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**Transport of Dangerous Goods by Vessels of Inland Shipping in  
the Light of ADN**

Key words: inland shipping, dangerous goods, transport

*The chief aim of the report is to bring closer the subject of dangerous goods in the aspect of their transport by vessels of inland navigation. There have been presented: the main features of latest regulations concerning transport of these goods by vessels of inland navigation – ADN; the degree of harmonisation with respective regulations in other transport branches; also the possibilities of applying ADN for transport of dangerous goods packaged and in solid and liquid state in bulk.*

**Transport ładunków niebezpiecznych statkami żeglugi  
śródlądowej w świetle ADN**

Słowa kluczowe: żegluga śródlądowa, ładunki niebezpieczne, transport

*Przybliżono temat transportu materiałów niebezpiecznych statkami żeglugi śródlądowej. Scharakteryzowano przepisy prawne dotyczące transportu tych materiałów zawarte w porozumieniu ADN, stopień harmonizacji tych przepisów z odpowiednimi przepisami odnoszącymi się do innych gałęzi transportu, a także możliwość zastosowania tych przepisów do transportu materiałów niebezpiecznych w opakowaniach oraz w postaci suchych i ciekłych ładunków masowych.*

## **Introduction**

Inland vessels are the most suitable means of transport of dangerous goods. This thesis is true on the condition that a modern specialist equipment of ships and berths is provided, as well as continuous monitoring of the transport process by a professional crew.

At present, inland navigation is the main means of transport of dangerous goods in Germany. In Holland, 60% of dangerous goods are transported by waterways. Considerable amounts of flammable and toxic liquid substances are safely transported by inland tankers, mainly liquid fuels (diesel oils, petrol), and liquid chemicals.

Poland's accession to the European Union poses new challenges for her in this range. The carriage of dangerous cargo by inland waterways has been insignificant so far. Even according to moderately pessimistic forecasts it has to be assumed that the fall persisting for many years in Polish inland shipping will be overcome.

Natural geographic conditions, positive models of West European countries and common sense speak in favour of taking maximum advantage of this transport branch as economically and ecologically justified.

In the case of dangerous goods another trump is higher safety of the carriage process than in other transport branches.

A significant role in limiting the accident rate and creating conditions for breakdown free carriage is played by regulations determining which cargoes can be carried by a given means of transport and in what way.

The appearance in 2003 of a new modified edition of regulations concerning the carriage of dangerous goods by vessels of inland shipping – European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN), taking into consideration the latest recommendations of the UN in the range of dangerous goods transport, testifies to a development of this transport branch, and simultaneously to the acceptance of translocating dangerous goods by vessels of inland shipping.

The aim of this paper is to bring closer the structure and content of ADN in the context of using inland vessels for the carriage of solid and liquid bulk cargo and general cargo.

## **Transport of dangerous goods of Polish foreign trade**

According to GUS statistics [7] there has been an insignificant increase in dangerous goods amount of Polish foreign trade carried by Polish and foreign carriers by inland waterways in 2003 in comparison to 2002.

Table 1

Transport of dangerous goods of Polish foreign trade by Polish and foreign carriers by inland waterways in 2002 and 2003

Cargo groups	2002		2003	
	Export	Import	Export	Import
Crude oil products: oil, petrol, kerosene	5,000	-	8,000	-
Products of chemical industry including:	320,000	11,000	443,000	7,000
- organic or inorganic chemicals	12,000	-	4,000	-
-fertilisers	308,000	1,000	439,000	4,000
Total	325,000	12,000	451,000	11,000

*Source:* Transport-Activity Results of GUS in: 2002, 2003. Information and Statistical Studies, Warsaw

In 2003, with little import, only 8,000 t of crude oil products were exported and 443,000 t of chemical products, mainly fertilisers, most of which are nitrate fertilisers, i.e. dangerous goods of oxidizing nature. This constituted 122,000 t of exported goods more than in 2002. This small growth does not settle the issue of generally insignificant amounts of dangerous cargo carried by inland vessels.

