Runways and taxiways

   Special care must be taken when the airfield is also in use by civilians.

2.6.4 FORWARD AMMUNITION AND REFUELLING POINT (FARP)

1. FD criteria for FARP
    a. The FARP criteria apply only to units conducting attack/rotary and/or fixed wing missions. A FARP is a temporary arming and refuelling point organized, equipped and deployed by an aviation unit to support tactical operations. It is usually located closer to the Area of Operations than the combat service support area of an aviation unit. It provides fuel and ammunition for aviation units in combat situations. The situation on a modern battlefield demands that the FARP be flexible, transitory and able to support specific mission objectives. It should be flexible enough to self deploy or to be aerially inserted. It must meet the fuel and ammunition needs of mission aircrafts..
    b. Aircraft parking should be in accordance with paragraph 2.6.3.
    c. Due to the situation, special care must be taken with the grounding/earthing procedures.
    d. FD from Table 2-3 will be used for separation of FARP PES and surrounding mission-related ES.

2. Rearming/Refuelling Pad (RP)
    a. The minimum distance for RP separation is based on rotor clearance or FD with a 40 m minimum separation required. The greater distance should be used.
    b. The quantity of ammunition allowed at each RP should be limited to one aircraft load plus one aircraft re-supply. The minimum FD separation between pads should be based on 2 aircraft loads.
    c. Aircraft maintenance and munitions loading should not be conducted concurrently.
    d. Fueling of fixed wing aircraft should not be carried out at RP. Hot refueling (motors running) with ammunition on board should be limited to operational necessity.

2.7. RISK MANAGEMENT

2.7.1 INTRODUCTION

1. In general, safety in handling of munitions during all phases of a deployed operation, (e.g., storage, handling, transportation, demilitarization) shall be assured by applying the rules and procedures based on the FDs as described in this manual.

2. Situations may occur where the FDs from a PES to an ES not containing explosives cannot be met, e.g.,
    a. Strategic, Operational, and Tactical mission requirements
    b. lack of available area
    c. lack of structural measures (e.g. missing barricades)
    d. lack of personnel
    e. security reasons.

    For these situations the danger to exposed assets: personnel (all individuals inside the camp, mission related) and the public (all individuals outside the camp, non-related, third party people); materiel (including munitions); and infrastructure must be assessed based on a risk analysis.

3. A risk analysis is a systematic process that will determine the actual level of the hazard of a given situation. It takes into account possible adverse effects (consequences) of an explosion or fire in a storage site as well as how often such effects may occur (frequency/probability).

4. Paragraph 2.7.2 provides a risk management process which utilizes a five step process in order to identify a level of hazard. This process is generally a combination of quantitative calculation where the data and tools are available and a qualitative assessment of this information, taking into account other factors such as operational requirements.

5. Paragraph 2.7.3 provides a description of a quantitative risk analysis method which was developed by AC/326 Sub-Group C for the storage of ammunition on deployed missions. This quantitative method can also be used to support the risk management process introduced above, but can be used independently. The Consequence Tables for this method are provided in Annex D. An example of an automated Consequence Analysis Tool including a manual is provided in Annex E.

6. Determining if a calculated or estimated risk is acceptable depends not only on the level of the risk to personnel, people and assets, but also on operational requirements, possible measures to reduce or mitigate a risk (and associated costs), and other factors. Therefore, no general rules on the acceptability of a risk can be given for Deployed Missions or Operations. However, a balanced decision must always take into account all relevant factors.

2.7.2 RISK MANAGEMENT PROCESS

This paragraph provides the basis for applying risk management on Multi-National operations in the form of an Explosives Safety Case (ESC).

1. General
    a. The process can be applied in order to enable decision-making in situations where the minimum acceptable safety standards cannot be met. The appropriate authority accepting the risk of an undesired explosive event must be well informed.
    b. The Risk Assessment Team shall consist of personnel capable of assessing munitions-related processes and their associated risks.
    c. The following diagram (Figure 2-8) shows the five steps that will be followed in the risk management process:

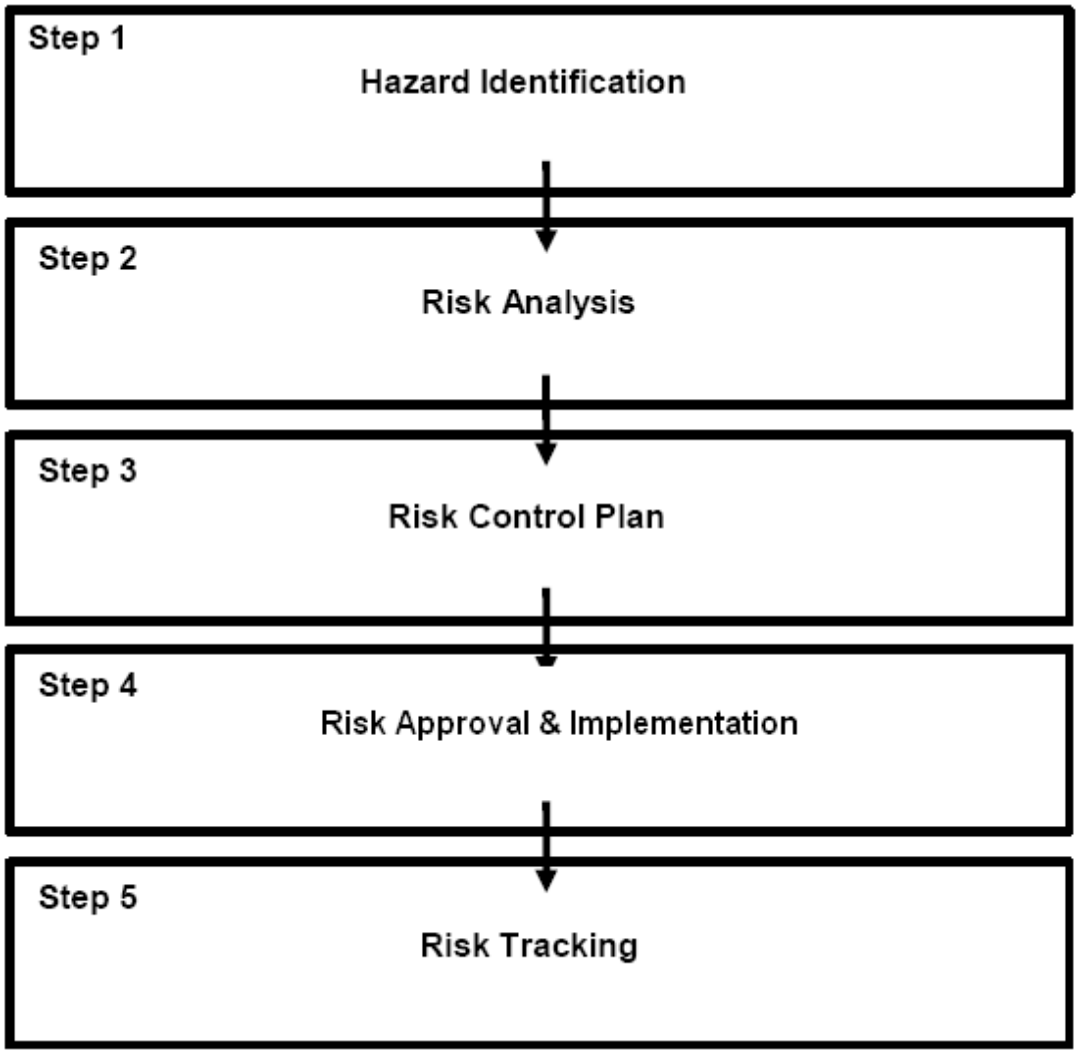


Figure 2-8 Risk Management Process Steps

2. Step 1 – Hazard Identification
    a. The details of the scenario must be defined. That is, the circumstances around which it is thought that an undesired explosive event may occur. Typically, the scenario and circumstances do not meet minimum

acceptable safety standards. The Explosives Safety Officer (ESO) refers to the standards and determines at this point that the formal examination of risk should begin.

b. The following provides an outline of the factors involved, for which the ESO must have a sound understanding:
   (1) The minimum Net Explosive Quantity (NEQ) to be held at the site for operational purposes, by nature, quantity, Hazard Division (HD) and Compatibility Group (CG).
   (2) The estimated destructive power of the total NEQ at the site, more commonly referred to as effective NEQ (those natures or components which will contribute to an event).
   (3) The geographical layout of the site including natural features which could affect hazards. These could result in a reduction of hazards, but also could increase the hazards – an example would be if the ammunition is stored in a location where nearby walls are steep, such as a ravine.
   (4) The accurate positioning (mapping) of all personnel, equipment and infrastructure permanently exposed to the hazard and located at the site. These are known as Exposed Sites (ES). Similarly, those personnel and equipment temporarily exposed to the hazard, or any structure temporarily erected, must be considered.
   (5) The operational roles of all personnel, equipment and infrastructure at the site and expected duration of occupancy.
   (6) The construction and structural strength of all equipment and infrastructure at the site.
   (7) All local Secondary Hazards present which could contribute to or initiate an event.
   (8) All existing contingency plans held by Theatre HQ and units at the site for emergency service response times and damage replacement/repair plans.
   (9) Occupied dwellings, public utilities, buildings and public traffic routes external to the site, which could influence the positioning of stocks. These are also ES.

c. Factors for Consideration:
   (1) Stock Levels, Quantities and NEQ Held
      (a) Knowledge of the specific natures, physical quantities and NEQ required at the site is imperative to the overall assessment of risk. The Explosives License limits shall be established in coordination with G2 (Intelligence), G3 (Operations), and G4 (Logistics) Headquarters staff.
      (b) When the Operational Commander believes that the likely usage of ammunition has fallen to a level that cannot justify the associated storage risk, he must be prompted by the ESO

to call for a reduction of ammunition stored at the site. This is a risk reduction measure that must always be considered.

(c) It should be noted that each storage site may usually hold significantly more stock than it needs at any one time, due to the difficulties of re-supply. Constant monitoring must therefore be maintained on all sites to prompt a reduction in the quantities of ammunition stored whenever the operational tempo lessens.

(2) Geographical Layout of the Site

The geography of any storage site may assist or hinder the protection of personnel, equipment and infrastructure in and around a storage site. This must be taken into account when analyzing the expected effects of an explosion, which are fragmentation, blast, secondary debris and thermal effects.

(3) Regular Dispositions of Personnel, Equipment and Infrastructure

For the purpose of compiling data needed to complete the ESC, personnel, equipment and infrastructure are to be regarded as an ES.Since many of these ES's are mobile, particularly the personnel, it is not possible to draw up an ESC that will predict exactly where everyone or everything will be at all times. It is therefore necessary to estimate where personnel, equipment and infrastructure are most of the time.

(4) Operational Roles of all Personnel, Equipment and Infrastructure

(a) Injuries to any of the personnel or damage to equipment and infrastructure assets must be expressed in terms of operational capability loss. To this end, it is vital that the ESO understands the operational role of all assets.

(b) The ESO must be in a position to advise the Operational Commander of the consequences of a worst-case undesired explosive event and the potential extent of loss of assets. To this end, the ESO should consult with other subject experts as necessary when advising whether an asset will remain operationally fit for role or otherwise.

(c) A good understanding of the structural strength of all equipment and infrastructure is important for an accurate prediction of the operational capability loss following an undesired explosive event. For example, while armoured vehicles may not receive any significant damage to their hulls at a given distance, the same might not be true for their peripherals such as communication aerials, sighting systems and related equipment.

(5) Secondary Hazards

A Secondary Hazard is something that will enhance the destructive effects of an explosion either immediately or over a longer period of time. It is important to consider the effects of all potential Secondary Hazards and take these into account when assessing the area that will be affected should an undesired explosive event occur. An obvious example is the storage of fuel.

(6) Contingency Plans

The state of preparedness to the contingency plans can have a significant effect on the consequences due to loss of assets or resources The loss of operational capability due to an undesired explosive event, is imperative for the ESO to assess, e.g.:

(a) A replacement for the damaged asset based on a time frame.

(b) The re-orientation of forces to cover any irreplaceable capability loss.

(c) The total repair by a suitable agency of a damaged asset, again based on a time frame.

(7) Exposed Sites (ES)

(a) The ESO will need to take into account the distances to both the internal and external Exposed Sites. In particular, the proximity and occupancy levels of all onsite accommodation, nearby public dwellings, public utilities and public traffic route usage.

(b) Terrain features can also influence the facility's layout. An examination of the topography must be conducted in order to determine if the existing terrain features offers risk mitigation, for example natural barricading can be used to protect personnel and material from the effects of an explosion, but storing ammunition near water reservoirs must be avoided.

(c) Identifying hazards is a continuous process and examination of mitigation possibilities must be conducted in order to reduce the risk to a more acceptable level, while not affecting operational capability.

(8) Explosive Safety Case

The formalized study of the risk is referred to as an ESC, which documents the examination of the risk activity. Annex C may be used to record the risk process. Nations may choose to present their ESC in a different format and examples.

3. Step 2 – Risk Analysis

a. Probability

(1) The probability of an event can be determined in two ways (or a combination of both): by historical record of events or by an

analytical examination by ESO based upon their experience and knowledge. Quantitative values, as well as the relation between quantitative values and qualitative levels are given in Table 2-7.

(2) Probability of an event. There are a number of possible causes of an undesired explosive event. Listed below are some of the potential causes that should be considered when developing an ESC[1]:

(a) Accidental fire - vehicle or storage container.

(b) Human Error – vehicle accident, handling, fatigue.

(c) Intruder – sabotage, theft, other subversive activity.

(d) Enemy Action- Improvised Explosive Device, Indirect or Direct Fire.

(e) Environmental - lightning strike, weather.

(f) Condition of the Ammunition – deteriorated (material fatigue or chemical breakdown), damaged, lower standard of manufacture (captured).

(3) In consideration of the above, the ESO would also consider the time aspects of the factors. For example, when considering indirect fire, the ESO should consider how many indirect fire attacks have occurred on the FOB during various periods of time.

Table 2-4: Event Probability (qualitative values)

LEVEL[2]	QUALITATIVE DEFINITION
Likely	Will occur frequently
Occasional	Will occur several times
Seldom	Unlikely, but can reasonably be expected to occur

1 The potential causes can be grouped differently under “influences on probability” such as Enemy Action, Human, Handling, Maintenance, Ammunition, and Environment. Those listed here are thought to relate more directly to the purpose of this Section.

