

Transport of Munitions in the Light of ADR

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Abstract

This article explains the concepts of explosives and hazardous materials. It presents the legal framework governing the road transport of hazardous goods. It discusses the classification of hazardous materials, with particular emphasis on Class 1, and outlines the rules for labelling, loading, and transporting Class 1 explosives.

Keywords: transport, explosives, hazardous materials, ADR regulations.

ENTRY

The state defence system includes various formations of the Polish Armed Forces.

Based on their specific operations, they can be divided into five types. These include the land forces, air forces, navy, special forces, and territorial defence forces. However, the thing that unites them is warfare, i.e., products containing explosives. Warfare includes, among others, ammunition, mine-barrier weapons, weapons of mass destruction defence, air and sea warfare assets, missiles, pyrotechnics, ammunition, and training and simulation combat assets. Pursuant to Article 98 of the Act of 19 August 2011 on the transport of dangerous goods, which specifies the rules for conducting activities in the field of domestic and international road, rail, and inland waterway transport of dangerous goods, as well as the authorities and units performing tasks related to this transport [1]. The authorities in the field of domestic transport of dangerous goods by means of transport belonging to the Armed Forces of the Republic of Poland are the Head of the Inspectorate for Support of the Armed Forces and the Head of the Military Technical Supervision, who are subject to the supervision of the Minister of National Defence. In the road transport of goods, we can find terms related to explosives and hazardous materials. Within the meaning of the Act of 22 June 2001 on the performance of business activities in the field of production and trade in explosives, weapons, ammunition, and products and technology for military or police purposes, and the Act of 21 June 2002 on explosives intended for civilian use, explosives are solid or liquid

chemical substances or mixtures of substances (explosive compositions) capable of a rapid exothermic chemical reaction, as a result of which a gas is produced at a temperature and pressure causing damage to the surrounding environment and products filled with explosives [2]. Whereas hazardous materials are within the meaning of the Regulation of the Minister of Labour and Social Policy of 26 September 1997 on general occupational health and safety regulations hazardous substances or hazardous mixtures and materials containing harmful biological agents classified as hazard groups 3 or 4 in accordance with the regulations issued on the basis of Art. 222¹ § 3Act - Labour Code [3]. Within the meaning of the above definitions, explosives strictly fall within the category of hazardous materials and are treated as class 1 hazardous materials.

1. LEGAL FRAMEWORKS THAT REGULATE THE ROAD TRANSPORT OF DANGEROUS GOODS

The general and specific conditions for road transport are contained in the provisions of the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), signed on September 30, 1957, in Geneva and issued by the European Road Transport Committee. The ADR Agreement is the result of many years of work by an international group of specialists in various fields of science and technology, including road transport, chemistry, physics, environmental protection, and others. It deserves to be called the main legislative act in the field of road transport. The provisions of the ADR agreement are amended every two years, at the beginning of odd years, at the forum of the United Nations Economic Commission for Europe [4].

2. CLASSIFICATION OF EXPLOSIVE AND HAZARDOUS MATERIALS

2.1 Discussion of the Division of Explosives Based on the Journal of Laws of 04/10/2019, Item 1888

Pursuant to the Regulation of the Council of Ministers of 17 September 2019, Journal of Laws of 4 October 2019, item 188, on the classification of types of explosives, weapons, ammunition and products and technologies for military or police use, the production or trade in which requires a license, explosives are classified as follows: Primary explosives - explosives highly sensitive to mechanical stimuli: impact, friction or electric spark and to thermal stimuli: flame or high temperature, used to

generate an appropriate energy impulse ensuring the activation of the basic charge made of another type of explosive. High-energy explosives - high-energy explosives with lower sensitivity to external stimuli (than in the case of primary explosives), whose basic form of transformation is detonation, thanks to which charges made of them are characterised by a high ability to perform work (e.g. demolition, crushing or fragmentation). Propellant explosives - explosives used primarily in the form of powder propellant charges as a source of energy to accelerate firearms, artillery, and rocket projectiles. They are also used in the production of pyrotechnic retarders, powder primers, and powder fuses. Pyrotechnic materials - materials or mixtures of materials intended to produce heat, light, sound, gas, smoke effects or a combination of these effects as a result of a non-detonating, self-sustaining, exothermic chemical reaction, as well as products filled with pyrotechnic materials [5].