## **Harmonizing ADN with regulations concerning carriage of dangerous goods by other transport branches**

It is assumed that the fulfilment of the requirements of the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways ensures the carriage of such goods in a way that does not endanger navigational traffic, restricts the probability of accidents menacing the life and health of vessels' crews and decreases environmental pollution.

The latest amended edition of this agreement [3] includes the Annexed Regulations, as revised of 1<sup>st</sup> January 2003, which take into consideration the need to harmonise ADN requirements with agreements, regulations and codices which control the carriage of dangerous goods by other means of transport. The chief purpose of this harmonisation is to create optimal conditions facilitating the development of international multimodal transport.

The change in the structure and content of the ADN was based on Model Regulations annexed to the twelfth revised edition of the UN Recommendations of the Transport of Dangerous Goods and the new structure of the 2003 version of the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) [5]. The novelty of the restructured ADN consists in maximum simplification of systems and content which according to the authors introduces a user-friendly clarity of form. The following have been gained by restructuring of the regulations:

- rational (in the authors' opinion) division of content into subject parts,
- an arrangement of carriage requirements in tabular form, in which dangerous goods are arranged according to identification numbers (UN Numbers),
- supplementing this arrangement with an alphabetical list of dangerous goods facilitates the quick finding of a particular cargo.

Apart from structural changes there have been introduced numerous changes pertaining to the content, as well as new data which standardise the technical requirements concerning carriage of cargo by means of inland transport by conforming it to other means of transport. An indisputable advantage of this harmonisation is the unambiguous marking of the goods, which does not change during the whole transport cycle in the "house-to-house" relation, by assigning the proper name and recognition number (UN No.), thus permitting a perfect identification of these goods at any point of the delivery chain.

Uniform systems of classification, terminology, carriage forms, packaging and marking eliminate technical barriers in the flow of cargoes at junction points of land, water and air transport, thereby increasing safety and shortening the time of the carriage process.

The degree of harmonisation of ADN content with comparable regulations in other transport branches is considerable. The conception of carriage requirements in nine parts and their range of subjects correspond to the one accepted in ADR. In the latest edition of International Maritime Dangerous Goods Code of 2002 [3], carriage requirements were depicted in seven parts, the titles and scope of which correspond exactly to parts 1 to 7 of ADN and ADR. The IMDG Code does not contain parts 8 and 9, in which requirements are

given by ADN concerning: documents, training of surveyors, ship construction and technological equipment.

## **Characteristics of quantity and kind of cargoes included in ADN**

The total number of dangerous goods included in ADN marked as UN No. or ID No. equals 2744. The inconsistency between this number and the latest value given in Dangerous Goods List, i.e. 3376, results from an intended incomplete use made of all UN Numbers, as it is expected that the list will be supplemented by new dangerous cargoes introduced into the goods turnover. The list also includes goods which it is prohibited to carry, unless additional conditions are met, which increase the transport safety. Dangerous goods which are not to be accepted for carriage are also listed in sub-sections of every class. It is there that additional requirements are given, the fulfilment of which permits their carriage by inland vessels.

ADN embraces all forms of dangerous goods carriage: in bulk (liquid and solid state) and packaged.

The form of carriage of dangerous cargoes by inland vessels is marked in the Dangerous Goods List by proper symbols:

- B – solid cargoes, which can be carried packaged and in bulk,
- TB – solid cargoes, including flammable liquids, permitted carriage packaged and in bulk,
- T – liquid cargoes, carriage permitted packaged and in bulk,
- P – cargoes which can be carried only packaged have not been assigned any symbols in the Dangerous Goods List. The symbol “P” (English “packaging”) has been created solely for the purposes of this paper.