2 The terms used here and their alternatives reflect the variety that are used by Nations (semantics) in their risk management processes. Some Nations’ processes may vary from three to five levels,

Unlikely	Unlikely to occur, but possible
Very unlikely	So unlikely it may be assumed it will never occur

(4) On deployed operations, for example, the probability of an event is considerably higher by the potential threat of deliberate enemy action in addition to field-expedient methods of storage, exposure of the ammunition to extreme climate conditions and frequent handling.

b. Exposure

(1) The critical aspect of the consequence – injury or death to people – is affected by the degree to which those persons are exposed to the hazard. This can be calculated based upon the likelihood of those persons being present when an undesired event occurs. Consideration is given to whether persons are always present, sometimes present or just passing through.

(2) Some risk assessment processes will also consider types of person in a variety of categories such as “related”, “non-related”, or “public” where there is a capability to calculate probabilities quantitatively and compare it to accepted risk thresholds.

c. Physical Effects

(1) The ESO must determine the magnitude of the physical effects in terms of blast, primary fragmentation/secondary debris and thermal effects. AASTP-4 Explosives Safety Risk Analysis includes more detail on physical effects.

(2) The ESO preparing the ESC will use a variety of tools in order to determine the probable results of the physical effects, primarily existing guidelines for safety distances which have been established based on trials, tests, and modeling. The expert(s) individual experience(s) with explosives is a vital ingredient in this assessment.

d. Consequences

(1) In every case the physical effects of the undesired explosive events will have consequences for exposed personnel, materiel and infrastructure. Although the normally accepted critical measure is the number of fatalities, the aspects of injuries, and loss or damage to materiel and infrastructure cannot be ignored. This is particularly true for munitions as a supply in itself whereby its loss or unavailability could affect operational capability. There may also be a significant EOD clean- up challenge.

(2) In order to properly staff an ESC to the appropriate approving authority for a decision, the ESO preparing it must be able to summarize all of the above information as to the severity of the risk. A procedure to calculate consequences quantitatively is given in Paragraph 2.7.3. Based on the quantitative analysis the commander determines the appropriate qualitative consequence level according to Table 2-6. Further details on consequences may be found in AASTP-4.

Table 2-5: Consequence Table (qualitative values)

Category	Definition
Catastrophic	• Severe consequences unacceptable in all but the most urgent of operational requirements • Multiple deaths and/or serious injury • Significant loss or damage to mission critical materiel & infrastructure
Major	• Critical consequences and acceptance implies operational imperatives • Some deaths and/or injury • Loss or damage to mission critical materiel & infrastructure
Minor	• Consequences are not expected to significantly disrupt operations • Minor injuries • Minimal impact on materiel & infrastructure
Negligible	Negligible or insignificant effects

(3) It should be noted that the Definition column in the above table includes descriptions of generic, basic criteria. A Nation may wish, for example, to include under each definition specific numbers or percentages of dead or serious injury and monetary figures relating to damage or loss of materiel and infrastructure.

e. Risk

Risk may be expressed in terms of quantitative or qualitative values. A way to calculate quantitative values in terms of persons killed or injured and possible damage to material and buildings/structures shown in Paragraph 2.7.3. In the absence of quantitative data the following qualitative procedure can be used.

Once the Level of probability and the Category of hazard consequence have been determined, Table 2-6 below provides a summary of the Risk Level. It is recognized that this table may vary depending on national requirements, but its intent is to provide a common, basic risk identification and acceptance framework, which nations participating in NATO multinational operations can use, understand, and work cooperatively.

Table 2-6: Risk Index Table

Consequence / Probability	Catastrophic	Major	Minor	Negligible
Likely	**High**	**High**	**Medium**	**Low**
Occasional	**High**	**Medium**	**Medium**	**Low**
Seldom	**Medium**	**Medium**	**Low**	**Low**
Unlikely	**Medium**	**Low**	**Low**	**Low**
Very unlikely	**Low**	**Low**	**Low**	**Low**

4. Step 3 – Risk Control Plan
   a. A Control Plan is developed to assure that all the mitigation techniques to reduce and/or eliminate the Risk Level identified in STEP 2 are documented. The Control Plan should address the probability and consequence of every hazard identified before counter measure(s) is/are applied, plus the probability and consequence after the countermeasure(s) are applied. However, If the initial Risk Level is acceptable, no mitigation techniques need to be applied. The Control Plan must be completed and presented to the Appropriate Authority for STEP-4 Risk Approval. The Control Plan is also the basis for STEP 5-Risk Tracking.

b. The spectrum of risk ranges from high to low. In terms of accepting risk the approach is often referred to as As Low As Reasonably Practicable (ALARP) – the aim being to mitigate a hazardous situation to an acceptable level by considering the following:
   (1) Quantity of ammunition stocks.
   (2) Numbers and types of exposed persons.
   (3) Criticality of the activity to support operations.
   (4) Construction type of the Potential Explosion Site (PES) or Exposed Site (ES).
   (5) Type and location of barricades.
   (6) Determination of the Maximum Credible Event (MCE).
   (7) Training, qualification and experience of personnel.
   (8) Availability and use of additional real estate.
   (9) Security measures.
   (10) Force Protection considerations.

5. Step 4 – Risk Approval and Implementation
   a. Having determined the level of risk and considered possible mitigation the ESO must present the risk assessment case to the appropriate authority (e.g., Operational Commander).
   b. Make Risk Decision. A key element of the risk decision is determining if the residual risk is justified. The appropriate authority, based upon the level of risk associated with the mission, must compare and balance the risk against mission expectations. The Operational Commander decides if controls are sufficient and acceptable and whether to accept the resulting residual risk. If the Operational Commander determines the risk level is too high, they can direct the development of additional or alternate controls, or they can modify, change, or reject the course of action.
   c. Coordination and communication. It is important to coordinate and communicate with adjacent units and organizations to ensure they understand the hazards identified and the controls to be implemented, especially if they will encounter the same hazards or play a role in implementing the required controls. In a Multi-National context this coordination is more complex, but all the more important to ensure it is completed.
   d. Implementation of the risk begins after the appropriate authority approves the Explosive Safety Case and after the mitigation efforts that were identified in the Risk Control Plan (Step 3) are applied.

6. Step 5 – Risk Tracking

a. In order to complete the risk management process, the specific risk situation must be periodically monitored:
   (1) If the hazard exposure to personnel and/or assets has changed.
   (2) Whether the risk owner has changed.
b. The monitoring of the implied mitigation techniques is an important aspect of the above, which is an important role of the ESO as an on-going activity.
c. It is also important to ensure that the risk management process itself is monitored for effectiveness and ways in which it could be improved. The ESO must also monitor this aspect and report to NATO and/or National authorities which are responsible for instituting the risk management process.
d. Elements of managing a risk decision include, but are not limited to:
   (1) Tracking the implementation of the risk-reducing actions.
   (2) Need for reassessment of the ESMRM risk decision based on conditions specified in paragraph 7.3.
   (3) Recommending when the ESMRM risk decision is no longer needed due to the conclusion of a munitions-related operation.

2.7.3 QUANTITATIVE RISK ANALYSIS

1. General
   a. A quantitative explosives safety risk analysis of an ammunition storage site consists of calculating the consequences (to people and assets) of a possible event in a PES and the estimation of the frequency of event. In general, the following main steps have to be performed:
      (1) Definition of the situation and survey of the relevant data of possible PESs and exposed ESs such as:
         (a) type of PES, barricaded/unbarricaded
         (b) NEQ stored in PES
         (c) distance between PES and ES
         (d) type of ES and number of exposed persons in it
      (2) Calculation of the consequences based on the data above for a given PES – ES relationship
      (3) Aggregation of the consequences for all ESs (= Risk in case of event)
      (4) Calculation or estimation of the frequency of event
      (5) Calculation of the total risk in terms of the number of personnel killed, injured, the amount of material damage/loss of assets, and the Operational Mission Impact.

b. This procedure is further outlined below in paragraph 2. The consequence and risk aggregation is explained in detail and the technical models are described for the quantitative calculation of the consequences from explosions in out of area/field storage sites for personnel occupying a wide range of structures used on deployed missions. Further, quantitative and qualitative information is given about the frequency of event in such storage sites.

c. For cases that cannot be treated with the models provided below in paragraph 2, e.g. due to lacking models for the PESs, or for cases where a more detailed risk analysis must be performed, e.g. due to the severity of the expected consequences, procedures are given in AASTP-4. Applying those procedures, however, requires special knowledge and education. In addition those procedures require much more detailed knowledge about the PESs and the ESs. Therefore, ample time is needed to collect and process those data.

2. Procedure

a. Introduction

(1) The procedure for calculating consequences described in the following paragraphs is applicable to operational storage situations. It allows performing a simple yet quantitative risk analysis within a short time and with minimal technical support.

(2) The consequences of an event as a function of Distance, NEQ and PES / ES types are given in the tables in Annex E. The indicated consequences consider the combined effects of blast, debris and primary fragments.

(3) The consequences in the tables are given in terms of:

(a) probability of fatality [%]

(b) probability of injury [%]

(c) structural damage [%]

Remark: Injury values in the consequence tables are defined as "at least injured", meaning that they include the probability of a fatality. To obtain the value for injury only, the lethality has to be deducted from the injury value taken from the table.

(4) For structural damage also the following qualitative measures apply:

(a) < 20 % damage = superficial damage

(b) 20 % - 80 % damage = considerable damage

(c) > 80 % damage = complete loss of structure and/or asset

(5) The tables are applicable for field storage structure classes as defined in Annex F.

(6) Instead of using the manual calculation procedure listed below, the

AASTP-5 Consequence Analysis Tool described in Annex E could be used.

b. Calculation of Consequences

(1) In this paragraph it is described how the consequences for a given situation can be calculated manually, using the consequence Tables and the calculation template in Annex D. First, the relevant data for the PES and all ESs needs to be collected. The following steps have to be taken (an example of a filled in calculation template is also provided):

Col A: List every ES in the column labeled using a brief description.

Col B: Identify the ES type using Annex F, Overview of ES Structure Classes.

Col C: Identify Yes or No if the PES or ES is barricaded.

Col D: Identify Yes or No if Normal Windows are in the ES.

Col E: Identify Yes or No if the ES has Overhead Protection.

Col F: Fill in the number of exposed persons for each ES. To calculate the maximum consequences for a given situation put in the maximum number of persons staying in the ES. For the calculation of the average consequences use the average number of persons staying in an ES.

Col G: Fill in the actual distance between the PES and ES.

Col H: Fill in the Case No. provided in the applicable table in Annex D for lethality. Tables are given for NEQ's between 100 kg and 4000 kg. In general the NEQ may not be exactly equal to the NEQ values given in the tables. If this is the case, the user should select the larger NEQ (this also applies to columns L and R).

Col J: Fill in the Lethality percentage provided at the intersection of the case number and distance in the applicable table. In general the distance from an ES to a PES may not be exactly equal to the distances given in the tables. If this is the case, the user should select the shorter distance (this also applies to columns M and S)..

Col K: Fill in the number of Persons Killed by calculating Col F times Col J divided by 100 (K=FxJ/100).

Col L: Fill in the Case No. provided in the applicable table in Annex D for injury.

Col M: Fill in the Injury percentage provided at the intersection of the case number and distance in the applicable table.

Col N: Fill in the number of Persons at least injured by calculating Col F times Col M divided by 100 (N=FxJ/100).

Col P: Fill in the number of Persons Injured by calculating Col N minus Col K. (P=N-K).

Col Q: Fill in the number of Persons Unharmed by calculating Col F minus Col N. (Q=F-N).

Col R: Fill in the Case No. provided in the applicable table in Annex D for Damage.

Col S: Fill in the Damage percentage provided at the intersection of the case number and distance in the applicable table.

Remarks:

(a) Round up the total values for lethality and injury to the next whole number.

(b) The total number of exposed persons should be approximately equal to the sum of total number of killed, injures and unharmed persons.

(c) The total numbers of personnel and asset damage allows a commander to make a judgment about the impact on the mission.

c. Probability of Event

(1) Whereas reliable technical models exist for the calculation of the consequences from explosion in out of area / field storage sites, for the probability of events there are only limited quantitative values available, as e.g. the ones documented in AASTP-4.

(2) For more peace-time like situations - where no enemy attack is imminent - the probability of event is mainly driven by the following factors:

(a) type of stored ammunition

(b) frequency of handling of the ammunition

(c) environmental conditions (climate)

Some information about quantitative probabilities for such situations is given in Table 2.7. More detailed information about probabilities of event during peace-time like situations can be found in AASTP-4.

(3) For war-time like situations - where a storage site could get under attack - the probability of event is mainly driven by the:

(a) enemy activities in general

(b) active and passive defence measures taken

(c) military value of a possible target

This implies that the probability of event in war-time like situations strongly depends on factors that can only be influenced up to some degree. Probabilities for such situations may vary many orders of magnitude. Therefore, it is nearly impossible to give a quantitative number for the probability in war-time like situations without the knowledge of the tactical situation at hand.

(4) As a general rule, in cases where it is not possible to determine a quantitative value for the probability of event of an operational storage site, the qualitative values given in Table 2-5 may be used.

Table 2-7: Probability of Event for Operational Storage

Case	Type of Ammunition	Location of Storage	Enemy Influence	Probability of Event (qualitative)	Probability of Event (quantitative)
1	own ammo in good condition	Home	no enemy attack imminent	**Very unlikely**	**$1*10^{-5}$/y** according to AASTP-4
2	own ammo in good condition	Field	no enemy attack imminent	**Unlikely**	equal to approx. **$1*10^{-4}$/y** according to AASTP-4 1)
3	captured ammo or UXO	Field	no enemy attack imminent	**Seldom**	equal to approx. **$1*10^{-3}$/y** according to AASTP-4 1)
4	own ammo in good condition	Field	storage under enemy attack	**Occasional**	not defined, see 7.3.2.3.c.
5	captured ammo or UXO	Field	storage under enemy attack	**Likely**	not defined, see 7.3.2.3.c.

1) For normal situations, without special influences from extreme climate or excessive handling times

2.7.4 RISK ASSESSMENT REPORT

1. The risk assessment shall be documented in a report that includes the following (See Appendix G for the summary form);
   a. Executive summary
   b. Purpose.
   c. Scope (with signatures and modifications).
   d. Methodology used to determine risk (e.g AASTP-5 paragraph 2.7, AASTP-4, national process)
   e. Explosives safety supporting information (e.g., site plans, deviations, exposures).
   f. Identification of munitions and munitions-related processes.

g. Infrastructure analysis based on risk to and from munitions and munitions-related processes as applicable.
h. Overall risks to and from munitions and munitions-related processes.
i. The Control Plan (see paragraph 2.7.2).
j. Organizations/agencies/units responsible for implementing and managing risk-reduction actions.(see 2.7.2 step 5 Risk Tracking)
k. Organizations/agencies/units responsible for overseeing approved risk reduction actions.
l. Estimated duration of the ESMRM risk decision.