2.2 Overview of Dangerous Goods by Class and Classification Code

Dangerous goods in land transport are divided into 13 classes based on their predominant hazard. Goods are assigned individual or group UN identification numbers _ _ _ . According to the degree of hazard posed by goods belonging to the same class, they are assigned so-called packing groups. Group I – the highest hazard, Group II – medium hazard, Group III – the lowest hazard. In addition to the predominant hazard corresponding to the class name, dangerous goods may also have one or more additional hazards. This hazard is determined based on the criteria appropriate for the classes in which these hazards are predominant. Dangerous goods of all classes, except for class 7, they have classification codes consisting of letters and numbers. These codes are given in the list of dangerous goods in the column "**Classification code/description**". Letters occurring in codes excluding class 1 they indicate hazards and are the first letters appearing in the names of these hazards in English. The numbers and names of classes and the UN number are presented in Table 1.

Table 1. Classes of dangerous goods [6]

Class number and name	
1	Explosives and explosive items
2	Gas
3	Flammable liquids
4.1	Flammable solids, self-reactive substances, polymerising substances and solid desensitised explosives
4.2	Materials susceptible to spontaneous combustion

4.3	Materials that release flammable gases when in contact with water
5.1	Oxidising materials
5.2	Organic peroxides
6.1	Poisonous materials
6.2	Infectious materials
7	Radioactive materials
8	Corrosive materials
9	Various hazardous materials and items

3. DETAILED OVERVIEW OF CLASS 1 (EXPLOSIVES AND EXPLOSIVE ARTICLES)

Due to the subject matter of this article, attention will be paid to class 1, which denotes EXPLOSIVES AND ARTICLES CONTAINING EXPLOSIVES – hazards include mass explosion, fragmentation, intense fire, and heat generation. Classification codes for Class 1 goods consist of the subclass number, as shown in Table 2.

Table 2. List of subclasses and their description [7]

Subclass	Description
1.1	Materials and objects posing a risk of a mass explosion involving the entire load.
1.2	Materials and objects posing a projection hazard do not cause a mass explosion.
1.3	Materials and objects that pose a fire hazard and a low explosion or projection hazard, but no mass explosion hazard.
Subsidiary risks for the above subclasses: toxic or corrosive effects, chemical burns and corrosive effects on metals in the event of contact with released UN material: 0015, 0016, 0018, 0019, 0076, 0143, 0224.	
1.4	Materials and items posing a low risk of explosion and fire, usually limited to a single package.
Subsidiary risks for the above division: toxic or corrosive effects, chemical burns and corrosive effects on metals in the event of contact with released material from ammunition UN: 0301, 0303.	
1.5	Low-sensitivity explosives with a mass explosion hazard – the possibility of their initiation or transition from ignition to detonation during transport is very small.
1.6	Items of extremely low sensitivity that do not pose a mass explosion hazard; the explosion is limited to one item.

The correct classification code should also consist of the compatibility group letter, which is illustrated in Table 3.

Table 3. List of compatibility groups of materials and objects of class 1 [7]

Compatibility Group	Description
A	Primary explosive.
B	An article with a primary explosive or an article containing no primary explosive, such as a fuse, fuse set, or primer.
C	A propellant or deflagrating explosive or an article containing such a substance.
D	Secondary detonating explosive, black powder or articles with secondary detonating explosive, without means of initiation and without a propelling charge, or an article with at least a primary explosive, with at least two safety devices.
AND	An article with a secondary detonating explosive and a propelling charge, without a means of initiation (no flammable liquid, pyrophoric liquid or gel).
F	An article with a secondary detonating explosive with its own means of initiation, with or without a propelling charge (no flammable liquid, pyrophoric liquid or gel).
G	A pyrotechnic substance, an item containing a pyrotechnic substance, or an item containing an explosive substance and an illuminating, incendiary, tear-producing or smoke-producing substance (excluding items activated by water or containing white phosphorus, phosphides, a pyrophoric substance, a flammable or pyrophoric liquid or gel).
H	An item with explosives and white phosphorus.
J	Item with explosives and flammable liquid or gel.
K	An item containing explosives and a poisonous chemical.
L	An explosive substance or articles containing an explosive substance that poses a special hazard (e.g. susceptible to activation by water or containing pyrophoric liquids, phosphides or pyrophoric materials).
N	Items containing only extremely insensitive explosives.
S	A material or article packaged or constructed so that the hazardous effects of its accidental operation are confined to the interior of the package and, in the event of its destruction by fire, explosion or projection, allow rescue operations to be carried out in the vicinity of the package.