Similar to other regulations concerning transport of dangerous goods, all of them have been classified in the ADN with respect to threat created, in 9 classes; in classes 4, 5, and 6 subclasses have been singled out.

The shares expressed in numbers showing the proportions of state (liquid or solid) and form of carriage and the kind of threat created (class number) in the total number of dangerous goods included in ADN have been presented in Table 2.

Table 2

States of aggregation and forms of dangerous goods carriage permitted by ADN, with consideration to kind of danger, in numerical depiction

Form of carriage	Total number of goods	Danger class								
		1	2	3	4	5	6	7	8	9
B	46	-	-	-	18	18	3	2	2	4
TB	1	-	-	-	1	-	-	-	-	-
T	336	-	17	163	1	1	64	-	86	4
P	2361	367	206	419	321	145	599	23	260	20
Total	2744	367	223	582	341	164	666	25	348	28

Source: own study on the basis of ADN

The percentage depiction of various states of aggregations and forms of dangerous goods carriage permitted by the Agreement has been presented in Figure 1.

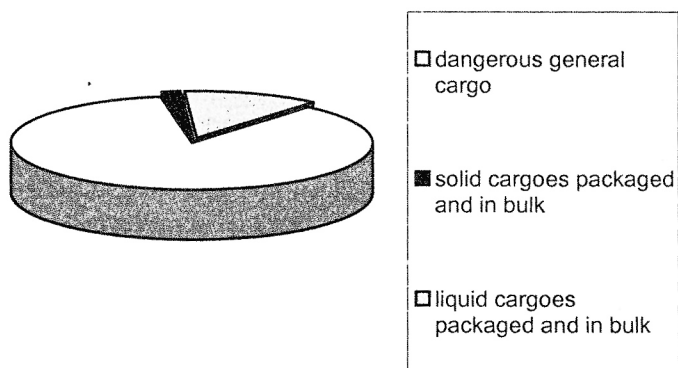


Fig. 1. States of aggregation and forms of dangerous goods carriage in percentage depiction

Source: own study on the basis of ADN

It follows from the comparison and graph (Figure 1) that only less than 14% of dangerous goods of the total number included in ADN can be carried both in bulk and packaged. The remaining overwhelming 86% are goods dangerous enough to require some form of protection like packages, selected according to danger degree and classified in three groups, I, II, III with descending technical and operational requirements.

A further, more detailed analysis showed that among cargoes which according to ADN may be carried in bulk, solid bulk cargoes make up only 1.7%.

Dangerous goods representative for this group divided into classes have been given in Table 3.

Table 3

Representative dangerous goods of type B

Class	Numbers of dangerous goods in ADN	Name and description
4.1	2	Naphthalene, Sulphur
4.2	11	Copra; Cotton Waste, oily; Cotton, Wet; Fibres or Fabrics, Animal or Vegetable or Synthetic, N.O.S. with Oil; Iron Oxide; Seed Cake; Maneb; Ferrous Metal: Borings, Shavings, Turnings or Cuttings in a form liable to self-heating, Self-heating solid, Inorganic, N.O.S.
4.3	4	Aluminium Silicon Powder, Uncoated; Ferrisilicon; Zinc Ashes;
5.1	18	Sodium nitrate; Calcium nitrate; Potassium nitrate; Ammonium Nitrate and other nitrates; Nitrates: Sodium, Calcium, Potassium, Ammonium
6.1	3	Fluorides: Sodium, Potassium, Ammonium
7	2	Radioactive Material Low Specific Activity (LSA-I) non-fissile or fissile-excepted Radioactive Material Surface Contaminated Objects, non-fissile or fissile-excepted
8	2	Ammonium Hydrogen Sulphate; Potassium Hydrogen Sulphate
9	4	Fish Meal, Castor Beans

Source: own study on the basis of ADN

No complete list of type-B goods has been given in Table 3. The most representative cargoes have been mentioned which often occur in other means of transports.