2.8. TRANSPORT

1. The purpose of this section is to provide expert advice to operational commanders assigned to out of area operations about the requirements for the transport of dangerous goods including munitions. This Section does not address the use of roads, road permission, etc., which are included in the guidance document to AMovP-6.
2. International regulations such as ICAO, IMDG, ADR, RID, and the guidance document to implement AMovP-6 plus local national regulations should be followed wherever possible. Deviations from these rules are possible, depending on the transport requirements and the operational situation. Refer to AMovP-6 for more information.

Transport situation	Deviation from international rules	Deviation from national rules	Remarks
From home country to POD and return (POE)	No deviations	Up to home country	Logistic transport
From POD to Staging Area[1)]	Deviations are possible (2)	Up to home country	Tactical or logistic transport. Deviations depending of the security risk
From Staging Area to POE[2)]	Deviations are possible (see Table 2-9)	Up to home country	Tactical or logistic transport. Deviations depending of the security risk
Inside the operational area[1)]	Deviations are possible (see note and Table 2-9)	Up to home country	Tactical transport. Deviations depending of the security risk
Captured/found ammunition inside the operational area[3)]	Not applicable (see notes)	Up to home country	Captured/found ammunition must be classified for transport or storage by Munitions Specialist

Notes:
(1) For logistic transport, international regulations and local national regulations must be applied.
(2) Special care is necessary when a tactical transport changes into a normal logistic transport. In this situation the international regulations and local national regulations have to be followed.
(3) See paragraph 2.4.3. CEA is to be certified by an EOD expert as safe for transport to a demolition place or for temporary storage.

Table 2-8 Examples of Deviations from Transport Regulations

3. The use of harbors, ports and airfields as a Point of Debarkation (POD) for loading and unloading dangerous goods and deviations from international rules should be, if possible, approved in agreement with the host nation.
4. This document provides guidance for those situations where deviations from the rules are required due to operational necessity. Every effort must be made to observe the minimum safety and risk requirements for the transport mode selected. For example:
    a. The use of CG.
    b. For air transport, the ammunition must be certified as air transportable and must meet criteria for (under)pressure, vibration, temperature, static electricity, and electro-magnetic radiation (type classification).
    c. Stuffing and stowing packaging and containers in accordance with IMDG Code for sea transportation.
    d. Securing of the load.
    e. Use of transmitters (radio, radar, mobile phone, etc.).

DELETE THIS TABLE *Table 2-9 In the operational area*			

Operational area: Deviations from (Inter)national rules do not affect the ammunition safety

DELETE THIS TABLE *Table 2-9 Deviations from (Inter)national rules for transport in Operational Area* ***Explanations Table 2-9 Deviations and Definitions***	

2.9. ACCIDENT REPORTING AND INVESTIGATION

1. All explosives accidents shall be reported, investigated and analyzed with the aim to prevent like occurrences and improve safety.

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

3. Analyzing the accident investigation results may establish lessons learned that can serve as a future preventive measure. Such measures may include the revision of operating systems and procedures, suspension of ammunition, eliminate the use of faulty material handling equipment, or disposal **of the ammunition type involved.**

4. Reporting explosive accidents include:
    a. An unplanned explosion or functioning of a device containing explosives, propellants, pyrotechnics, or other similar substances associated with these items which present real or potential hazards to life or property. Included are:
        (1) Accidents occurring during the explosives or pyrotechnics handling such as maintenance or surveillance process.
        (2) Off-range impacts of projectiles, bombs, missiles, or their fragments/components, during range operations.
        (3) Accidents occurring during disposal; reclamation and demilitarization.
        (4) Accidents involved with Explosive Ordnance Disposal (EOD) Operations.
        (5) The inadvertent actuation, jettisoning, release, or launching of explosive devices.
    b. Explosives accidents do not include the accidental discharge of small arms weapons (in unit arms rooms, on guard duty,) and hunting or recreational shooting accidents.

5. The national authority or the organization responsible for the munitions shall ensure that a system of reporting ammunition accidents is developed, and all users are aware of the procedures. Users shall be instructed to immediately report an ammunition accident through their chain of command and inform the lead ESO. The following information is provided as a guide for the initial report:
    a. name of individual submitting the report;

b. user unit;
c. user unit contact person;
d. date and time of explosives accident;
e. probable cause, if known;
f. details regarding fatalities, injuries and damage and their location indicated on the map;
g. location where the explosives accident occurred, including map grid reference;
h. type and quantity (NEQ) of munitions involved (full technical name);
i. weapon type involved (full technical name);
j. batch, lot and/or serial number of the munitions involved;
k. description of accident and type of activity (e.g. loading, transport);
l. weather conditions;
m. action(s) taken by user unit.

6. Investigating the accident:
   a. Explosives accident investigations shall be led by an individual of the appropriate rank appointed by the national authority. The team shall determine the cause of the accident, contributing factors and lessons learned.
   b. In a situation where other factors may have contributed to the accident, additional assistance from specialists may be essential in determining the cause.
   c. The team lead shall submit a full technical report in a timely manner through their chain of command to their national authority and the lead ESO. A preliminary report shall be provided to the base commander and to the lead ESO as soon as possible if there is a need for urgent action to immediately improve safety.

2.10. MUNITIONS AMNESTY PROGRAM

1. All NATO bases that include tenants and transient units who issue ammunition to their personnel shall implement a Munitions Amnesty Program. The Amnesty Program is intended to ensure maximum recovery of ammunition and explosives outside the supply system. The Program is not intended to circumvent normal turn-in procedures.

2. The NATO Base's Munitions Amnesty Program shall consist of four integrated components:

a. A turn-in capability at the NATO Base's ammunition storage area for turn-in of munitions that do not fit into the MABs described below.
b. A process (e.g., a 24 hour telephone number), whereby anyone wanting to turn in munitions under the Amnesty Program, has access to directions on how to do so.
c. A system of MABs placed throughout the NATO Base. The purpose of these MABs is to provide personnel with a safe, tamperproof receptacle into which small amounts of ammunition and explosives, which may have been accidentally forgotten in clothing, personal equipment, vehicles, and / or was collected somewhere, can be deposited anonymously for collection and disposal.
d. Close coordination / cooperation between the NATO Base ESO, national ESOs and Ammunition Supply Issuing Activities, EOD, and other supporting elements.

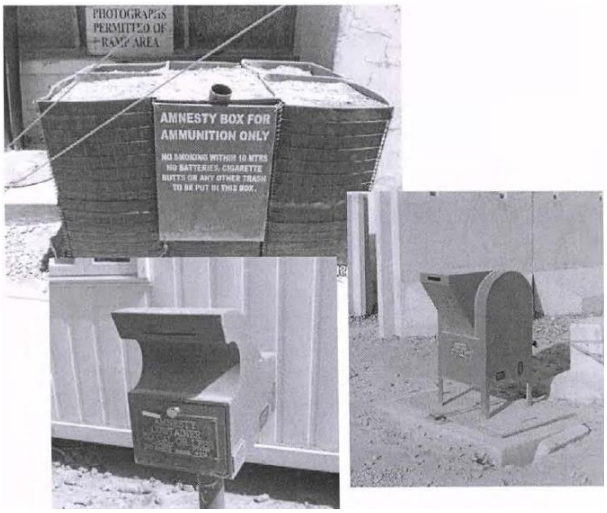
3. Lead ESO Responsibilities.
   a. Assume primary responsibility for the management of the NATO Base Munitions Amnesty Program and its components.
   b. Propose locations for MABs and their required mitigation for NATO Base Commander review / approval. Approved locations shall be identified in the Base SOP detailed below, and as such, no licensing of MABs is required. The placement of MABs must be strategic and well thought out, to assure maximum collection potential at locations where there is an increased potential for personnel having such items (e.g., airfields, near hospitals – personnel airlifted in for medical care), where personnel congregate or reside (e.g., quarters, dining facilities), and at other locations where such items may turn up (e.g., the ammunition storage area entrance, post office, laundry facility).
   c. Review and accept all MAB designs for compliance with the requirements given below. A number of nations have existing MAB designs which will meet those requirements and can be used if accepted.
   d. Develop a NATO Base SOP which describes the purpose of the Amnesty Program, its components, details specific functional responsibilities and highlights explosive safety requirements for handling Amnesty Program items. The SOP shall identify approved MAB locations and the process for their safe operation.
   e. Establish and manage the MAB key control process. Keys shall be kept under strict control to prevent unauthorized access to MABs contents.
   f. Participate in the MAB collection activities as described in paragraph g below, and brief the members of the Explosive Safety Board on the types and amounts of munitions being turned in.
   g. Maintain accurate inventories of items collected as part of the Amnesty Program. The sole purpose for this is for awareness purposes and trend

assessments. : Trends can point to weaknesses in national or NATO Base procedures and operations that can be rectified to eliminate or minimize MAB usage (e.g., troops are not turning in ammunition at their ammunition supply point upon return from training / operations because they are too tired or the supply point closes too early).

h. Publicize the Base's Amnesty Program and post the SOP throughout the base camp/airfield. All personnel on the NATO Base should be aware of all MAB locations and their purpose.

4. Responsibilities of Nations on a NATO Base.
   a. It is incumbent on nations that own / issue / use munitions to properly account for it and to prevent the collection of non-issued (e.g., found or enemy) munitions by their personnel. Proper accountability and sound leadership can go far towards managing the quantity of amnesty items that are turned in.
   b. For everyone's safety, it is important that all nations, whether or not they have / use munitions, educate their personnel about the hazards of abandoned, lost, or enemy munitions, what steps to take if they find such materials on-base, and the role the Base's Amnesty Program plays in mitigating the hazards and in disposal of those items.
   c. Support the NATO Base Commander and NATO Base's ESO in implementation of the Base's Amnesty Program.

5. MAB shall meet the following minimum requirements:
   a. Be of robust construction to prevent breakage and pilfering. Some photo examples of MABs are given below and construction details are provided in the NATO D-Document on Nationally Approved Construction.



b. Provided with a funnel or slot suitably large enough for users to deposit items intended to be collected. The opening shall be configured in such a manner so that items cannot be removed from the box once deposited.

c. Provided with a door / access panel for removal of deposited munitions. The door / access panel shall be secured by a robust hasp / padlock or keypad.

d. Secured to prevent them being stolen or their unauthorized removal.

e. MABS shall be prominently identified so that they are clearly visible to all personnel. They shall be painted red or yellow (or any highly visible color) and associated signage shall be in contrasting white or black letters.

f. For risk mitigation, the MAB shall be surrounded by gabions that are capable of being filled with fine earth or sand. The bastion to the rear of the MAB shall have sufficient separation from the MAB enough to allow easy access to the box for the collection of munitions contained therein.

6. Collection of items from MABs.

a. MABs shall be visited and emptied at a minimum once a week by qualified weapons / explosives specialist. This may need to be increased if trends are observed that dictate the need for more frequent visits (e.g., larger items being placed outside the container because they don't fit in the slot provided).

b. If there is any doubt as to the safety of the items contained within the MAB or found at a MAB (i.e., it was too large for the MAB slot and was placed next to the MAB), then Explosive Ordnance Disposal (EOD) shall be contacted to assess the item(s) and to remove the contents. Prior to their arrival, an initial evacuation zone of 50 m, increased out to 100 m, shall be established if possible. Upon the arrival of EOD personnel, the EOD on-site commander shall establish the required evacuation distance needed to ensure the safety of surrounding personnel.

c. Munitions collected from MAB shall be disposed of by qualified personnel in accordance with national and AASTP-1 requirements.

2.11. MISSILE INSTALLATIONS

1. For the purposes of AASTP-5, this paragraph pertains specifically to mobile missile systems (e.g., Patriot) positioned around or in the vicinity of a NATO base and which are being used in a static, defensive role.

2. When determining locations for missile systems, the threats posed by such systems to its surroundings need to be understood, considered, and coordinated with the Lead ESO before missile locations are selected. Generally, missile replacement, missile storage, and other missile system functions occur at the immediate missile installation site. Because of this, missile installations present potential hazards to surrounding operations, personnel, and facilities from:
    a. The explosion effects from an accident involving the munitions associated with missile installation.
    b. Electromagnetic radiation being emitted by the system (see AASTP-1, Part II, chapter 7 for additional information related to hazards of electromagnetic radiation to munitions containing electrically initiated devices).
    c. Backblast generated during the launch of a missile, which may place nearby facilities at risk of collapse or damage from backblast pressures; windows may break and generate hazardous glass fragments; personnel within backblast distance may be severely injured.

3. Required FD shall be the greater of a. or b. below;
    a. Treat each missile system and each of its associated, separate operations, as an aboveground PES and apply the FD given in paragraph 2.6, based on the HD and NEQ involved. Where minimum FD cannot be met, aggregate all NEQ and treat as a single PES.
    b. Missile system technical documentation (e.g., field manual, pamphlet, standard operating procedures (SOP)) specify required safety distances, for technical and/or operational reasons, applicable to each system. Missile systems/installations shall be deployed in accordance with their specific implementation documentation.

2.12. CONCLUDING A MILITARY OPERATION

2.12.1. INTRODUCTION

1. This chapter identifies general requirements related to the conclusion of a NATO military operations and NATO bases as part of the redeployment and disestablishment stage of missions or operations. Specific requirements are found in chapter 6 of NATO's Explosives Safety and Munitions Risk Management (ESMRM) publication ALP-16.

3. Preparing for the conclusion of munitions-related activities at operational locations must be planned for during the initial analysis of the desired end state, together with the means to achieve it.

3. All munitions operation associated with the 7 activities identified below must meet NATO explosive safety requirements of AASTP-1 or AASTP-5 as applicable or have a ESMRM risk assessment and risk decision by the appropriate approval level.

4. The following munitions and munitions-related processes and activities are associated with the redeployment and disestablishment stages of concluding a military operation. All activities described below must be assessed for hazards that potentially risk personnel, property and mission.
    (1) Consolidation and Collection (Reception) involving the relocation of munitions to central locations for further action.

    (2) Storage of munitions in preparation for retrograde or disposal (e.g., transfer, sale, demilitarization, destruction). Storage is likely to be temporary in nature and care must be exercised since munitions turned in will be done by a large number of units.

    (3) Transportation associated with redeployment and disestablishment stages.

    (4) Distribution of munitions back to consolidation, collection, and storage locations as part of unit turn-ins.

    (5) Maintenance of munitions to include packaging and preparation by units prior to turn-in.

    (6) Retrograde of munitions by units through lines of communication (LOC) to the country of origin or final destination.

(6) Disposal of munitions (e.g., transfer, sale, demilitarization, and destruction).

