

Fire and explosive hazards for explosives and ammunition storage

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Abstract: This report presents the different types of explosives. It presents a classification of explosives according to their sensitivity to external influences, as well as a classification of the permissible quantities of explosives, ammunition and pyrotechnic articles that can be safely stored in one room. An analysis was performed and the possibility of safely combined storage of explosives and ammunition was considered. The need of applying specific requirements for the design and exploitation of sites for the production, storage and trade of explosives, ammunition and pyrotechnic articles is described.

Keywords: EXPLOSIVE HAZARD, EXPLOSIVES, AMMUNITION, STORAGE

1. Introduction

Incidents involving the production and storage of explosives and ammunition carry risks for both staff and population, as well as the environment. One of the main issues for reducing the harmful effects of explosive and munitions incidents is the determination of their fire and explosive hazard. The sites for the production and storage of explosives and ammunition are of interest, both in terms of the requirements imposed in their design and construction, and in terms of the permissible quantities for the combined storage of explosives and ammunition.

In this regard, the report examines the types of explosives and the basic rules for ensuring safety in activities related to the production, use and storage of different types of explosives and ammunition. [1-5]

Explosives are chemical compounds or their mixtures capable of exploding under the influence of certain external effects, releasing heat and gases.

"Explosion" means the very rapid transformation of a substance or mixture of substances from one state to another, which is accompanied by the release of heat and the formation of gases and vapors capable of mechanically destroying and displacing the environment.

2. Classification, comparison and analyses of explosives

According to Ordinance No. RD-02-20-1 of January 19, 2017 on the planning and design of constructions intended for the production, storage and trading of weapons, ammunition, explosives and pyrotechnic articles, depending on their sensitivity to External impacts and how explosives are used, explosives are divided into:

1. Initiating (primary);
2. Blasting (secondary):
 - a) explosive compounds;
 - b) explosive mechanical mixtures;
3. Throwing (gunpowder);
4. Pyrotechnic compositions (mixtures and articles).

The types of explosives and their basic representatives, depending on their sensitivity to external influences, are divided into four groups and are discussed in Table. 1.

Table 1: Classification of explosives depending on their sensitivity to external influences [6]

№	Types of explosives	Basic representatives
1.	Initiating (primary) explosives	- diazodinitrophenol; - thundering mercury (mercury fulminate); - lead azide; - teneres (lead trinitroresorcinat or TNRS); - initiating mixtures and compositions of mercury, potassium chlorate (berthollet salt), ammonium sulfide (antimony), etc.
2.	Blasting (secondary) explosives: a) explosive compounds b) mechanical explosive mixtures	- tan, hexogen, octogen, tetryl, TNT, nitroglycerin, nitroglycol, picric acid, dinitronaphthalene, nitropentane and others. - nitrosilitrenes (dynamites); - dynamos; - plastic; - ammonium nitrate; - naphthalenes; - water-filled; - emulsion, etc.
3.	Throwing (gunpowder)	- smoke gunpowder - all types; - smokeless pyroxylin and nitroglycerin gunpowder - all types – etc.
4.	Pyrotechnic compositions and articles	compositions and articles having inflammatory, tear, smoke, sound, light and other effects

The initiating explosives are used to initiate the explosion (fig.1). They are very sensitive to temperature and mechanical influences. For this reason, they are used for the production of capsule igniters or detonator capsules. The most commonly used are mercury, lead azide, lead trinitroresorcinat and others.



Fig. 1 Initiation of an explosion

Blasting explosives are used in military equipment as projectiles, as well as for the preparation of explosives. They are also used for blasting in the mining industry. The most common explosives are TNT, ammonol (a mixture of TNT, ammonium nitrate and other substances), melinite, hexogen in the alloy with TNT, dynamite and many others (fig.2).