3.1 Marking of Class 1 Dangerous Goods

All packages (packages) containing dangerous goods, including warfare agents, must be labelled in accordance with the models shown in Figure 1. For subclasses 1.1, 1.2 and 1.3 we use the same model warning label No. 1, which contains a black symbol in the form of an "exploding bomb" on an orange background, with the specific subclass number and the number 1 in the bottom corner. The remaining labels No. 1.4, 1.5 and 1.6 contain black numbers on an orange background.

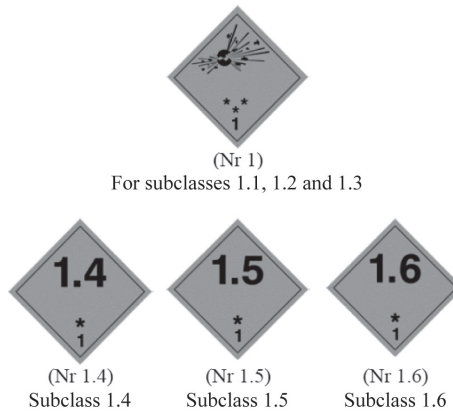


Fig. 1. Templates of warning labels used for class 1.

3.2 Labelling of Packages Containing Dangerous Goods

Packaging used in ADR transport must meet specific standards to ensure safety during transport. Hazardous materials should be packed in high-quality packaging to withstand the rigors of transport and loading and unloading operations. The packaging should be resistant to transport conditions such as vibration, changes in temperature, pressure, and humidity. The packaging should be closed according to the manufacturer's instructions. Four basic types of packaging are used in ADR transport:

- P – packaging with a capacity of up to 450 litres or 400 kg net (boxes, drums or canisters);
- ICB – large bulk containers, abbreviated as DPPL, with a capacity of more than 3000 litres (prohibited for use with 1 GP liquids);
- R – light metal packaging with a capacity of up to 40 litres or 50 kg net (not suitable for liquids 1 GP);
- LP – large packaging with a capacity of not more than 3 m³, consisting of an outer packaging containing items or inner packaging with a total weight exceeding 400 kg or 450 litres of capacity.

Furthermore, packaging can be divided into types and materials. In terms of types, we can distinguish:

- light metal packaging (up to 40 litres/50 kg) (0)
- drum (1);
- canister (up to 60 litres/120 kg) (3);
- chest (4);

- bag (up to 50 kg) (5);
- composite packaging (6);
- Rigid IBCs for solids loaded and unloaded by gravity (11);
- Flexible IBCs for solids loaded and discharged at a pressure higher than 10 kPa (13);
- Rigid IBC for liquids (31);
- large rigid packaging (50);
- large flexible packaging (51).

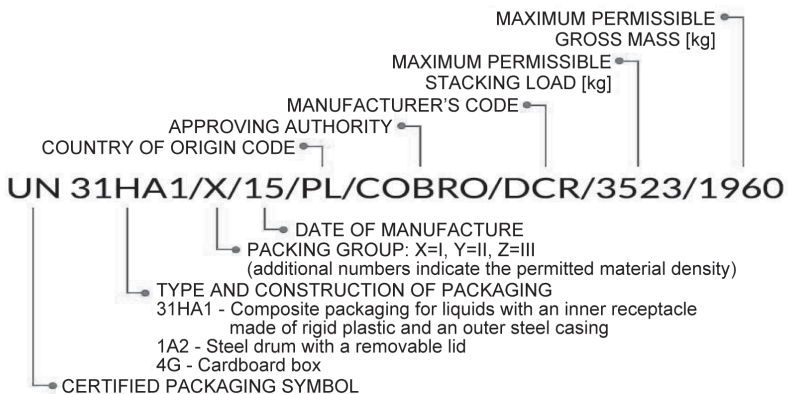
When it comes to packaging materials, we distinguish:

- became (A);
- aluminium (B);
- wood (C);
- plywood (D);
- wood-based material (F);
- cardboard (G);
- plastic (H);
- fibre (L);
- multi-layer paper (M);
- metal other than steel or aluminium (N);
- glass, porcelain or stoneware (P).

The numbers and letters in parentheses indicate the certification code. Every package for the transport of hazardous materials must be certified. In Poland, this is handled by the Central Packaging Research and Development Centre (*Pl.*: COBRO). The certification marking consists of the following elements: UN symbol - confirms that the packaging meets the guidelines. An alternative is: "RID/ADR" symbol - used for composite packaging (glass, porcelain or stoneware) and light metal packaging that meet simplified conditions. Packaging code - identifies the type of package and consists of: an Arabic numeral indicating the type of packaging (e.g. drum, bag, box); a capital letter referring to the construction material (e.g. plywood, plastic, multi-layer paper); an Arabic numeral identifying the packaging category and type (e.g. with a removable lid, with dust-proof walls, without an insert or inner lining). Additionally, the packaging code may contain letter symbols with additional meaning, e.g.: T (emergency packaging) or V (special packaging). Packing group letter - indicates for which materials the packaging can be used. There are three letters:

- X - packaging for materials from packaging groups I, II and III;
- Y - packaging for materials from packaging groups II and III;
- Z - packaging for materials from packaging group III.