2.12.2. CONSOLIDATION AND COLLECTION (RECEPTION)

1. Consolidation and collection is the equivalent of reception during the redeployment and disestablishment stages at the conclusion of a NATO military operation.

2. ESMRM risk assessments are an integral part of managing the potential risks during the consolidation and collection phase and may need to be performed for these locations. Actions typically associated with consolidation and collection include:
    a. Reception of all munitions at munitions storage areas. Munitions not returned in their original packaging shall be assumed to be in an "unknown" condition.
    b. Inspection of munitions to determine condition. During inspection of returned munitions, a qualified technical expert shall assess the condition of returned munitions with special regard to it being safe to move on the imminent retrograde movement.
    c. Repacking of serviceable munitions. Munitions requiring repackaging must be packaged into containers that meet United Nations and International Organization for Standardization requirements for storage and transport.
    d. Arrangements for any required disposal (e.g., transfer, sale, demilitarization, destruction).

2.12.3. STORAGE

1. Storage of munitions is the same throughout the deployment, redeployment, and disestablishment stages of a NATO military operation. Storage during the redeployment and disestablishment stage is likely to be temporary and dynamic due to unforeseen munitions turn-ins. Assessments of munitions storage locations shall also focus on the following prior to redeployment:
    a. Condition of munitions
    b. Condition of packaging
    c. Hazard classification
    d. Expected munitions throughput. During retrograde, significant quantities of munitions may be delivered to a storage location at a rate far beyond the capabilities of that location. Increased throughput will likely cause licensed explosives limits to be exceeded, resulting in violations of established quantity-distance and may exacerbate or worsen safety cases. Increasing throughput will likely require a new ESMRM Storage Risk Assessment.

2. Previously approved ESMRM risk assessments and risk decisions will likely need to be updated during the redeployment and disestablishment stage due to the dynamically changing operational environment.

3. Refer to AASTP-1 for detailed storage information for depleted uranium munitions stored during the redeployment and disestablishment stage.

2.12.4. TRANSPORTATION

1. Additional hazards during the redeployment and disestablishment stages may require modifications of existing ESMRM assessments or performance of new assessments. Examples of modifications include but are not limited to:
    a. Hazard classification if repackaged in other than original packaging. A munition's assigned hazard classification is only valid in its tested, packaged configuration. If not in that configuration, the hazard classification is no longer valid and the munitions may actually present a very different threat (e.g., hazard division (HD) 1.3 or storage sub-division (SsD) 1.2.1 may now be HD 1.1).
    b. Foreign munitions and weapons systems requiring intelligence exploitation.
    c. Munitions locations (e.g., safe haven, unforeseen delays, temporary holding) during the redeployment and disestablishment.
    d. Movement of munitions shall comply with AMovP-6 Allied Multi-Modal Transportation of Dangerous Goods Directive.

2.12.5. DISTRIBUTION / COLLECTION

1. During the Distribution / Collection stage, the focus is on units returning munitions (e.g., excess, unaccounted for, or other types of munitions) to consolidation and storage locations in preparation for transportation.

2. A major challenge during the redeployment and disestablishment stage at the unit level is munitions returned in unknown condition, and in varying configurations (e.g., unpackaged, improper packaging, flares without safety caps, taped grenades). To preclude hazardous conditions during the redeployment and disestablishment stage, munitions personnel must make every effort throughout the operational stage to maintain original munitions packaging materials.

2.12.6. MAINTENANCE

1. During the redeployment and disestablishment stage, maintenance of munitions will shift from preparing munitions for employment to inspecting, repackaging, and unit return in preparation for demilitarization, sale, transfer, or retrograde. Munitions maintenance during the redeployment and disestablishment stage may be done at a separate munitions operating location or as part of a storage operation.

2. A separate ESMRM assessment may need to be developed or the existing ESMRM Maintenance Risk Assessment may need to be modified during the maintenance stage.

2.12.7. RETROGRADE

1. Munitions may also be removed from the area of operations (AOO) in which case NATO explosives safety requirements of AASTP-1, AASTP-3, AASTP-5, ESMRM, and national requirements also apply.

2. Retrograde during the redeployment and disestablishment stage involves returning munitions from the AOO. During the redeployment and disestablishment stage, retrograde involves transporting munitions from LOC nodes (e.g., airport of debarkation, seaport of debarkation, railhead) to their final destination.

2.12.8. DISPOSAL

1. Complying with NATO or National Requirements. During the redeployment and disestablishment stage, disposal of munitions (e.g., transfer, sale, demilitarization, and destruction) within the AOO becomes a major function. See AOP-38. Standardization Agreement 4518, “Safe Disposal of Munitions, Design Principles and Requirements, and Safety Assessment” provides information related to demilitarization that does not involve destruction. Part IV of AASTP-1 provides specific NATO explosives safety requirements for destruction areas (i.e., open burning (OB) and open detonation (OD)).

2. Some nations’ regulations do not allow destruction of surplus munitions by OB or OD. In this case, munitions must meet transportation requirements and risk assessments/decisions, as applicable.

2.12.9. POST-OPERATION ACTIVITIES

1. Post-operation activities may include munitions-related processes and activities that require further hazard assessments. Examples include:

a. Infrastructure. The potential transfer or destruction of any munitions operations infrastructure built by NATO member nations in support of the mission. Any residual munitions-related risks should be removed or communicated and accepted by the receiving nation.
b. Removal of explosive remnants of war. Any residual munitions-related risks from explosive remnants of war should be removed or communicated and accepted by the receiving nation.
c. Closing or transferring training ranges. Any residual munitions-related risks from ranges where munitions were used should be removed or communicated and accepted by the receiving nation.

ANNEX B EXPLOSIVES SAFETY OFFICER

B.1. COMPETENCIES OF AN EXPLOSIVES SAFETY OFFICER

He/She should:

(1) Have knowledge and understanding of NATO Standards and Guidelines regarding Storage, Maintenance and Transport of Ammunition.

(2) Be able to identify FD applied from PES to PES and to ES.

(3) Be able to plan an Ammunition Area (e.g. number of PES required, barricade requirements, appropriate FD).

(4) Be able to organize an ammunition field depot based on economical storage principles and procedures.

(5) Have knowledge and understanding of lightning protection system and fire prevention requirements.

(6) Be able to visually identify explosive safety standard shortcomings during a survey of ammunition storage and maintenance operations.

(7) Be knowledgeable of accident reporting procedures.

(8) Be able to develop SOP.

(9) Be able to determine the risk and consequences of deviations from the regulations and communicate with the Operational Commander the mitigating efforts necessary to reduce or eliminate hazards.

(10) Be able to prepare draft explosives licences

ANNEX C AMMUNITION SAFETY INSPECTIONS

Checklist Quarterly - Scheduled

The purpose of scheduled explosives safety inspections is to detect hazards to life, materiel and facilities.

Inspections will provide positive accident prevention measures by:

(a) Detecting unsafe conditions and personnel operating errors.

(b) Highlighting the need for specific safeguards for personnel, materiel and facilities.

(c) Encouraging individuals to increase their overall explosives safety awareness within their own operating or training areas and to cultivate improvement.

Quarterly

HQ authorities should conduct explosives safety inspections of all areas and operations under their control.

Commander :

Officer in charge :

Explosives Safety Officer (ESO)

Fire Protection Officer (FPO)

Verification

(1) Are SOPs existent and current,

(2) Do SOPs contain required elements,

(3) Are magazine inspections current,

(4) Are deficiencies properly reported,

(5) Are corrective actions completed in a timely manner,

(6) Are corrective actions verified,

(7) When was last inspection by a responsible institution?

Storage Situation

(1) Are installation maps accurate,

(2) Is the Quantity limit to each PES verified and documented,

(3) Are IBD fixed and respected,

(4) Are calculated origin distances from PES to ES/accommodations/facilities in the field camp respected,

(5) Are there any deviations to the current storage regulations,
(6) Are barricades in good condition,
(7) Can it be verified at any time which people are in ammo area,
(8) Are the workers authorized within a proper described working area,
(9) Are the ammo workers well instructed to handle the ammo,
(10) Are the ammo workers properly following the procedures,
(11) Is the equipment and the tools they use in good condition and permissible,
(12) Is electrical installation correct and permissible for use with explosives,
(13) Is non-standard ammunition separated from own ammo,
(14) Is the storage area restricted to regular traffic?

Ammunition Stacks

(1) Stacks in good condition,
(2) Stacks under weather protection,
(3) Allowed quantity in stack,
(4) Compatibility groups respected,
(5) Packaging correct,
(6) Clean area?

Lightning protection

(1) Containers earthed,
(2) Lightning Protection System (LPS) effective,
(3) Are checks of LPS documented?

Fire Protection

(1) Fire protection rules established,
(2) No open fire,
(3) Vegetation control practiced,
(4) Are fire breaks adequate,
(5) Do alarm systems exist and signals understood
(6) Is an ESO notified if ammo is involved in fire,
(7) Is/are the assembly point/-s planned and known,
(8) Fire hazard symbols,
(9) Fire fighting equipment in place,
(10) Cooperation between ESO and Fire Protection Officer,
(11) Are fire fighting procedures clarified with FPO and rescue forces,

(12) Are all people in camp informed about reaction in case of an ammo fire?

Ammo loaded vehicles

(1) Safety distances to accommodation and buildings,
(2) Parking area min 25 m away from ammo stacks,
(3) Parking places barricaded?

Drivers

(1) Do drivers know the standard hazard distances of their load in case of a fire,
(2) do they know basic emergency and alert behaviours?

APPENDIX 1 TO ANNEX C

SITE SURVEY CHECK LIST

Subject	Topic	Points
1. General	Type of Mission	Humanitarian Mission Peace keeping Peace enforcement Other:
	Host Nation Rules with demands of Ammo Safety	
	MOU with demands of Ammo Safety	
	Population	Density: Low , medium, high Attitude: Friendly Hostile
2. Climate	Temperature	High: Average : Low (< 0 ◦C):
	Weather	Dry Average humidity Rainy seasons:
3. Infrastructure	Airports	Traffic density: Distance to tower to dispatch building to runway
	Harbours	Availability of: Temporary storage / parking Access roads Rail
	Waterways	Depth Width
	Railways	Bridges Tunnels
	Highways / Mainstreets	Traffic density: Bridges Tunnels
	Sensitive structures	Hospitals Chem. Industry Nuclear Power Station
	Agriculture and stockbreeding	
	Cultural Facilities	
4. Forces	Type of unit:	Combat Force Combat Support Force
	Combat loaded platforms	(Airplanes, vehicles, vessels) Number:
	Number of military personnel	Own Troops: Other Troops:

Subject	Topic	Points
5. Ammunition	Refer to Tables 2-2 and 2-3.	
6. Additional Risks	Defence against terrorism	Threat
	Civil Organisation	NGO
	Natural disaster Risk zones	Earthquake Zones Flood Zones Avalanche Zones Hurricane “Don’t use dry riverbeds!”
	Contamination of dangerous goods	
	UXO /Mines	
7. Ammo Storage Sites	Distances to infra structure and type of buildings	Field camp structures incl. ammo storage Other military infrastructure
	Area incl. Protection zone	Usable storage area in general: Total area including hazard zones: Maximum Storage Quantity in NEQ (kg)
	Internal roads	Pass ability (two way roads) Turning possibility for trucks with lorries Loading and unloading
	Environment	Hilly/Flat Vegetation
	Usable Barricades ? Ground strength: Height:	Natural Barricades Gabion Sand sack Other
	Soil	Usable for Barricades
	Existing storage areas: number, capacity, quality	Shelter: Open stacks: Container: Other:
	Free storage areas	
	Storage areas in use	for Ammo, for other hazard goods
	Drainage systems	

Subject	Topic	Points
continued 7. Ammo Storage Sites	Electric Support	Availability
	Illumination	Availability Inside magazines Outside Level of protection
	Lightning protection	Availability
	Grounding	Availability
	Climate systems	Availability
	Fire protection	Availability of water
	Explosive working facility	Necessity and availability
	Parking space for	Cars Trucks Hazard good vehicles Combat loaded vehicles
	Distance to gas station	Internal (military or civil): External (civil):
	Radar/Radio station, antennas	Power: Frequency: Antenna sector:
	Communication	Availability of Telephone Radio
8. Guarding of the storage site	Guarded by:	Own troops Allied troops Local troops
	Existing fence	Distance
9. Field camp	Ammunition in the compound total number	NEQ 1.1 – 1.3 NEQ 1.4
	Location of ammo storage	Necessity and availability Distance to and structure of camp accommodation
	Parking of combat loaded vehicles	
	Fire Protection	

ANNEX D TABLES FOR QUANTITATIVE RISK ANALYSIS

D.1. CONSEQUENCE TABLES

			PES WITH Barricade		PES NO Barricade		PES
ES type	**Windows**	**OHP**	**Lethality**	**Injury**	**Lethality**	**Injury**	**Damage**
Hesco	No	No	1	1	1	1	1
HRS	No	No	1	1	3	1	1
RS	No	No	2	1	6	5	2
NS	No	No	3	1	6	5	2
	Yes	No	4	8	6	5	
LS	No	No	4	3	6	6	3
	Yes	No	4	3	6	6	
	No	Yes	4	3	-	-	
	Yes	Yes	4	3	-	-	
Tent	No	No	3	2	6	6	2
	No	Yes	3	2	-	-	
FF	No	No	1	1	6	6	-
	No	Yes	1	1	-	-	
IB	Yes	No	5	4	7	7	2
	No	No	2	1	7	7	
	No	Yes	2	1	-	-	
	Yes	Yes	5	4	-	-	

Table D1a Case Number Table for NEQ = 100 kg

NEQ = 100 kg

	Lethality (with or without barricades) for case number							**Injury** (with or without barricades) for case number								**Damage** for case number		
Distance	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	1	2	3
[m]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
10	0.0	20	35	55	25	100	100	100	100	100	90	100	100	100	100	0	100	100
20	0.0	2.0	20	50	25	100	100	50	100	100	50	100	100	100	90	0	60	100
30	0.0	0.0	5.0	40	25	100	70	5.0	80	100	30	100	100	100	40	0	30	100
40	0.0	0.0	1.0	35	25	95	40	1.0	10	95	25	100	100	90	35	0	20	100
50	0.0	0.0	0.0	30	25	65	30	0.2	0.0	50	25	100	100	50	30	0	15	100
60	0.0	0.0	0.0	10	25	45	20	0.1	0.0	10	25	99	99	35	15	0	10	80
70	0.0	0.0	0.0	1.0	20	25	15	0.0	0.0	1.0	20	70	70	25	5.0	0	5	60
80	0.0	0.0	0.0	0.0	15	17	10	0.0	0.0	0.1	15	40	40	15	1.5	0	0	40
90	0.0	0.0	0.0	0.0	10	13	7.0	0.0	0.0	0.0	10	30	30	10	0.1	0	0	30
100	0.0	0.0	0.0	0.0	5.0	10	5.0	0.0	0.0	0.0	5.0	20	20	8.0		0	0	20
120	0.0	0.0	0.0	0.0	2.0	5.0	3.0	0.0	0.0	0.0	2.0	10	15	5.0		0	0	10
140	0.0	0.0	0.0	0.0	1.0	2.0	1.0	0.0	0.0	0.0	1.0	5.0	8.0	3.0		0	0	0
160					0.2	1.0	0.7				0.2	2.0	6.0	1.5				
180					0.1	0.5	0.4				0.1	0.5	4.0	0.9				
200					0.0	0.3	0.3				0.0	0.3	3.0	0.7				
250													0.8	0.3				
300													0.2	0.1				

