

MIXING OF AMMUNITION AND EXPLOSIVES IN STORAGE

Alena BREZNICKÁ^{1*}

¹Ing. Alena Breznická, PhD., Faculty of Special Technology, Alexander Dubcek University of Trencin,
Pri parku 19, 911 06 Trencin, Slovakia

*Corresponding author E-mail address: alena.breznicka@tuni.sk

Abstract

Ammunition and explosives of different hazard divisions may be stored together if compatible. The required quantity-distances and the permitted quantities must be determined in accordance with from the security principles for the storage of military ammunition and explosives AASTP-II.

Keywords: Military ammunition, explosives, different hazard divisions.

1 Storage Limitations

Quantities of conventional ammunition can be in the hundreds of thousands in a single stockpile. Furthermore, there are different types of ammunition, different calibers, different manufacturers and different ages, all with varying degrees of volatility. The combination of these factors makes the strict organization of a stockpile essential in ensuring safety and the effective use of materials. In order to facilitate the organization of ammunition and explosives and to ensure that they are safely housed in a facility, they are assigned to specific groupings. These “ammunition compatibility groups” are assigned to ammunition in order to reduce the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident [2].

The rules which apply to the mixing of hazard divisions and compatibility groups in above ground storage are detailed below. Special rules apply to underground storage. The basic rules are given in the form of three tables as follows:

TABLE 1: Aboveground Storage, Mixing and Aggregation Rules for Hazard Divisions.

TABLE 2: Aboveground Storage of Explosive Substances. Rules for mixing of Compatibility Groups.

TABLE 3: Aboveground Storage of Explosive Articles. Rules for Mixing of Compatibility Groups.

Mixed hazard divisions (HD) should be aggregated in the following table:

Table 1 Aboveground Storage, Mixing and Aggregation Rules for Hazard Divisions[4].

Hazard Division	1.1	1.2	1.3	1.4	1.5	1.6
1.1	1.1	1.1	1.1	1) ¹⁾	1.1	1.1
1.2	1.1	1.2	2) ²⁾	1) ¹⁾	1.1	3) ³⁾
1.3	1.1	2) ²⁾	1.3	1) ¹⁾	1.1	3) ³⁾
1.4	1) ¹⁾	1) ¹⁾	1) ¹⁾	1.4	1) ¹⁾	1) ¹⁾
1.5	1.1	1.1	1.1	1) ¹⁾	1.1	1.1
1.6	1.1	1.2	1.3 ³⁾	1) ¹⁾	1.1	1.6 ³⁾

NOTES:

1) 1.4 may be stored with any other HD without aggregation of the NEQ.

2) Mixed 1.2 and 1.3 will usually behave as aggregated 1.2 or 1.3. However, there is a significant risk that, in certain circumstances, a mix of 1.2 and 1.3 will behave as an aggregated quantity of 1.1.

If any of the following circumstances exists the mix must be aggregated as 1.1, unless relevant trials or analyses indicate otherwise:

- The presence of 1.2 shaped charges.
- High energy propellants (e.g. as used in some tank gun applications).
- High loading density storage of 1.3 in conditions of relatively heavy confinement.

d) 1.2 articles with an individual NEQ > 5 kg.

There may also be other circumstances, not yet defined, under which the mix should be aggregated as 1.1.

3) If demonstrated by testing or analogy. If not 1.1. [3].

Substances may be mixed in aboveground storage as shown in the following table:

Table 2 Aboveground Storage of Explosive Substances Rules for Mixing of Compatibility Groups [4].

Compatibility Group	A	C	D	G	L	S
A	X					
C		X ¹⁾	X ¹⁾	3)		X
D		X ¹⁾	X ¹⁾	3)		X
G		3)	3)	X		X
L					2)	
S		X	X	X		X

LEGEND: X = Mixing permitted

NOTES:

1) Mixing permitted provided substances have all passed UN Test Series 3. Storage of substances of any Compatibility Groups C, D or G which have failed UN Test Series 3 will require special consideration by the National Competent Authority.

2) Compatibility Group L substances must always be stored separately from all substances of other compatibility groups as well from all other substances of Compatibility Group L.

3) The mixing of Compatibility Group G substances with other compatibility groups is at the discretion of the National Competent Authority.

Articles may be mixed in aboveground storage as shown in the following table:

Table 3 Aboveground Storage of Explosive Articles - Rules for Mixing of Compatibility Groups [4].

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

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) Compatibility Group L articles must always be stored separately from all articles of other compatibility groups as well as from all other articles of different types of Compatibility Group L.

4) Mixing of articles of Compatibility Group G with articles of other compatibility groups is at the discretion of the National Competent Authority.

5) Articles of Compatibility Group N should not in general be stored with articles in other compatibility groups except S. However, if such articles are stored with articles of Compatibility Group C, D and E, the articles of Compatibility Group N should be considered as having the characteristics of Compatibility Group D and the compatibility groups mixing rules apply accordingly.

6) It is allowed to mix 1.6N munitions. The Compatibility Group of the mixed set remains N if the munitions belong to the same family or if it has been demonstrated that, in case of a detonation of one munition, there is no instant transmission to the munitions of another family (the families are then called "compatible"). If it is not the case the whole set of munitions should be considered as having the characteristics of Compatibility Group D.

7) A mixed set of munitions 1.6N and 1.4S may be considered as having the characteristics of Compatibility Group N. [4].

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

Group B: Articles containing a primary explosive substance and not containing two or more effective protective features. Some articles, such as detonators for blasting, detonator assemblies for blasting and primers, cap-type, are included, even though they do not contain primary explosives.