Over 63% of solid goods admitted for carriage in bulk is made up by Substances liable to spontaneous combustion (Class 4.2) and Oxidizing substances (Class 5.1), i.e. such, which are not always flammable themselves, but whose characteristic feature is the ability to keep up burning, but also a tendency to self-decomposition.

Table 4

Representative dangerous goods of type T

Class	Numbers of dangerous goods in ADN	Names and descriptions
2	17	Ammonia, anhydrous; Butane, Propylene; Dimethyl ether, Vinyl chloride
3	81	Acetone; Benzene, Aerolein, stabilized; Carbon Disulphide; Chlorobenzene; Dioxan; Ethanol; Formaldehydes; Gas oil or Diesel Fuel; Methanol; Petroleum Crude Oil; Ksylenes; Ethers
4.1	1	Sulphur molten
5.1	1	Hydrogen peroxide, aqueous solution with not less than 20% but not more than 60% hydrogen peroxide (stabilized as necessary)
6.1	1	Nitrites, toxic. N.O.S.; Nitrobenzene; Trichloroethylene; Chloroform
8	86	Acids: Sulphuric acid; Ammonia solution; Hydrochloric acid; Phosphoric acid; Hydroxides: Potassium hydroxide solution; Sodium hydroxide, solid; Acetic acid solution; Fuel, Aviation, Turbine; Nitric acid, Acrylic acid
9	4	Environmentally hazardous substances, solid N.O.S.; Substances with Flash-Point above 61°C and not more than 100°C

*Source:* own study on the basis of ADN

Liquid goods that can be carried in bulk (of type T) are in 92.85% flammable liquids (Class 3), toxic substances (Class 6.1) and caustic substances (Class 8).

What deserves to be stressed is the possibility of being carried by inland tankers of liquid in bulk sulphur, which is the only representative of class 4.1,



i.e. named – Flammable solids, self-reactive substances and solid desensitized explosives, and at the same time a traditionally liquid cargo in sea-going vessels.

As follows from an analysis presented in Table 3, for a total number of 2744 dangerous goods, according to ADN rules only 14% can be carried in bulk. The danger degree of the remaining 86% is so high that it is necessary to apply protection in the form of packaging, selected depending on the degree of danger of the goods, classified in three groups: I, II, III, in descending order of operational requirements.

The dispersion of amount of dangerous goods in particular ADN classes is very large and changes in the range from 25 to 666.

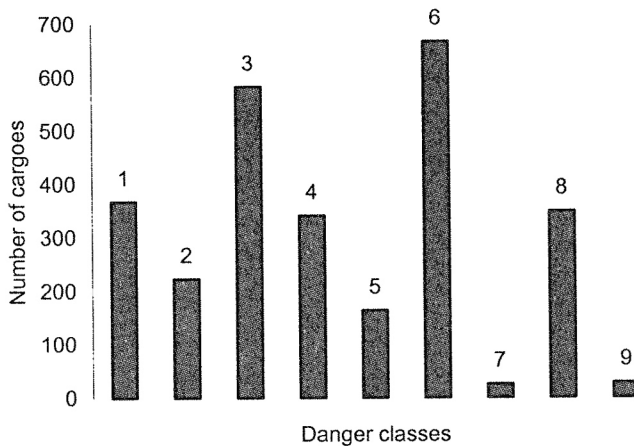


Fig. 2. Share of dangerous cargoes of particular classes carried by inland navigation vessels in numerical depiction

*Source:* own study on the basis of ADN

In the total number of cargoes contained in ADN, regardless of carriage form (in bulk or packaged), almost half (45.4%) is constituted by toxic substances (Class 6.1) and flammable liquids (Class 3).

## **Dangerous Goods List**

ADN contains three lists of dangerous goods:

- list in numerical order (Table A),
- list in alphabetical order (Table B),
- list accepted for carriage in tank vessels in numerical order (Table C).