Table D1b Consequence Table for NEQ = 100 kg

			PES WITH Barricade		PES NO Barricade		PES
ES type	**Windows**	**OHP**	**Lethality**	**Injury**	**Lethality**	**Injury**	**Damage**
Hesco	No	No	1	1	1	1	1
HRS	No	No	2	1	3	2	1
RS	No	No	3	1	6	6	2
NS	No	No	3	2	6	6	2
	Yes	No	4	9	6	6	
LS	No	No	4	4	6	7	3
	Yes	No	4	4	6	7	
	No	Yes	4	4	-	-	
	Yes	Yes	4	4	-	-	
Tent	No	No	3	3	6	7	2
	No	Yes	3	3	-	-	
FF	No	No	2	2	6	7	-
	No	Yes	2	1	-	-	
IB	Yes	No	5	5	7	8	2
	No	No	3	2	8	8	
	No	Yes	3	2	-	-	
	Yes	Yes	5	5	-	-	

Table D2a Case Number Table for NEQ = 250 kg

NEQ = 250 kg

	Lethality (with or without barricades) for case number								**Injury** (with or without barricades) for case number									**Damage** for case number		
Distance	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	1	2	3
[m]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
10	0.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	100	100
20	0.0	0.0	50	85	70	100	100	100	70	100	100	100	70	100	100	100	100	0	100	100
30	0.0	0.0	10	60	40	100	99	99	20	95	100	100	40	100	100	99	95	0	60	100
40	0.0	0.0	2.0	45	30	99	90	80	2.0	10	95	100	30	100	100	90	70	0	40	100
50	0.0	0.0	0.5	35	27	95	50	33	0.5	1.0	70	100	27	100	100	80	50	0	30	100
60	0.0	0.0	0.1	30	25	85	40	20	0.1	0.7	10	100	25	99	100	65	30	0	22	100
70	0.0	0.0	0.0	25	23	70	35	13	0.0	0.5	0.1	100	24	95	99	45	26	0	15	100
80	0.0	0.0	0.0	20	22	50	30	8.0	0.0	0.3	0.0	90	24	85	90	30	24	0	10	85
90	0.0	0.0	0.0	15	21	35	27	5.5	0.0	0.2	0.0	50	23	65	70	27	20	0	6	55
100	0.0	0.0	0.0	10	20	25	25	4.0	0.0	0.1	0.0	25	23	50	50	25	13	0	3	30
120	0.0	0.0	0.0	2.0	18	15	20	2.5	0.0	0.0	0.0	5.0	18	30	30	20	5.0	0	1	17
140	0.0	0.0	0.0	0.3	13	7.0	15	1.5	0.0	0.0	0.0	0.5	13	15	15	15	0.5	0	0	5
160				0.1	9.0	3.0	10	1.0				0.1	9.0	5.0	10	10	0.0			0
180					6.0	1.5	6.0	0.6				0.0	6.0	1.0	7.0	6.0				
200					4.0	0.8	4.0	0.4				0.0	4.0	0.2	5.0	4.0				
250					0.2	0.2	0.7	0.2					0.2	0.0	3.0	0.7				
300					0.0	0.0	0.1	0.1					0.0		0.5	0.2				
350															0.1	0.1				
400																				

Table D2b Consequence Table for NEQ = 250 kg

			PES WITH Barricade		PES NO Barricade		PES
ES type	**Windows**	**OHP**	**Lethality**	**Injury**	**Lethality**	**Injury**	**Damage**
Hesco	No	No	1	1	1	1	1
HRS	No	No	1	1	2	1	1
RS	No	No	2	2	5	6	2
NS	No	No	2	2	5	6	2
	Yes	No	3	9	5	6	
LS	No	No	3	4	5	4	4
	Yes	No	3	4	5	4	
	No	Yes	3	4	-	-	
	Yes	Yes	3	4	-	-	
Tent	No	No	2	3	5	6	3
	No	Yes	2	3	-	-	
FF	No	No	1	1	5	6	-
	No	Yes	1	1	-	-	
IB	Yes	No	4	5	6	8	3
	No	No	2	1	7	7	
	No	Yes	2	1	-	-	
	Yes	Yes	4	5	-	-	

Table D3a Case Number Table for NEQ = 500 kg

NEQ = 500 kg

	Lethality (with or without barricades) for case number							**Injury** (with or without barricades) for case number									**Damage** for case number			
Distance	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	3	4
[m]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	30	100	100	100
20	10	30	50	35	100	100	100	90	100	100	100	95	100	100	100	100	0	100	100	100
30	0.1	20	48	32	100	100	100	50	100	100	100	70	100	100	100	100	0	100	85	100
40	0.0	10	46	28	100	90	90	20	80	100	100	50	100	100	100	95	0	100	65	100
50	0.0	5.0	44	25	100	50	60	5.0	20	100	100	35	100	100	100	70	0	70	50	100
60	0.0	2.0	42	25	100	35	50	2.0	2.0	97	100	30	100	97	96	50	0	45	40	100
70	0.0	0.5	40	25	85	20	40	1.0	0.5	70	100	28	100	70	65	40	0	25	30	100
80	0.0	0.1	38	25	65	12	35	0.4	0.1	20	100	27	100	50	30	38	0	10	25	100
90	0.0	0.0	36	25	55	8.0	32	0.2	0.0	2.0	100	26	90	40	22	36	0	0	21	100
100	0.0	0.0	34	25	45	6.0	30	0.1	0.0	0.1	100	25	60	35	16	34	0	0	18	100
120	0.0	0.0	16	25	30	4.0	28	0.0	0.0	0.0	94	25	40	31	10	25	0	0	12	70
140	0.0	0.0	6.0	25	15	2.5	26	0.0	0.0	0.0	40	25	25	30	6.0	15	0	0	6	40
160			2.0	23	7.0	1.5	24				10	23	12	27	4.0	8.0			2	25
180			0.5	21	4.0	1.0	22				4.0	20	4.0	23	2.5	2.0			0	10
200			0.1	19	2.0	0.7	20				2.0	18	2.0	20	1.7	0.5				0
250				9.0	0.5	0.3	9.0				0.5	9.0	0.2	10	0.7	0.1				
300				4.0	0.1	0.1	4.0				0.2	4.0	0.1	4.0	0.3					
350				0.1			0.5				0.1	0.2		0.7	0.2					
400							0.0				0.0			0.1	0.1					

Table D3b Consequence Table for NEQ = 500 kg

			PES WITH Barricade		PES NO Barricade		PES
ES type	**Windows**	**OHP**	**Lethality**	**Injury**	**Lethality**	**Injury**	**Damage**
Hesco	No	No	1	1	1	1	1
HRS	No	No	1	1	2	2	1
RS	No	No	2	2	5	6	2
NS	No	No	2	2	5	6	3
	Yes	No	3	9	5	7	
LS	No	No	3	4	5	4	4
	Yes	No	3	4	5	4	
	No	Yes	3	4	-	-	
	Yes	Yes	3	4	-	-	
Tent	No	No	2	3	5	7	3
	No	Yes	2	3	-	-	
FF	No	No	1	1	5	7	-
	No	Yes	1	1	-	-	
IB	Yes	No	4	5	6	5	3
	No	No	2	2	7	8	
	No	Yes	2	2	-	-	
	Yes	Yes	4	5	-	-	

Table D4a Case Number Table for NEQ = 1000 kg

NEQ = 1000 kg

	Lethality (with or without barricades) for case number							**Injury** (with or without barricades) for case number									**Damage** for case number			
Distance	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	3	4
[m]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
20	10	50	70	80	100	100	100	100	100	100	100	100	100	100	100	100	0	100	100	100
30	0.5	35	50	50	100	100	100	70	100	100	100	100	100	100	100	100	0	100	100	100
40	0.2	25	48	40	100	95	95	30	100	100	100	100	100	100	100	100	0	100	90	100
50	0.1	15	46	33	100	80	80	15	90	100	100	99	100	100	100	100	0	100	75	100
60	0.0	9.0	44	30	100	55	70	5.0	50	100	100	70	100	100	97	95	0	75	60	100
70	0.0	6.0	42	27	90	30	50	2.0	30	95	100	50	100	100	80	50	0	45	50	100
80	0.0	3.5	40	26	80	20	35	1.0	5.0	85	100	40	100	100	45	40	0	25	40	100
90	0.0	2.0	38	25	70	14	33	0.5	2.0	70	100	35	97	97	35	38	0	10	35	100
100	0.0	1.0	36	25	55	10	31	0.2	1.0	40	100	33	90	90	25	36	0	0	30	100
120	0.0	0.4	34	25	40	6.0	30	0.1	0.4	10	100	31	65	75	15	34	0	0	25	80
140	0.0	0.2	32	25	25	3.0	28	0.0	0.2	2.0	96	29	30	50	8.0	32	0	0	20	55
160		0.0	25	25	15	2.0	26		0.0	0.5	80	27	15	30	5.5	25			15	40
180			15	25	8.0	1.5	26			0.2	40	26	8.0	20	4.0	18			10	30
200			5.0	25	4.0	1.0	25			0.1	10	25	4.0	13	2.5	12			7	22
250			0.2	22	0.5	0.5	22				1.0	22	0.5	4.0	1.0	0.7			0	10
300				18	0.2	0.2	18				0.2	18	0.2	1.0	0.5	0.0				0
350				11	0.1	0.1	10				0.1	11	0.1	0.3	0.2					
400				6.0			6.0					6.0		0.1	0.1					
450				1.0			1.0					1.0								
500				0.2			0.1					0.2								

Table D4b Consequence Table for NEQ = 1000 kg

			PES WITH Barricade		PES NO Barricade		PES
ES type	**Windows**	**OHP**	**Lethality**	**Injury**	**Lethality**	**Injury**	**Damage**
Hesco	No	No	1	1	1	1	1
HRS	No	No	1	1	1	1	1
RS	No	No	2	2	6	4	2
NS	No	No	2	2	6	4	2
	Yes	No	4	9	7	7	
LS	No	No	4	5	7	5	4
	Yes	No	4	5	7	5	
	No	Yes	4	5	-	-	
	Yes	Yes	4	5	-	-	
Tent	No	No	3	4	7	7	3
	No	Yes	3	4	-	-	
FF	No	No	1	1	7	7	-
	No	Yes	1	1	-	-	
IB	Yes	No	5	6	8	6	3
	No	No	3	3	9	8	
	No	Yes	3	3	-	-	
	Yes	Yes	5	6	-	-	

Table D5a Case Number Table for NEQ = 2000 kg

NEQ = 2000 kg

	Lethality (with or without barricades) for case number									**Injury** (with or without barricades) for case number									**Damage** for case number			
Distance	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4
[m]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
20	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	20	100	100	100
30	5.0	40	30	54	60	100	100	100	100	85	100	100	100	100	100	100	100	100	0	100	100	100
40	1.0	35	25	52	50	100	100	100	100	60	100	100	100	100	100	100	100	100	0	100	100	100
50	0.5	33	20	50	45	100	100	100	100	40	100	100	100	100	100	100	100	100	0	100	85	100
60	0.30	30	16	48	40	100	100	97	97	20	100	95	100	100	99	100	99	100	0	85	70	100
70	0.25	20	12	46	35	100	100	70	70	10	98	70	100	100	80	100	95	100	0	70	55	100
80	0.22	5.0	10	44	30	100	100	45	30	5.0	70	25	100	100	60	100	75	99	0	55	50	100
90	0.20	0.5	8.0	42	28	85	85	40	20	4.0	5.0	15	100	100	50	100	50	80	0	40	45	100
100	0.18	0.1	6.0	40	27	50	70	35	15	3.0	0.3	7.0	99	100	40	100	40	50	0	30	40	100
120	0.16		4.0	38	26	30	60	32	10	2.0	0.0	5.0	80	100	35	96	25	38	0	18	35	100
140	0.14		2.5	36	25	15	50	30	6.0	1.5		3.5	40	100	32	70	15	36	0	5	32	100
160	0.13		1.5	34	25	5.0	40	29	4.0	1.0		3.0	15	100	30	40	11	34		0	30	90
180	0.12		1.0	32	25	1.5	30	28	3.0	0.8		3.0	3.0	98	29	30	8.0	32			29	70
200	0.11		0.7	30	25	0.5	20	27	2.0	0.6		2.5	1.5	90	28	20	6.0	30			28	55
250	0.10		0.3	10	25	0.1	10	26	1.0	0.4		0.5	0.5	40	27	10	2.5	12			17	30
300			0.1	2.0	25		3.5	25	0.3	0.2		0.1	0.2	3.5	26	5.0	0.8	5.0			5	20
350				0.5	23		1.0	23	0.1	0.2			0.2	1.0	24	1.5	0.4	0.5			4	10
400				0.1	20		0.3	21		0.1			0.1	0.3	22	0.5	0.2	0.1			3	0
450					15		0.1	15						0.1	16	0.2	0.1				1.5	
500					10			10							11	0.1					0	
600					2.5			2.5							3.0							
700					0.0			0.0							0.0							

Table D5b Consequence Table for NEQ = 2000 kg

			PES WITH Barricade		PES NO Barricade		PES
ES type	**Windows**	**OHP**	**Lethality**	**Injury**	**Lethality**	**Injury**	**Damage**
Hesco	No	No	1	1	1	1	1
HRS	No	No	1	1	1	1	1
RS	No	No	2	2	6	4	2
NS	No	No	2	2	6	4	2
	Yes	No	4	5	7	5	
LS	No	No	4	6	7	6	3
	Yes	No	4	6	7	6	
	No	Yes	4	6	-	-	
	Yes	Yes	4	6	-	-	
Tent	No	No	3	5	7	5	3
	No	Yes	3	4	-	-	
FF	No	No	3	3	7	5	-
	No	Yes	1	1	-	-	
IB	Yes	No	5	7	8	7	4
	No	No	3	3	9	3	
	No	Yes	3	3	-	-	
	Yes	Yes	5	7	-	-	