Fig. 2 Explosion

Metal explosives or gunpowder (fig.3) do not detonate but burn. They are mainly used for the production of shots - giving a bullet or cannon to a firearm, as well as for propelling rockets and some rockets. The most common are pyroxylin and nitroglycerin gunpowder.



Fig. 3 Gunpowder

Pyrotechnic mixtures and articles can be lighting, signaling, incendiary and can be used for the preparation of special ammunition. When burned, they give a pyrotechnic effect (fig.4).



Fig. 4 Pyrotechnic effect

The fire and explosion hazard of storing explosives, ammunition and pyrotechnic articles depends on the quantities of stored substances and materials, as well as on the possibility of storing the various articles in one room. A major problem with the storage of explosives is the storage of large quantities of materials, as well as the storage of explosives and ammunition that are not compatible for storage in one room or site. This, in turn, is a prerequisite for the occurrence of serious incidents with permanent material and non-material damage to the building stock, environment, life and health of the staff and population. Ordinance No. RD-02-20-1 of January 19, 2017 on the planning and design of constructions intended for the production, storage and trading of weapons, ammunition, explosives and pyrotechnic articles defines the maximum permissible quantities of different types of explosives, ammunition and pyrotechnic articles for storage in one room, depending on their degree of explosion hazard.

Table 2 presents the classification of explosives, ammunition and pyrotechnic articles and their permissible quantities placed in one room, identifying thirteen compatibility groups.

Table 2: Classification of explosives, depending on their sensibility to external influences and permissible quantities placed in one room [6]

No	Description of the explosive or article	Compatibility group	Permissible quantity in one room
1.	Primary explosives	A	150 kg
2.	A product containing primary explosives and not having two or more reliable safety devices. Some articles are also included, although they do not contain primary explosives, such as explosion detonators, assembled detonator components, capsule igniters	B	2 000 000 pcs.
3.	Throwing explosives or other explosive deflagrant or article containing such substance	C	100 t
4.	Secondary detonating BB (pure chemical compounds or mechanical mixtures) or black gunpowder	D	50 t ^a
	Secondary detonating explosive device, in any case without fuse or throwing charge, or primary explosive device and equipped with two or more reliable safety devices		150 t ^b

5.	Product containing explosion-free secondary detonation BB with metallic charge (other than charge containing flammable liquid or gel or hypergolic liquids)	E	150 t
6.	Product containing secondary detonation explosive, self-igniting, with a metallic charge (other than a charge containing flammable liquid or gel or hypergolic liquids) or with no metallic charge	F	150 t
7.	A pyrotechnic substance or article containing a pyrotechnic substance or an article containing both explosive and a substance having a luminous, inflammatory, tear-forming or smoke-forming effect (other than a water-active article or article containing white phosphorus, phosphides, pyrophoric substance, inflammatory fluid)	G	50 t ^c
8.	A product containing both explosive and white phosphorus	H	150 t
9.	A product containing both explosive and a flammable liquid or gel	J	150 t
10.	A product containing both explosive and a toxic chemical agent	K	150 t
11.	Explosive or substance or article containing explosive and presenting a particular risk (eg due to its water activity or the presence of hypergolic fluids, phosphides or pyrophoric substance) and necessitating the isolation of any species	L	150 t
12.	A product containing only substances with extremely low sensitivity to detonation	N	150 t
13.	Substance or article packaged or designed to limit within the package any hazardous effects caused by accidental actuation and, in the event of damage to the package in the event of fire, all effects of the explosion or the ejection of particles are so minor that almost no prevent fire fighting and other emergency measures in the immediate vicinity of the package	S	without restriction if it meets the relevant test of product

* The markings in the table are as follows:

a - the figure refers to pure chemicals in crystalline type and articles thereof.

b - converted to TNT.

c - calculated quantity in pyrotechnic mixture.