Labelling elements resulting from the physical state of the material and the type of specific packaging, e.g.: for solid materials - maximum gross mass in kg for packaging or inner packaging; for liquid materials - relative density of the liquid. The production date of the packaging, which depends on the type of package. We distinguish: for packaging - the last two digits of the year of production; for IBCs, large packaging, as well as plastic drums and canisters - the month and year of manufacture. Symbol of the country authorising the marking. Name of the certification body authorised by the competent authority. Manufacturer's name or other distinguishing mark. Additional markings, e.g.: load used during the stacking resistance test (kg) for IBCs and large packaging; tare (empty mass of the packaging in kg) - for metal, rigid plastic, composite, cardboard and wooden IBCs; manufacturer's serial number - for metal IBCs.



Outline. 2 COBRO Certification Code Example

4. RULES FOR LOADING AND TRANSPORTING SELECTED DANGEROUS GOODS

Not all hazardous materials are transportable under ADR regulations. This provides for a number of exclusions. These are total exclusions, in which case the provisions of the ADR agreement do not apply. Another example are partial exclusions, an example of which is the exclusion commonly referred to as exclusion 1.1.3.6. We call them this because the information regarding this exclusion are recorded in the Act in Annex A General provisions and regulations regarding dangerous materials and articles Section 1.1. Scope and Application 1.1.3 Exclusions 1.1.3.6 Exclusions regarding quantities transported in a transport unit.

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Table 4. The ADR Table 1.1.3 6. [8]

Transport category	Substances or articles Packing group or classification code / group or UN number	Maximum total quantity per transport unit ^b
(1)	(2)	(3)
	<p>Class 1 1.2A/1.1L/1.2L/1.3L and also UN 0190</p> <p>Class 3 UN 3343</p> <p>Class 4.2 Substances belonging to Packing Group I</p> <p>Class 4.3 UN 1183, 1242, 1295, 1340, 1390, 1403, 1928, 2813, 2965, 2968, 2988, 3129, 3130, 3131, 3132, 3134, 3148, 3396, 3398 and also 3399</p> <p>Class 5.1 UN 2426</p> <p>Class 6.1 UN 1051, 1600, 1613, 1614, 2312, 3250 and also 3294</p> <p>Class 7 UN 2912 to 2919, 2977, 2978 and 3321 to 3333</p> <p>Class 8 UN 2215 (MALEIC ANHYDRIDE, MOLTEN)</p> <p>Class 9 UN 2315, 3151, 3152 and 3432 and articles containing such substances or their mixtures</p> <p>and uncleaned empty packaging which has contained substances belonging to this category, except for packaging classified under UN 2908</p>	0
1	<p>Substances and articles belonging to Packing Group I which do not fall under transport category 0, and substances and articles of the following classes:</p> <p>Class 1 1.1B to 1.1J^a/1.2B to 1.2J/1.3C/1.3G/1.3H/1.3J/1.5D^a</p> <p>Class 2 Group T, TC^a, TO, TF, TOC* and also TFC aerosols of group C, CO, FC, T, TF, TC, TO, TFC and also TOC chemicals under pressure UN: 3502, 3503, 3504 and also 3505</p> <p>Class 4.1 UN 3221 to 3224, 3231 to 3240, 3533 and also 3543</p> <p>Class 5.2 UN 3103 to 3104 and 3111 to 3120</p>	20
2	<p>Substances belonging to Packing Group II which do not fall under transport categories 0, 1 and 4, and substances and articles of the following classes:</p> <p>Class 1 1.4 B to 1.4G and also 1.6N</p> <p>Class 2 Group F aerosols of group F chemicals under pressure with UN No. 3501</p> <p>Class 4.1 UN 3225 to 3230, 3531 and also 3532</p> <p>Class 4.3 UN 3292</p> <p>Class 5.1 UN 3356</p> <p>Class 5.2 UN 3105 to 3110</p> <p>Class 6.1 UN 1700, 2016 and 2017 and substances of Packing Group III</p> <p>Class 6.2 UN 3291</p> <p>Class 9 UN 3090, 3091, 3245, 3480, 3481 and also 3536</p>	333