Table D6a Case Number Table for NEQ = 4000 kg

NEQ = 4000 kg

	Lethality (with or without barricades) for case number									**Injury** (with or without barricades) for case number							**Damage** for case number			
Distance	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	1	2	3	4
[m]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
20	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
30	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	100	100	100
40	2.0	80	100	100	100	100	100	100	100	90	100	100	100	100	100	100	0	100	100	100
50	0.5	50	50	80	70	100	100	100	100	70	100	100	100	100	100	100	0	100	100	100
60	0.40	45	30	60	50	100	100	97	97	50	100	100	100	100	100	100	0	100	100	100
70	0.35	40	20	55	45	100	100	85	85	25	100	100	100	100	100	100	0	100	95	100
80	0.30	35	15	49	40	100	100	65	55	12	100	100	100	100	100	99	0	100	80	100
90	0.25	20	12	47	35	95	95	55	35	3.0	95	90	100	100	100	80	0	100	75	100
100	0.20	10	10	45	30	80	85	45	28	1.5	70	50	100	100	100	55	0	75	65	100
120	0.15	0.5	7.0	43	28	50	70	40	18	0.15	0.5	20	99	100	100	45	0	45	50	100
140	0.10	0.0	5.0	41	27	20	55	35	10	0.10	0.0	15	80	85	100	35	0	25	40	100
160			3.5	39	26	8.0	45	30	7.0			12	40	50	100	30		10	35	100
180			2.5	37	25	2.0	40	29	4.0			8.0	15	40	100	29		0	32	100
200			2.0	35	25	1.0	35	28	3.5			6.0	3.0	35	100	28			30	100
250			1.5	25	25	0.2	22	27	2.0			4.0	1.5	25	95	27			27	75
300			1.0	18	25		12	26	1.5			3.0	1.0	18	40	26			18	50
350			0.4	8.0	25		6.0	25	0.4			1.0	0.4	8.0	12	25			7	30
400			0.1	2.0	24		2.0	24	0.1			0.2	0.1	3.0	3.0	24			4	20
450				0.1	23		0.5	23				0.1		1.0	1.0	23			3	10
500					22		0.1	22						0.3	0.5	22			2	0
600					17			17						0.1	0.2	17			0	
700					7.0			7.0							0.0	7.0				
800					2.0			2.0								2.0				
900					0.1			0.1								0.1				

Table D6b Consequence Table for NEQ = 4000 kg

Calculation Template

Location:		
Situation No:	Description:	
PES No:	Analysis by	
NEQ [kg]	Date:	Classification:

Exposed Sites (ES)								Lethality			Injury				-	Asset Damage	
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
No.	Name / Description	Type	Barricade PES or ES Yes / No	Normal Windows Yes / No	Overhead Protection Yes / No	Exposed Persons	Distance PES-ES [m]	Case No.	Lethality [%]	Persons killed	Case No.	Injury [%]	Persons at least injured	Persons injured	Persons unhar-med	Case No.	Damage [%]
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
-	-	-	-	-	TOTAL		-	-	TOTAL		-	TOTAL				-	-

Consequence Catagory (from Table 7.2)		**Probability Level (from Table 7.1)**		**Risk Level (from Table 7.3)**	

Remarks:
Approved: Date:

Table D7 Calculation Template

Location: Example	Camp Elsewhere	
Situation No:	Description:	Unbarricaded
PES No: 150	Analysis by	I.M. de Mann
NEQ [kg] 2000	Date: YYMMDD	Classification: Unclassified

Exposed Sites (ES)								Lethality			Injury				-	Asset Damage	
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
No.	Name / Description	Type	Barricade PES or ES Yes / No	Normal Windows Yes / No	Overhead Protection Yes / No	Exposed Persons	Distance PES-ES [m]	Case No.	Lethality [%]	Persons killed	Case No.	Injury [%]	Persons at least injured	Persons injured	Persons unhar-med	Case No.	Damage [%]
1	Office	NS	No	Yes	No	5	100	7	70	3.5	7	100	5.0	1.5	0.0	2	30
2	Sleeping	LS	No	Yes	No	5	133	7	60	3.0	5	100	5.0	2.0	0.0	4	100
3	Field	FF	No	No	No	10	200	7	20	2.0	7	20	2.0	0.0	8.0	-	-
4	House	IB	No	Yes	No	10	150	8	30	3.0	6	32	3.1	0.1	6.9	3	32
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
-	-	-	-	-	TOTAL	30	-	-	TOTAL	12	-	TOTAL	16	4	15	-	-

Consequence Catagory (from Table 2.5)	Catastrophic	Probabiltiy Level (from Table 2.4)	Unlikely	Risk Level (from Table 2.6)	Medium

Remarks: - Own ammunition
- Enemy attack is not imminent
Approved: Date:

Table D8 Sample of completed calculation template

ESMRM - Certificate of Risk Acceptance Form xxxx **Risk Acceptance Form**	Page 1 of …….. 1. Issue Date 2. Expiration Date

General Information

3. Location Requiring Certificate *(Name and Address)*	4. Organisation Issuing Certificate *(Name and Address)*

5. Installation (PES) Description		6. PES No.
7.. Mitigation Measures necessary: Yes ☐ No ☐	8. Total Time to Implement	
	9.. Total Cost of Measures $	

Risk Summary / Residual Risks to be Accepted *(Details see Page 2)*

10. Risk Level		11.Fatalities	
12.Mission Impact			

Risk Acceptance

I have reviewed the risk assessment for the risk I am accepting. I understand the hazard, the risk, the cause and the consequences of the risk on the mission, personnel, and the environment. I have evaluated the recommended correc- tive actions and the mission requirements. After careful consideration, I am accepting the risk and its consequences due to the constraints it imposes on the mission's execution and/or unavailability of a timely, cost effective, corrective action

13. Printed Name	14. Rank	15. Organization	16. Signature	17. Date *(YYYY/MM/DD)*

Reviewed By:

18. Printed Name	19. Rank	20. Organization	21. Signature	22. Date

ESMRM - Certificate of Risk Acceptance Form xxxx **Risk Mitigation / Risk Details / Risk Tracking Form**	Page 2 of …….. 1. Issue Date 2. Expiration Date

Mitigation Measures Summary	6. PES No.

30. Mitigation Measures to be Implemented *(No. and Short Description of all Measures)*

31. Type of Measure: permanent ☐ interim ☐ mix ☐	32. Total Time to Implement	
	33. Total Cost of all Measures $	

Final Residual Risks = Accepted Risks

(After Implementation of all the Mitigation Measures According to Point 30.) Nos. Reduction %

34. Consequence Category		37. Fatalities		
35. Probability Category		38. Injured Personnel		
36. Risk Level		39. Buildings Damaged.		

40. Other Risk Relevant Factors *(if any)*

41. Overall Mission Impact

Risk Tracking / Monitoring

42. Situation to be Checked each …….. *(Day / Week / Month)*

43. Printed Name	44. Rank	45. Organization	46. Signature	47. Date *(YYYY/MM/DD)*	48. Concur (Yes/No)

ESMRM - Certificate of Risk Acceptance Form xxxx **Baseline Risk Analysis**	Page 3 of …….. 1. Issue Date 2. Expiration Date

General Information

50. Installation (PES) Description Details	6. PES No.

51. Method of Risk Assessment, according to: AASTP-5 Table Based Approach ☐
Other ☐ ……. AASTP-5 Consequence Analysis Tool ☐

Risk Analysis Details

General Risk Information

52. Consequence Category *(from Table 2.5)*		55. No. of Fatalities *(from Table D7, if applied)*	
53. Probability Category *(from Table 2.4)*		56. No. of Injured Personnel *(from Table D7, if applied)*	
54. Risk Level *(from Table 2.6)*		57. No. Buildings Damaged/Destroyed *(from Table D7, if applied)* *(Damage [%] divided by 100)*	

Mission Impact

58. Mission (general)
59. Personnel
60. Equipment
61. Other *(e.g. environment / political)*
62. Remarks *(any other useful information)*

ESMRM - Certificate of Risk Acceptance	Page 4 of ……..
Form xxxx	1. Issue Date
Risk Mitigation Measures Details	2. Expiration Date
Mitigation Measure No. ……	**6. PES No.**

80. Mitigation Measure				
81. Type of Measure: permanent ☐		82. Time to Implement		
interim ☐		83. Cost of Measure $		
Residual Risks			Nos.	Reduction %
84. Consequence Category		87.Fatalities		
85. Probability Category		88.Injured Personnel		
66.Risk Level		89.Buildings Damaged.		
Mission Impact				
90.General				
Approval of Measure				
91. Measure Approved Yes ☐ No ☐		92. Reason for Disapproval		

Mitigation Measure No. ……	6. PES No.

80. Mitigation Measure				
81. Type of Measure: permanent ☐		82. Time to Implement		
interim ☐		83. Cost of Measure $		
Residual Risks			Nos.	Reduction %
84. Consequence Category		87.Fatalities		
85. Probability Category		88.Injured Personnel		
86.Risk Level		89.Buildings Damaged.		
Mission Impact				
90.General				
Approval of Measure				
91. Measure Approved Yes ☐ No ☐		22. Reason for Disapproval		

ANNEX E CONSEQUENCE ANALYSIS TOOL

E.1. WEBLINK TO THE TOOL

https://www.msiac.nato.int/weblink/0/fol/478105/Row1.aspx

E.2. BACKGROUND AND USER'S MANUAL

Introduction

As described in paragraph 2.7, the consequence analysis is a central part of the risk analysis that is needed when Field Distances cannot be met in an operational situation. Instructions on how to do a consequence analysis using just pen and paper are also described. The Excel workbook does the same analysis. The only difference is that the tables in the manual method are compressed to reduce the number and the size of the tables. The results of the workbook and the manual method will be the same, within a few percent.

Neither the workbook nor the manual method includes the likelihood of an explosion or the exposure time of persons. This has to be added by the user if a risk analysis instead of a consequence analysis is required.

Besides calculating the consequences of an explosion scenario, the Excel workbook can be used:

- to quickly evaluate improvement options like relocating of the exposed site, adding protective measures like barricades to the exposed site or removing windows from the exposed site, or reducing the amount of stored explosives;
- to assist in the choice of the placement of new buildings in an existing compound, or possibly even in the design of the entire layout of a new compound.

Background

The Excel workbook is based on tables that were generated by Risk-NL v5.0, a risk analysis code for ammunition storage. Each table gives the probability of injury or lethality for a given combination of PES and ES, as a function of distance between the PES and ES. A workbook was written that selects the correct table based on user input, reads the tables, does the consequence calculations and presents the results. A complete description of the development is given in [Wees, 2011].

Lethality and Injury tables

The lethality and injury tables form the core of the consequence analysis tool. The tables were computed with TNO's risk analysis code Risk-NL v5.0 [Van der Voort et al., 2009-1]. For ammunition storage out-of-area an adapted version of this code was written that includes PESs and ESs that are typical of out-of-area operations [Van der Voort, 2009-2] and [Van der Voort and Kummer, 2010].

The PES is taken as an ISO container with 155 mm artillery shells, which is the "maximum credible event". The calculation was done for a series of NEQ: 50, 75, 100, 250, 500, 750, 1000, 1500, 2000, 2500, 3000 and 4000 kg. Note that although 4000 kg NEQ of 155 mm shells do not fit in one container, AASTP-5 allows several containers in one storage module, up to 4000 kg NEQ.

Lethality and injury tables were produced for the ES structure types:

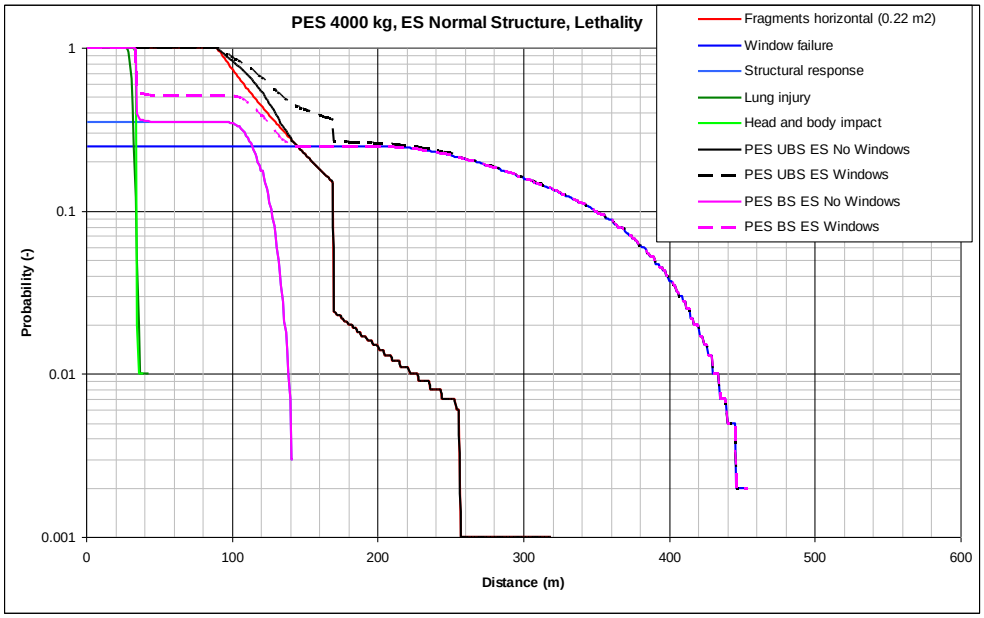
- Gabion : Earth-filled Gabion or similar;
- HRS: Heavily Reinforced Structure;
- RS: Reinforced Structure;
- NS: Normal Structure, similar to a steel ISO container;
- LS: Light Structure, similar to a portacabin;
- Tent;
- FF: Free Field, i.e. a person in the open;
- IB: Inhabited Building, a civilian building outside the compound.

Variations to these basic PES-ES combinations were made by considering the presence of a barricade between the PES and the ES, an overhead protection (OHP) either above the PES or above the ES, and whether the ES has windows that are vulnerable to blast. Not all combinations occur in practice. For reference, all combinations are listed in the Table within Annex E.

The probability was calculated at each metre distance out to distances where the probability was reduced to 0.1%, which could be 650 m for the most vulnerable structures.

The tables calculated by Risk-NL give the contribution of each explosion effect (e.g. fragments, window breakage) to the lethality and injury probability and adds these to give the total probability. This explains the steps that are visible in the lethality and injury curves. The effect of a barricade, of overhead protection and of windows is taken into account by not counting the contribution of horizontal fragments and debris; vertical fragments and debris, or glass shards from broken windows, respectively.