The main list is the one containing an inventory of cargoes according to UN No compiled in tabular form, where the following pieces of information are given in successive cells:

- UN No. or ID No.; Name and description; Class; Classification Code; Packaging Group; Labels; Special Provisions; Limited quantities; Information of permitted carriage form (B, T, TB and in packagings); Equipment required; Ventilation; Provisions concerning loading, unloading and carriage; Number of cones, blue lights (on inland ships); Remarks.

The cell named "Remarks" is almost in all cases empty. Descriptions given after names (entries) are very laconic.

From this follows the present writer's reservation concerning the direction of changes in content and structure of the ADN and ADR. A tabular lay-out naturally imposes a compact and terse presentation of particular cargoes, which considerably restricts the possibilities of their more accurate characteristics.

In the IMDG Code edition from before 2000 each cargo had an individual card of its own containing information about the properties of the dangerous cargo, which provided a basis for classing it in a certain group; apart from that, properties important for the carriage process (e.g. flash point, explosiveness range, kind of toxicity etc.), the chemical formula, also the package group, which facilitated the selection of suitable packaging and estimation of this selection by the carrier, the required danger label, as well as stowage and segregation requirements.

In IMDG Codes published in 2000 and 2002, in accordance with the principle of harmonisation with carriage regulations in other transport branches, individual cards were replaced by tabular form entitled "Dangerous Goods List and Limited Quantities Exceptions." The last cell of the table, named "Properties and Observations", in a considerably restricted scope gives concise characteristics of the cargoes.

Lack of so much information (empty cell "Remarks") makes the user, before making his decision about the carriage, perform a penetrative search of the whole, very extensive contents of the regulations, and look for other literature to find the data.

In contrast to the small number of data, a positive aspect of the ADN is the introduction for each kind of goods of a Classification Code, and then making use of it in "decision trees", which is of particular significance in the case of N.O.S. cargoes. The application of classification codes has been presented in Table 5 on the example of a substance with oxidization properties of Class 5.1.

Table 5

Classification codes of dangerous goods with oxidation properties of Class 5.1 according to ADN

Classification Code	Description
0	Oxidizing substances without subsidiary risk or articles containing such substances
01	Liquid
02	Solid
03	Articles
OF	Oxidizing substances, solid, flammable
OS	Oxidizing substances, solid, self-heating
OW	Oxidizing substances, solid, which in contact with water emit flammable gases;
OT	Oxidizing substances, toxic:
OT1	Liquid
OT2	Solid
OC	Oxidizing substances, corrosive
OC1	Liquid
OC2	Solid
OTC	Oxidizing substances, toxic, corrosive

Source: ADN

Symbols of the classification codes are derived from the first letters of their English names:

- O – oxidizing
- F – flammable
- W – substances which in contact with water involve dangerous gases
- T – toxic
- C – corrosive.

The digit “1” denotes liquid substances, “2” solid ones. Goods with one dangerous property are marked with a one-letter symbol (e.g. “O”), with two dangerous properties – two letters (e.g. “OF”), with three dangerous properties – three letters (e.g. “OTC”).

The abbreviation N.O.S., mentioned in Tables 3 and 4 after names of goods, is of particular significance in the nomenclature of dangerous goods. It is applied in all regulations concerning various transport branches.

N.O.S. means “not otherwise specified” and shall be supplemented with the technical name of the goods unless a national law or international convention prohibits its disclosure if it is a controlled substance.

N.O.S. is used as:

- specific N.O.S. entries covering a group of substances or articles of a particular chemical or technical nature, not otherwise specified (entries of type C),
- general N.O.S. entries covering a group of substances or articles having one or more dangerous properties, not otherwise specified (entries of type D).

Besides, dangerous goods have simple entries for well defined substances (type A) and generic entries for a well defined group of substances or articles (type B).

In other words, N.O.S. goods do not appear as single strictly defined and named substances or articles. Such goods, including solutions and mixtures, should be classed on the basis of the kind of danger they present, in order to enable the carrying out of a suitable carriage procedure.