3	<p>Substances belonging to Packing Group III which do not fall under transport categories 0, 2 and 4, and substances and articles of the following classes:</p> <p>Class 2 Groups A and O Aerosols of groups A and O chemicals under pressure UN 3500</p> <p>Class 3 UN 3473</p> <p>Class 4.3 UN 3476</p> <p>Class 8 UN 2794, 2795, 2800, 3028, 3477 and also 3506</p> <p>Class 9 UN 2990, 3072</p>	1 000
4	<p>Class 1 1.4S</p> <p>Class 2 UN 3537 to 3539</p> <p>Class 3 UN 3540</p> <p>Class 4.1 UN 1331, 1345, 1944, 1945, 2254, 2624 and also 3541</p> <p>Class 4.2 UN 1361 and 1362 belonging to Packing Group III and UN 3542</p> <p>Class 4.3 UN 3543</p> <p>Class 5.1 UN 3544</p> <p>Class 5.2 UN 3545</p> <p>Class 6.1 UN 3546</p> <p>Class 7 UN 2908 to 2911</p> <p>Class 8 UN 3547</p> <p>Class 9 UN 3268, 3499, 3508, 3509 and also 3548</p> <p>and uncleaned empty packaging which has contained dangerous goods other than those of transport category 0</p>	No limit

^a For UN numbers: 0081, 0082, 0084, 0241, 0331, 0332, 0482, 1005 and 1017, the maximum total quantity per transport unit is 50 kg.

^b The maximum total quantity specified for each transport category corresponds to a calculated value of "1000" (see also 1.1.3.6.4).

The entries in the above table are used as follows:

In the case of dangerous goods that are classified in the same transport category, the values presented in column 3 of the maximum total quantity per transport unit apply, which are as follows:

- for transport category 0 – **we cannot use this exclusion;**
- for transport category 1 – the maximum quantity is 20 kilograms or litres;
- for transport category 2 – the maximum quantity is 333 kilograms or litres;
- for transport category 3 – the maximum quantity is 1000 kilograms or litres;
- for transport category 4 – no restrictions.

If we wish to transport dangerous goods belonging to different transport categories in the same transport unit, in accordance with the provisions of Act 1.1.13.6.4, we

apply a multiplier whose calculated value (sum) does not exceed "1000". We then apply the following multipliers:

- the number of materials belonging to transport category 1 is multiplied by "50";
- the amount of materials belonging to transport category 1 referred to in footnote a to the table is multiplied by "20";
- the number of materials belonging to transport category 2 is multiplied by "3"
- for transport category 3 we assume the multiplier "1".

The calculations do not include the quantity of goods in transport category 4.

For Class 1 dangerous goods with different compatibility groups, mixed loading is permitted only in the cases indicated in Table 7.5.2.2 of the ADR. The table and its symbols are shown below.

- "X" charging together is allowed;
- "a" packages containing articles of compatibility groups B and D may be loaded into one vehicle provided that they are effectively separated from each other, i.e. the risk of transmission of an explosion is excluded;
- "b" different types of articles classified under 1.6N may be carried with other 1.6N articles if it is demonstrated that there is no mass explosion hazard, otherwise the articles shall be considered as articles of Division 1.1;
- "c" if articles of compatibility group N are transported with materials of compatibility groups C, D or E then objects of compatibility group N should be considered as objects having the properties of dignity group D;
- "d" packages containing compatibility group L materials may be loaded together in the same vehicle with packages belonging to the same compatibility group.

Table 5. Loading Class 1 Materials and Objects Together, Taking Into Account Compatibility Groups [9]

Compatibility group	A	B	C	D	E	F	G	H	J	L	N	S
A	X											
B		X		a								X
C			X	X	X		X				b c	X
D		a	X	X	X		X				b c	X
E			X	X	X		X				b c	X
F						X						X
G			X	X	X		X					X
H												

Compatibility group	A	B	C	D	E	F	G	H	J	L	N	S
J									X			X
L										d		
N			bc	bc	bc						b	X
S		X	X	X	X	X	X	X	X		X	X

SUMMARY

Knowledge of the issues presented in the article regarding the correct classification of materials

and Class 1 explosives, as well as the rules for their proper labelling, packaging, loading, and transportation, is extremely important. It has a significant impact on the safety of road transport. Applying the provisions contained in the ADR agreement significantly reduces the risk of hazards in the event of unforeseen road situations, and in the event of dangerous situations, it allows the services arriving at the scene to quickly and easily recognise what danger they are facing.

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