In all, the workbook includes 1152 tables, generated by Risk-NL.



Example of plots of injury and lethality tables produced by Risk-NL.

Damage

To give the field commander an impression of the amount of damage after an explosion, and therefore an idea of the state of readiness after an accident, damage tables were generated.

Damage predictions were taken from [Sibma, 2009], [Baker *et al.*, 1983] and [CPR 16E, 2000]. The damage prediction is rough; only three damage levels (undamaged, damaged and collapsed) are considered (except for "inhabited buildings", where five levels were used.) Undamaged means that the structure can be used with little or no repairs. Plugging fragment holes or replacing windows is considered as little work, so an "undamaged" structure does not mean that personnel inside will be uninjured or equipment remains undamaged. The exposed site type "free field" is not a structure and consequently does not have damage levels. The spreadsheet always gives "undamaged" as output for this exposed site type.

List of Exposed Site types

The list of all exposed site types, combined with OHP, barricade and windows is given below. In addition, the ballistic resistance and the STANAG 2280 protection level is specified (without barricade or OHP).

To make the tool also useable for deciding the distance at which a new building has to be sited, Q-D tables were added. It was decided to only add those Q-D tables that are applicable to field storage operations: the AASTP-5 field distances and the AASTP-1 inhabited building distance and public traffic route distance for HD 1.1.

The tables were automated, so that when the PES and the ES are specified, the required distance is automatically looked up. The distance is compared to the actual

PES-ES distance and a warning is given when the required distance is larger than the actual PES-ES distance.

The exposed site types in the spread sheet do not match perfectly with the ES types (classes) in AASTP-5 Table 2-2. The lookup table that is used for the conversion is listed below. For exposed sites outside the compound (types “free field” and “inhabited building”), the AASTP-1 public traffic route distance (D11) and inhabited building distance (D13) for HD 1.1 are given. The spread sheet also gives more choice in the amount of explosive in the PES than AASTP-5 Table 2-2. For amounts that do not match, the next higher amount is used.

List of ES types in the spread sheet, conversion to classes used in AASTP-5 Table 2-2

ES type and protection	AASTP-5 Table 2.2 class	AASTP-1 HD 1.1 Q-D	Ballistic resistance of ES	STANAG 2280 protection level of ES
FF No OHP Barricaded	Open, personnel mission related, barricaded	PTRD	N/A	A0 B0 C0 E0
FF No OHP Unbarricaded	Open, personnel mission related, unbarricaded	PTRD		
FF OHP Barricaded	Open, personnel mission related, barricaded	PTRD		
FF OHP Unbarricaded	Open, personnel mission related, unbarricaded	PTRD		
Gabion No OHP Barricaded	Hardened, barricaded	N/A	0.8-1 m of sand	A4 B2,3 C5 E5
Gabion No OHP Unbarricaded	Hardened, unbarricaded	N/A		
Gabion OHP Barricaded	Hardened, barricaded	N/A		
Gabion OHP Unbarricaded	Hardened, unbarricaded	N/A		
HRS No OHP Barricaded	Hardened, barricaded	N/A	2×8 mm armour steel sandwich	A2 B3 C4 E5
HRS No OHP Unbarricaded	Hardened, unbarricaded	N/A		
HRS OHP Barricaded	Hardened, barricaded	N/A		
HRS OHP Unbarricaded	Hardened, unbarricaded	N/A		
IB No OHP Barricaded	Unprotected people outside compound, barricaded	IBD	230 mm reinforced concrete or 300 mm brick	A0 B0 C0 E0
IB No OHP Unbarricaded	Unprotected people outside compound, unbarricaded	IBD		
IB OHP Barricaded	Unprotected people outside compound, barricaded	IBD		
IB OHP Unbarricaded	Unprotected people outside compound, unbarricaded	IBD		
LS No OHP Barricaded	Light structure, not conforming to note 7, barricaded	N/A	0.75 mm mild steel	A0 B0 C0 E0
LS No OHP Unbarricaded	Light structure, not conforming to note 7, unbarricaded	N/A		
LS OHP Barricaded	Light structure, conforming to note 7, barricaded	N/A		
LS OHP Unbarricaded	Light structure, conforming to note 7, unbarricaded	N/A		
NS No OHP Barricaded	Light structure, conforming to note 7, barricaded	N/A	2 mm mild steel	A0 B0 C0 E0
NS No OHP Unbarricaded	Light structure, conforming to note 7, unbarricaded	N/A		
NS OHP Barricaded	Light structure, conforming to note 7, barricaded	N/A		
NS OHP Unbarricaded	Light structure, conforming to note 7, unbarricaded	N/A		
RS No OHP Barricaded	Light structure, conforming to note 7, barricaded	N/A	5 mm mild steel	A0 B0 C0 E0
RS No OHP Unbarricaded	Light structure, conforming to note 7, unbarricaded	N/A		
RS OHP Barricaded	Semi-hardened, barricaded	N/A		
RS OHP Unbarricaded	Semi-hardened, unbarricaded	N/A		
Tent No OHP Barricaded	Light structure, not conforming to note 7, barricaded	N/A	none	A0 B0 C0 E0
Tent No OHP Unbarricaded	Light structure, not conforming to note 7, unbarricaded	N/A		
Tent OHP Barricaded	Light structure, conforming to note 7, barricaded	N/A		
Tent OHP Unbarricaded	Light structure, conforming to note 7, unbarricaded	N/A		

APPENDIX 1 TO ANNEX E

E.3. APPENDIX - USER'S MANUAL

1. Installation

Requirements

The .xlt version of the tool requires a MS Windows computer with Microsoft Office Excel 2003 or higher (or another system that can handle Excel 2003 .xls files). The tool uses macros, therefore the macro security level should be set to medium (Tools| Options | Security | Macro security). It is possible to use the tool without the macros.
The .xltm version requires Excel 2010.

Copy to directory

Copy the file "AASTP-5 consequence analysis tool ..." to a directory of your choice.

2. Using the tool

The AASTP-5 consequence analysis tool is designed for several situations:

- to analyse the consequences of an explosion of an ammunition storage module in a compound;
- to quickly evaluate improvement options like relocating of the exposed site, adding protective measures like barricades to the exposed site or removing windows from the exposed site, or reducing the amount of stored explosives;
- to assist in the choice of the placement of new buildings in an existing compound, or possibly even in the design of the entire layout of a new compound.

Analyse the consequences of an explosion

The calculation of the consequences of an explosion of one ammunition storage module on exposed sites is the main purpose of the tool. The effects on other ammunition storage modules are not calculated; it is assumed that the ammunition storage is built to regulation and sympathic detonation does not occur.
The properties of the potential explosion site (PES, the ammunition storage module) and the exposed sites (ESs) must be provided by the user, and the tool automatically looks up the lethality and injury probability in the appropriate table and calculates the number of personnel who are killed, injured or unharmed. It also gives the damage to the ES structure.

It is most efficient to provide all input for the entire compound at once. PES-ES combinations that give problems quickly become apparent in this way.
To simplify the tool, distances are calculated from the centre of the PES to the centre of the ES. This is not a conservative approach, it is more accurate to use the minimum distance between the PES and ES. For large, spread-out ESs, either use

the minimum distance by specifying the corners of the PES and ES instead of the centres, or split the ES into multiple smaller units.

Evaluate improvement options

The effect of protection measures on PES-ES combinations that give problems can be quickly tried out, just by clicking and selecting the option. Options that are possible to evaluate are:

- Add a barricade. Barricades are assumed to be able to stop all fragments that have a horizontal trajectory. The required thickness varies with the threat and distance.
- Add an overhead protection (although this is not possible or effective for all ES types);
- Replace normal windows by blast-resistant windows (this is only appropriate for ES types LS, NS and possibly IB);
- Replace the structure with a stronger ES type;
- Increase PES-ES distance;
- Reduce the number of personnel inside the ES;
- Reduce amount of explosive in the PES.

Find a safe location

It is possible to find the PES-ES distance at which the consequences meet the user's acceptance criteria by trial-and-error, but using the built-in assistance is easier. The tool provides both the AASTP-5 field distance and the distance at which a user-defined probability of injury and lethality exists for the PES-ES combination.

The idea is to use AASTP-5 field distances whenever possible. When it is impossible to use these distances in the operational situation, the commander can decide to accept distances that have greater consequences.

Note that the AASTP-5 field distances do not correspond exactly to distances with a certain probability of lethality. This is mainly due to the fact that there are many more ES types and protection options in the tool than in AASTP-5, so often the match is not perfect.

Evaluate more than one PES

The tool can, in its current version, only do calculations for one scenario at a time. For the user's convenience it is made possible to provide input on all PESs and then select the PES for which the calculations are to be made. The calculation results for the PESs can be collected in a single document.

Report and file the work

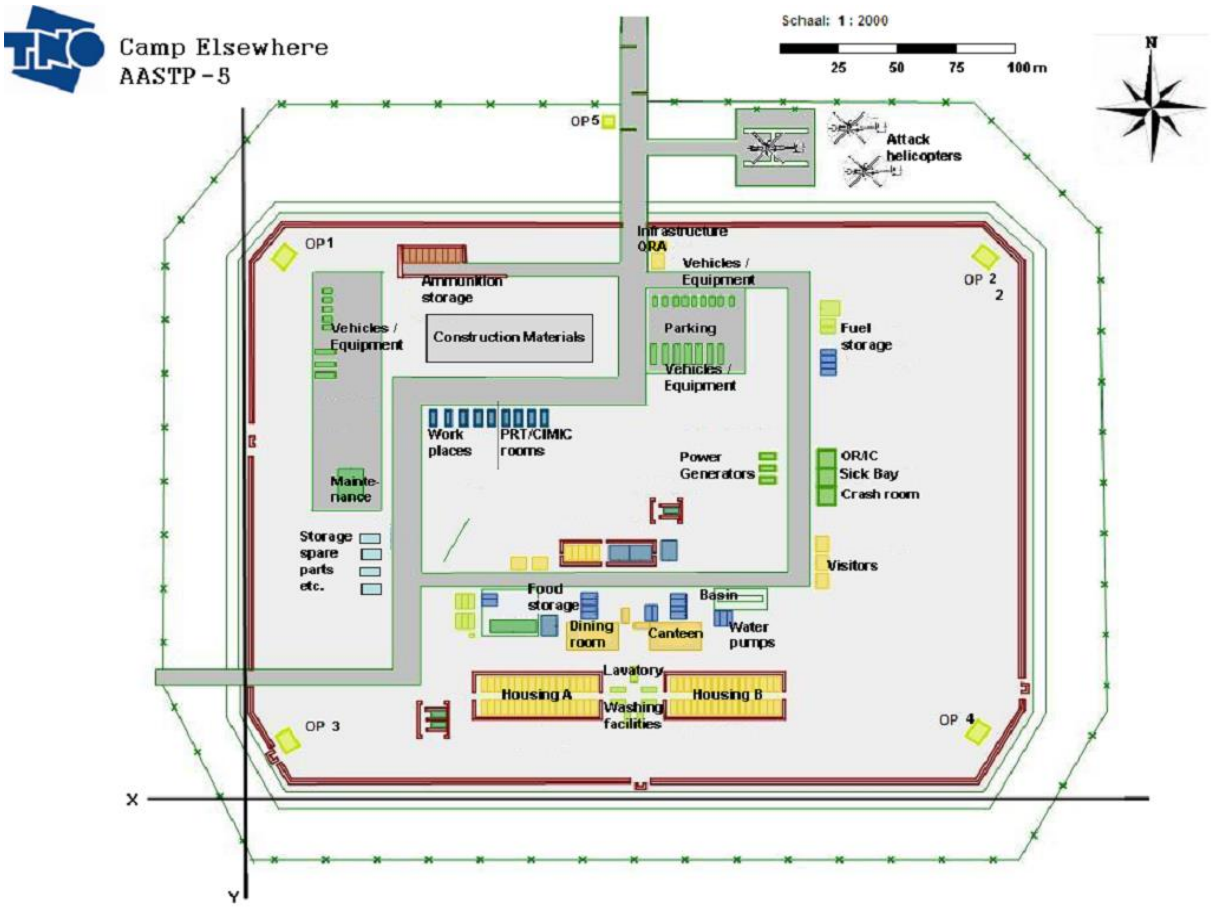
The results can be printed or saved. The file could be saved as is, but the file size is fairly large. Also, the input is easily changed which makes it less suitable for documentation purposes. Therefore it is best to copy the sheet "Input and results" to a separate worksheet. Macros are provided that does this automatically.

Reuse old files

Compounds are constantly being modified; therefore make sure that your work is available for future analyses.

The input data from old files can be copied and reused in a fresh workbook (note: use Paste special | Values).

3. Example: camp Elsewhere



Layout of the fictitious camp ‘Elsewhere’

Consequence analysis

The camp ‘Elsewhere’ is modelled by measuring the coordinates of the PESs and ESs from the map and entering them into the spreadsheet. Note that many ESs, e.g. ‘Housing A’, consist of many units. These are modelled as a single ES in this example. The example is included in the download as ‘Example camp Elsewhere. AASTP-1 consequence analysis tool v1.0.xls’.