The exploitation of sites related to the production and storage of explosives, ammunition and pyrotechnic articles have a high risk of accidents and incidents. Due to the high fire and explosion

hazard, the facilities for the production and storage of explosives, ammunition and pyrotechnic articles have the risk of explosion, significant harmful effects on the environment or the spread of toxic or harmful substances during their exploitation. In this regard, an emergency plan of action is required for these sites, which contains:

- the biggest possible consequences for the staff, the population and the environment from an accident at the site, determined on the basis of a risk assessment;
- measures for limiting and eliminating the consequences of an accident at the site;
- personnel protection measures;
- the allocation of responsibilities and responsible structures and persons for the implementation of the envisaged measures;
- the resources needed to implement the measures;
- the time, necessary to be prepared for response and the procedure for informing the executive authorities when necessary to introduce disaster protection plans. [7]

In the planning and design and construction of sites for weapons, ammunition, explosives and pyrotechnic articles, qualitative and quantitative analyzes must be carried out in order to determine the type of explosion hazard, depending on the type and estimated quantity of the produced and / or stored weapons, ammunition, explosives and pyrotechnic articles, as well as risk assessment and management. Due to the high fire and explosive danger of explosives, firearms and ammunition, specific requirements are made to the sites for their production and storage, in terms of their location, the distance to neighboring buildings and equipment, electrical installations and etc. The specific requirements are intended to ensure safe distances for people and property inside and outside the territory of the sites that produce and store weapons, explosives and ammunition, as well as environmental hazards.

Depending on the degree of danger in the production, transportation, storage and exploitation, explosive materials can be divided into five groups:

1. First group - explosives with a content of nitroesters above 15% (dynamite), hexogen, tetryl, nitropenta, octagen;
2. Second group - ammonium nitrate explosives, TNT, mixtures of TNT with other nitro compounds, dinitrotoluene, dinitronaphthalene, explosives with a content of nitroesters up to 15%, phlegmatized hexogen, detonating cord, petroleum nitrates, emulsifiable;
3. Third group - smoke gunpowder, smokeless gunpowder, pyrotechnic compositions and articles made of them, fire-fighting cord and means for its ignition;
4. Fourth group - capsule detonators, detonators, delayers for detonating cord, non-electric systems and other explosive means;
5. Fifth group - finally fired explosive devices and anti-theft devices.

When carrying out explosive works, as well as any kind of activities related to explosives and ammunition, in view of their high fire and explosive characteristics, it is necessary to observe strict safety rules:

- explosive materials with different hazard groups are stored and transported / transported separately;
- the explosive materials are packed in such a way that they do not allow movement in the packaging;
- the gross mass of one pack of explosive materials may not exceed 32 kg;
- polymer and other materials with antistatic properties are used in the production and packaging of explosive materials;
- when carrying out blasting operations or other activities involving blasting materials, persons who are not related to their performance are not allowed in the protected area;

- explosive materials are not allowed to be thrown, dragged, overturned, struck or rubbed;
- maximum safety at work must be ensured when operating explosive materials;
- it is forbidden to smoke, to light a fire, to carry out fire and other open fire work at a distance of less than 100 m from the place where explosive materials are located;
- all activities with frozen nitro-explosives having a content of nitroesters above 15% are prohibited, except for defrosting.

For international transport (import, export and transit), it is also necessary to comply with the international norms of separation according to the degree of danger and compatibility. [8]

3. Conclusions

In conclusion, it can be noted that the study, classification and analysis of the types of explosives with regard to their fire and explosive hazards contributes to their adequate identification and proper risk assessment in the production, storage and handling of them.

The identification of hazards, the providing of safe distances for people and property inside and outside the territory of the sites that produce and store weapons, explosives and ammunition, as well as environmental hazards is a prerequisite for avoiding enormous property and human losses.

Proper identification of the fire and explosive hazard of different types of explosives and ammunition leads to a significant reduction in the risk of accidents and to the reduction of their consequences.

Compliance with the regulatory requirements, regulated by laws and regulations, minimizes the damage caused by incidents and accidents with explosives.

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