Group C: Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance. Examples are single-, double-, triple-based, and composite propellants, rocket motors (solid propellant), and ammunition with inert projectile.

Group D: Secondary detonating explosive substance or black powder or articles containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features.

Group E: Article containing a secondary detonating explosive substance, without means of initiation, with a propelling charge (other than one containing flammable liquid or gel or hypergolic liquid).

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

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

Group H: Ammunition containing both explosives and WP or other pyrophoric material. Ammunition in this group contains fillers which are spontaneously flammable when exposed to the atmosphere.

Group J: Ammunition containing both explosives and flammable liquids or gels. Ammunition in this group contains flammable liquids or gels other than those which are spontaneously flammable when exposed to water or the atmosphere.

Group K: Articles containing both an explosive substance and a toxic chemical agent. Articles in this group contain chemicals specifically designated for incapacitating effects more severe than lachrymation.

Group L: Explosive substance or article containing an explosive substance and presenting a special risk needing isolation of each type.

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

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

2 Mixed Storage - Special Circumstances

a) There may be special circumstances where the above mixing rules may be modified by the National Competent Authority subject to adequate technical justification based on tests where these are considered to be appropriate.

b) These special circumstances are likely to occur when a very small quantity of one hazard division is mixed with a large quantity of another hazard division. For example:

1. Very small quantity Hazard Division 1.1 and large quantity Hazard Division 1.2. It should be possible to arrange the storage in such a manner that the mixture will behave as 1.2.

2. High weight ratio Hazard Division 1.3 to Hazard Division 1.5. Generally, the fire risk will dominate, but under heavy confinement the risk of a mass explosion dominates. Therefore, the greater quantity-distance (Hazard Division 1.3 or Hazard Division 1.1) for the aggregate NEQ might be applicable having taken into account the relative quantities of Hazard Division 1.3 and Hazard Division 1.5.

3. Low weight ratio Hazard Division 1.3 to Hazard Division 1.5. The risk of a mass explosion is minimal and therefore the Hazard Division 1.3 quantity distances for the aggregate NEQ might be applied having taken into account the relative quantities of Hazard Division 1.3 and Hazard Division 1.5.

c) Mixing of Hazard Division 1.1, Hazard Division 1.2 and Hazard Division 1.3

The quantity-distance to be applied in this unusual circumstances is that which is the greatest when considering the aggregate NEQ as Hazard Division 1.1, Hazard Division 1.2 or Hazard Division 1.3.

d) With the exception of substances in Compatibility Group A, which should not be mixed with other compatibility groups, the mixing of substances and articles is permitted as shown in Tables 2 and 3. [5].

3 Description of achieved results

In order to organize and maintain an ammunition stockpile properly, the storage facility must be able to safely store and physically contain the various classes of ammunition and explosives and also have sufficient capacity to perform the necessary activities of a stockpile storage facility. National facilities supplying smaller, local facilities must have the capacity to handle large amounts of ammunition and have the ability to facilitate the staging and shipping of that ammunition. Smaller, local stockpile facilities must have the capacity to receive shipments of ammunition and provide adequate storage and security. In addition, the buildings must have the capacity to organize its stockpiles. Facilities must be large enough to facilitate the organization of various types of ammunition so that they are kept separate and not mixed with other incompatible stock.

4 Conclusion

A process for overall management of the quality of the ammunition and explosives must be established within the national system. Quality must be monitored upon initial receipt, while in storage and transport, during interim storage in other locations, during use by national authorities, during maintenance and finally during demilitarization. Continually observing and maintaining records on the condition of ammunition, explosive material, and detonating devices will aid both in ensuring safety for the facility and the surrounding areas and in increasing the cost-effectiveness of the stockpile facility. By constantly examining the condition of the ammunition, Participating States can identify deteriorated or unsafe ammunition and remove it from the stockpile. If ammunition stockpiles are managed properly, older ammunition can be used prior to the newer stocks, ensuring that the older ammunition does not deteriorate and require disposal.

Acknowledgements

Author are grateful for the support of experimental works by project of the Ministry of Defense of the Slovak Republic 123-25 / 2017.

References

- [1] Standard: NATO - Stanag 4397, NATO catalogue of explosives, 2009. [9] Standard: NATO - Stanag 4540, explosives, procedures for dynamic mechanical analysis (DMA) and determination of glass transition temperature, 2013, p.27.
- [2] P. Vicieník: Zásady bezpečnosti pro přepravu vojenské munice a výbušnin, Úřad pro obrannou standardizaci, katalogizaci a státní ověřování jakosti, Praha, 2007, p. 32.
- [3] Standard: NATO - Stanag 4657, NATO guidelines for the storage, maintenance and transport of ammunition on deployed missions or operations, 2009, p. 14.
- [4] Standard: NATO – AASTP-1, Manual of NATO safety principles for the storage of military ammunition and explosives, 2009, p. 287.
- [5] Standard: NATO - Stanag 4397, NATO catalogue of explosives, 2009. [9] Standard: NATO - Stanag 4540, explosives, procedures for dynamic mechanical analysis (DMA) and determination of glass transition temperature, 2013, p.27
- [6] L. Kučera: Bezpečná likvidace munice – Konstrukční principy a požadavky, hodnocení bezpečnosti, Úřad pro obrannou standardizaci, katalogizaci a státní ověřování jakosti, Praha, 2005, p. 6.
- [7] V.Cibulka: Charakterizovanie podmienok prevádzkových skúšok malokalibrového streliva po dlhodobom skladovaní, ICMT 2018, Medzinárodná konferencia o vojenských a špeciálnych technológiách, ISBN 978-8075-806-6.