Input

Location	Camp Elsewhere
Case number	101
Case description	Demonstration
Analysis performed by	Van der Sluijs
Date	14-06-11
Classification	NATO Unclassified

Explosion of:	NEQ / kg	Explosion probability	Location of PES x-coord / m	y-coord / m
Container 1	4000	high	70	232

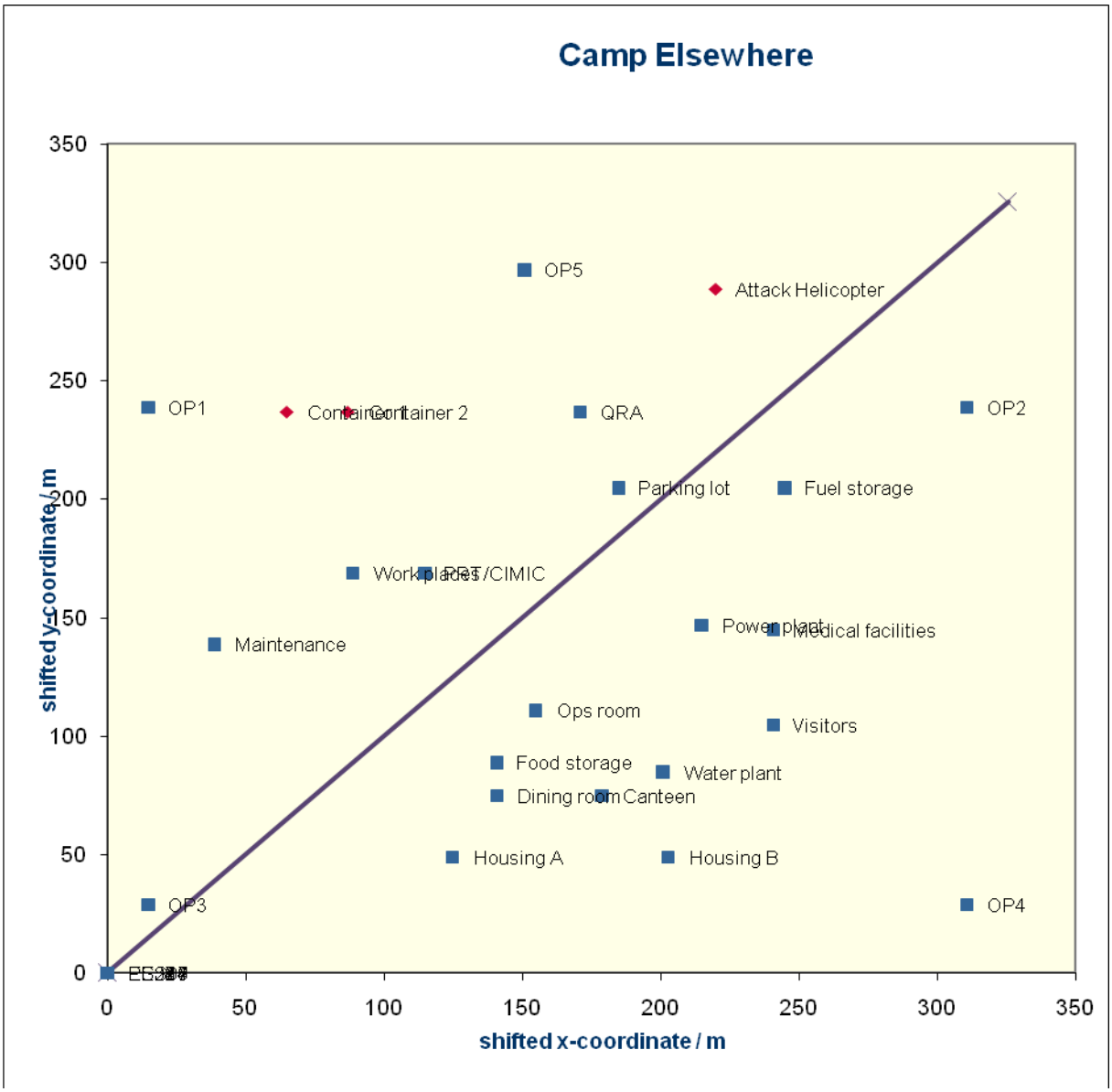
Definition of PES (Potential Explosion Site) and calculation of donor-PES distances

Name	PES type	Barricade between donor and PES?	NEQ / kg	Explosion probability	Location of PES x-coord / m	y-coord / m
Container 1			4000	high	70	232
Container 2			3000	high	92	232
Attack Helicopter			100	high	225	284
PES04						
PES05						
PES06						
PES07						
PES08						
PES09						
PES10						

Definition of Exposed Sites (acceptors), calculation of required donor-ES distances and calculation of dam

Name	Structure	Barricade between donor and ES	OHP	Windows	Persons	Coordinates of ES x-coord / m	y-coord / m
Parking lot	FF	Barricaded	No OHP	No windows	8	190	200
Dining room	RS	Unbarricaded	No OHP	No windows	40	146	70
Housing A	RS	Barricaded	No OHP	No windows	68	130	44
Canteen	RS	Barricaded	No OHP	Windows	20	184	70
Housing B	RS	Barricaded	No OHP	Windows	68	208	44
OP1	FF	Barricaded	OHP	No windows	2	20	234
OP2	FF	Barricaded	OHP	No windows	2	316	234
OP3	FF	Barricaded	OHP	No windows	2	20	24
OP4	FF	Barricaded	OHP	No windows	2	316	24
QRA	RS	Barricaded	No OHP	No windows	4	176	232
Food storage	NS	Barricaded	No OHP	No windows	3	146	84
Ops room	RS	Barricaded	No OHP	No windows	6	160	106
Medical facilities	RS	Barricaded	No OHP	No windows	10	246	140
Maintenance	HRS	Barricaded	No OHP	No windows	10	44	134
Fuel storage	NS	Barricaded	No OHP	No windows	0	250	200
Power plant	NS	Barricaded	No OHP	No windows	0	220	142
Water plant	NS	Barricaded	No OHP	No windows	0	206	80
Work places	HRS	Barricaded	No OHP	No windows	10	94	164
PRT/CIMIC	HRS	Barricaded	No OHP	Windows	10	120	164
OP5	FF	Barricaded	OHP	No windows	2	156	292
Visitors	RS	Barricaded	No OHP	No windows	6	246	100
ES22		Unbarricaded	No OHP	No windows			
ES23		Unbarricaded	No OHP	No windows			
ES24		Unbarricaded	No OHP	No windows			
ES25		Unbarricaded	No OHP	No windows			
ES26		Unbarricaded	No OHP	No windows			
ES27		Unbarricaded	No OHP	No windows			
ES28		Unbarricaded	No OHP	No windows			
ES29		Unbarricaded	No OHP	No windows			
ES30		Unbarricaded	No OHP	No windows			
Totals	**21**				**273**		

The site plan is shown in a graph, making it easy to spot mistakes in the input.



Definition of Exposed Sites (acceptors), calculation of required donor-ES distances and ca

Name	Structure	Barricade between donor and ES	Number of persons killed	injured	unharmed	Damage level
Parking lot	FF	Barricaded	0.3	0.4	7.3	Undamaged
Dining room	RS	Unbarricaded	0.2	0.2	39.6	Undamaged
Housing A	RS	Barricaded	0.0	0.0	68.0	Undamaged
Canteen	RS	Barricaded	0.0	0.0	20.0	Undamaged
Housing B	RS	Barricaded	0.0	0.0	68.0	Undamaged
OP1	FF	Barricaded	0.0	1.3	0.7	Undamaged
OP2	FF	Barricaded	0.0	0.0	2.0	Undamaged
OP3	FF	Barricaded	0.0	0.0	2.0	Undamaged
OP4	FF	Barricaded	0.0	0.0	2.0	Undamaged
QRA	RS	Barricaded	0.0	0.0	4.0	Damaged
Food storage	NS	Barricaded	0.0	0.0	3.0	Damaged
Ops room	RS	Barricaded	0.0	0.0	6.0	Undamaged
Medical facilities	RS	Barricaded	0.0	0.0	10.0	Undamaged
Maintenance	HRS	Barricaded	0.0	0.1	9.9	Undamaged
Fuel storage	NS	Barricaded	0.0	0.0	0.0	Damaged
Power plant	NS	Barricaded	0.0	0.0	0.0	Damaged
Water plant	NS	Barricaded	0.0	0.0	0.0	Undamaged
Work places	HRS	Barricaded	0.0	2.2	7.8	Undamaged
PRT/CIMIC	HRS	Barricaded	0.0	0.8	9.2	Undamaged
OP5	FF	Barricaded	0.0	0.0	2.0	Undamaged
Visitors	RS	Barricaded	0.0	0.0	6.0	Undamaged
ES22		Unbarricaded				
ES23		Unbarricaded				
ES24		Unbarricaded				
ES25		Unbarricaded				
ES26		Unbarricaded				
ES27		Unbarricaded				
ES28		Unbarricaded				
ES29		Unbarricaded				
ES30		Unbarricaded				
Totals	**21**		**0**	**5**	**267**	**4**

The results of the consequence analysis show that there is a probability of lethality in the parking lot and the dining room.

Evaluating the consequences of an explosion in container 2 gives a similar result with the addition of lethality in the QRA, while an explosion of the attack helicopter causes no injuries.

Evaluating mitigation measures

Looking at the dining room, it is easily found that adding a barricade will solve the problem. (In fact, there is already a barricade between the PES and the dining room, because the entire ammunition storage is surrounded by a barricade. The dining room was only made 'unbarricaded' for demonstration purposes.)

For the QRA (quick reaction force), upgrading to a HRS structure or relocating to a greater distance would solve the problem. Whether the consequences need to be accepted or whether mitigation measures need to be taken must be decided by the national authority.

Finding a location for a new building

Suppose that a new building is needed, and for comfort a light structure with windows is desired. The AASTP-5 Field Distance for that structure is quickly evaluated to be 206 m for both container 1 and container 2, and 46 m for the attack helicopter.

Exposed Sites (acceptors)						Coordinates of ES		
Name	Structure	Barricade	OHP	Windows	Persons	x-coord. / m	y-coord. / m	Distance fr	AASTP-5 FD
New building	LS	Barricaded	No OHP	Windows					206

However, when an ES type 'LS' is placed at 206 m, it is found that the lethality probability is actually rather high, because the structure collapses and the windows are blown in. Upgrading to a 'normal structure' with blast resistant windows (i.e., option 'no windows') fixes the problem.

If the 206 m Field Distance is not available in the compound, one could look at the 'user defined' distances. These give the distance at which the injury and lethality probabilities of the defined PES-ES combination reach a user-defined level. For e.g. a 1% lethality probability a distance of 140 m is found for this particular PES-ES combination.

Reporting

The spreadsheet generates a summary for the scenario and these summaries are easy to collect manually into an overall report for the compound

Summary

location	Camp Elsewhere
case number	101
description	Demonstration

Explosion of:

name	Container 1	Container 2	Attack Helic
NEQ / kg	4000	3000	100
probability	high	high	high

Loss of personnel

consequence	number	number	number
killed	0	1	0
injured	5	5	0
unharmed	267	267	273

Loss of assets

consequence	number	number	number
collapsed	0	1	0
damaged	4	3	0
undamaged	17	17	21

4. References

[Baker *et al*, 1983] Baker, W.E.; Cox, P.A.; Westine, P.S; Kulesz, J.J. and Strehlow, R.A., Explosion Hazards and Evaluation, Elsevier Scientific Publishing, Amsterdam, 1983.

[CPR16E, 2000] Commissie Preventie van Rampen door Gevaarlijke Stoffen, Methods for the determination of possible damage to people and objects resulting from releases of hazardous materials, Sdu Uitgevers, CPR-16E, 2e druk, Den Haag, 2000.

[Sibma, 2009] Sibma, P.C., Out-of-area structures subjected to blast; experiemental and numerical data. TNO-DV 2008 A446, March 2009.

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Van der Voort, M.M. van der, et al., A description of Risk-NL v5.0, TNO Defence, Security and Safety, TNO-DV 2009 A315, Rijswijk, December 2009.

[Van der Voort et al, 2009-2]
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[Voort and Kummer, 2010]
A consequence analysis method for out of area field storage, 34th DoD Explosives Safety Seminar, Portland, 2010. Also published as NATO informal working paper AC326(SG6)(NLD)IWP01-2010.

[Wees, 2011] Wees, R.M.M. van, Consequence analysis tool for AASTP-5, TNO, Annex to letter 11PPS/186, Rijswijk, 11 August 2011.

ANNEX F ES STRUCTURE CLASSES FOR CONSEQUENCE ANALYSIS

The following table gives an overview of ES structure classes to be used for consequence analysis. Models for the blast and ballistic resistance of these structures have been described in AASTP-4, Part II

Structure class	Class for table 2-2	Description	Structure class example
Tent	Light structure	No ballistic resistance	
Light (LS)	Light structure	Container with walls of 12.5 mm multiplex or 0.75 mm mild steel	
ISO Container (NS)	Light structure	Container with walls of 2 mm mild steel	
Reinforced (RS)	Semi-hardened	Container with walls of 5 mm mild steel	
Heavily Reinforced (HRS)	Semi-hardened structure	Container with 2*8 mm armour steel sandwich	
Gabion	Hardened structure	Structure consisting of sand filled barriers of 0.8 - 1 m thickness	
Inhabited Building (IB)	Unprotected people outside compound	Local construction, not rated	To be determined at location
Free Field (FF)	Open-Personnel mission related	Not a structure	No rating

The blast and ballistic resistance of the structures described above can be enhanced by barricades (for example Gabion) and Over Head Protection. The presence of windows poses and additional hazard for personnel when window failure takes place. This can be improved by installing blast resistant windows, or choosing structures without windows.

ANNEX G EXPLOSIVES LICENCE (SAMPLE)

Explosives Storage License

Structure: ______________________

Type: ______________________ Location: ______________________

HC/D	Amount of Permitted Explosives	Limiting Target Information		Distance		
Mixed Total						
		Target ID	Name	Type	Actual m	Required m
1.1						
1.2.1						
1.2.2						
1.2.3						
1.3						
1.4	**Mission Necessity**					
1.6						

Notes:
1. This license was prepared IAW
2. Any mishap or violation of this license will be reported immediately to the undersigned.
3. Should the site limits exceed the license limits, notify the Safety Office immediately.

Issuing Official: ______________________ Date: __________

Title: Safety Manager

Reviewed for adequacy and compliance by: ______________________ Date: __________

Reviewed for adequacy and compliance by: ______________________ Date: __________

Reviewed for adequacy and compliance by: ______________________ Date: __________

Reviewed for adequacy and compliance by: ______________________ Date: __________

ANNEX H VERSION 2 – LIST OF REFERENCES

Date	IWP/WP	Nation	Description
1 Aug 2010	Paper, 34th DDESB	NLD/SWI	Quantitative Risk Analysis (TNO/Bienz Kummer)
1 Dec 2010	PFP(AC/326-SG6)IWP(2010)002	NLD	Custodian Working Group Meeting, Den Haag
13 May 2011	PFP(AC/326-SG6)IWP(2011)002	NLD	Technical Working Group Meeting, Brussels
18 Aug 2011	PFP(AC/326-SG6)IWP(2011)004	USA	Added Electrical Safety paragraph 2.5.3.4 to Chapter 2
30 Aug 2011	PFP(AC/326-SG6)IWP(2011)83(A)	SWI/NLD	Section and Annex on Consequence and Risk Analysis
7 Sep 2011	PFP(AC/326-SG6)IWP(2011)003	NLD	Changed the Scope of Work in Chapter 2
20 Sep 2011	PFP(AC/326-SG6)IWP(2011)002	BEL	Changed the Field Distance Tables in Chapter 2
16 Dec 2011	PFP(AC/326-SG6)IWP(2010)001,R3	CAN	Added a new Section in Chapter 2 titled Risk Management
2 Feb 2012	PFP(AC/326-SG6)IWP(2011)001, R4	BEL	Added a new Section in Chapter 2 titled Multi-National Installation Operations
15 Feb 2012	PFP(AC/326-SG6)IWP(2012)001	NLD	Custodian Working Group Meeting, Den Haag
	N-document	NLD	Custodian Working Group Meeting, Den Haag

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