The next step is the determination of an additional threat and group of packagings, and assigning the proper UN No. In order to select the proper UN group number, decision trees may be applied (Fig.3). The selection of a UN number and group name of dangerous goods assigned to these numbers should be performed on the basis of the properties of the goods in the sequence of fitting to the names of type B, C, and finally D.

The application of a decision tree for the subordination of respective UN No. and the group name on the basis of form and kind of basic threat and additional threats, has been presented on the example of oxidizing substances and articles N.O.S. 5.1.

<b>Oxidizing substances</b>	<u>liquid</u>	<b>O1</b>	3210 CHLORATES, INORGANIC, AQUEOUS SOLUTION, N.O.S. 3218 NITRATES, INORGANIC, AQUEOUS SOLUTION, N.O.S. 3139 OXIDIZING LIQUID, N.O.S.	
	<b>Without subsidiary risk</b>	<u>solid</u>	<b>O2</b>	1461 CHLORATES, INORGANIC, N.O.S. 1477 NITRATES, INORGANIC, N.O.S. 3139 OXIDIZING SOLID, N.O.S. 1482 PERMANGANATES, INORGANIC, N.O.S.
		<u>articles</u>	<b>O3</b>	3356 OXYGEN GENERATOR, CHEMICAL
<b>Solid, flammable</b>		<b>OF</b>	3137 OXIDIZING SOLID, FLAMMABLE, N.O.S.	
<b>Solid, self-heating</b>		<b>OS</b>	3100 OXIDIZING SOLID, SELF-HEATING, N.O.S.	
<b>Solid, water reactive</b>		<b>OW</b>	3121 OXIDIZING SOLID, WATER REACTIVE, N.O.S.	
<b>Toxic</b> <b>OT</b>	<u>liquid</u>	<b>OT1</b>	3099 OXIDIZING LIQUID, TOXIC, N.O.S.	
	<u>solid</u>	<b>OT2</b>	3087 OXIDIZING SOLID, TOXIC, N.O.S.	
<b>Corrosive</b> <b>OC</b>	<u>liquid</u>	<b>OC1</b>	3098 OXIDIZING LIQUID, CORROSIVE, N.O.S.	
	<u>solid</u>	<b>OC2</b>	3085 OXIDIZING SOLID, CORROSIVE, N.O.S.	
<b>Toxic, corrosive</b>		<b>OTC</b>	collective entry is not available	

Fig. 3. Decision trees of oxidizing substances and articles for choosing collective entries (N.O.S.)  
Source: ADN

\* The chemically unstable substances shall not be accepted for carriage unless the necessary steps have been taken to prevent their dangerous decomposition or polymerization during carriage.

## Conclusions

1. Considering the development of multimodal transport, harmonisation of regulations concerning the carriage of dangerous goods by inland vessels with carriage by other means of transport is indispensable.
2. The structure of content division in the ADN is at present fully harmonised with the ADR, and in a large degree with the IMDG Code.
3. Tabular depiction of data concerning dangerous goods and the means of their carriage largely restricts the amount of information on the properties of the cargo. Modelled on the IMDG Code, it is necessary to introduce into the Dangerous Goods List a cell named "Properties and descriptions" for providing cargo properties essential for carriage safety.
4. The scope of regulations in inland and marine water transport continues to be differentiated. ADN concerns the carriage of dangerous goods in bulk and packaged. In marine transport each form and state of aggregation of the goods has had a separate set of regulations worked out (Codes: IMDG, IBC, BC, IGC).
5. The ADN authors' opinion about the system and way of content presentation being clear is to be considered as controversial. According to the present paper's writer, the present content system and information included therein do not favour quick access to information, which constitutes a great hindrance in using it. Therefore it is necessary to improve and develop further harmonised regulations of dangerous goods carriage.

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