VÉDELEM TUDOMÁNY
KATASZTRÓFAVÉDELMI ONLINE TUDOMÁNYOS FOLYÓIRAT

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TRANSPORTATION OF FLAMMABLE DANGEROUS GOODS IN HUNGARY

Abstract

Nowadays the economic operators and the authorities concerned place particular emphasis on compliance with and control of the special rules for the transport of dangerous goods. Knowledge of the rules and regulations relating to flammable dangerous goods is essential for both actors, as a significant proportion of the dangerous goods transported are provided by such goods. In this article, we analyze the groups of flammable dangerous goods, the basic classification rules related to the transport of dangerous goods, and by analyzing international and domestic statistical data, we can see insight into the proportions of transport of flammable substances and the analysis of official control figures.

Keywords: dangerous goods, transportation, flammable, accident, disaster management

TŰZVESZÉLYES VESZÉLYES ÁRUK SZÁLLÍTÁS MAGYARORSZÁGON

Absztrakt

Napjainkban a veszélyes áruk szállításának speciális szabályainak betartására és azok ellenőrzésére különösen nagy hangsúlyt fektetnek mind a gazdasági szereplők, mind pedig az érintett hatóságok. A tűzveszélyes veszélyes árukkal kapcsolatos ismeretek és szabályok ismerete nélkülözhetetlen mindkét szereplő részére, hiszen a szállított veszélyes áruk jelentős részét ilyen áruk adják. A közleményben elemezzük a tűzveszélyes veszélyes áruk körét, a veszélyes áru szállítással kapcsolatos alapvető osztályba sorolási szabályokat, valamint a

nemzetközi és hazai statisztikai adatok elemzésével betekintést nyerhetünk a tűzveszélyes anyagok szállításának arányaiba és a hatósági ellenőrzések számadatainak elemzésébe.

Kulcsszavak: veszélyes áru, szállítás, tűzveszélyes, baleset, katasztrófavédelem

1. INTRODUCTION

Regulations of the dangerous goods transport is just as big challenge these days as reducing the risks associated with their transport or preventing accidents. The increase in the volume of dangerous goods shipments from year to year poses serious challenges for both the persons involved in the transport and the authorities.

That is the reason why we consider it important for the reader to gain a comprehensive knowledge of flammable dangerous goods and the detailed rules for the transport. With following the rules would have avoided most of the recent foreign and domestic accidents what happened with flammable dangerous goods. So many factors that can contribute to the development of an accident that we need to place particular emphasis on. In addition to taking into climatic conditions, the preparedness of the persons involved in the transportation chain and the performance of their jobs, e.g. the selection of a suitable packaging or the affixing of a mark on the packaging can all contribute to the occurrence of an accident which could be fatal or seriously damage the environment.

The purpose of this article is to present flammable goods of transported different groups by road and to examine the statistics of flammable materials. In writing this article, we assume that persons involved in the transport of flammable goods have sufficient knowledge of the selection of packaging, the marking of the vehicle, and the necessary equipment. Therefore, this article does not deal with these detailed rules.

During the research of our topic, we were confronted with the fact that neither EUROSTAT nor the Hungarian Central Statistical Office (KSH) provide detailed data on flammable substances, so we do not know which dangerous goods class the flammable substance belongs to.

Past and recent foreign and domestic accidents have all highlighted the importance of dealing with flammable materials and drawing attention to the dangers of transportation activities involving such materials. Take, for example, the accident of a vehicle carrying a highly flammable substance on the M6 motorway, almost a year ago, UN 1307, where the chassis of the vehicle caught fire. Fortunately, the fire did not reach the cargo and the accident occurred in a non-densely populated area. We chose this topic to avoid events like this and highlight the importance of the topic. [1]

2. ANALYSIS OF THE PROPERTIES OF FLAMMABLE HAZARDOUS GOODS CLASSES

Flammable materials involved in road transport as dangerous goods are classified according to strict international standards. Based on their physical state and physical and chemical properties, we describe the rules for the classification of flammable substances with a little historical review.

The transport of dangerous goods in all transport sub-sectors, including the road sub-sector, is based on the United Nations (UN) ECOSOC Model Regulation, the so-called "*Orange Book"*. From time to time, a narrow group of international experts working within the UN processes the experience gained in the various transport sectors, as well as the results of scientific research, which may appear in a constantly updated new edition of the Yellow Paper as a UN recommendation. The transport sectors in each country can gradually transpose these recommendations as legal norms and incorporate them into their current regulations. Using this method, the systems of rules in the transport sectors are shaped in different ways, for some regulations through international organizations overseeing the sector, and in other cases with the involvement of the UN ECOSOC Working Group. [2]

The UN recommendations are regularly amended and updated. Its development is based on the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), the UN classification system, and the Regulation on Classification, Labeling and Packaging of

Substances and Mixtures (CLP). The Regulation is indicated by the acronym CLP, based on the initials of the English words for the classification, labeling and packaging to which it relates. [3]

The CLP Regulation harmonises the rules for classification, labeling and packaging of substances and mixtures, applying the main UN GHS guidelines, which build on more than forty years of EU practice. It obliges companies to classify their substances and mixtures themselves and to notify the classifications to the European Chemicals Agency. Establishes a list of substances with harmonized classification and labeling at Community level, including the above-mentioned notifications and harmonized classifications. [4]

3. RULES FOR THE TRANSPORT OF DANGEROUS GOODS BY ROAD

In case of the international transport of dangerous goods by road, the provisions of the ADR apply if the transport route involves at least two ADR member countries. The provisions of the ADR shall also apply to the national transport of dangerous goods by road, unless the matter is governed by other domestic legislation. If other legislation contains regulations for the transport of dangerous goods, it shall apply, whether it contains stricter or less stringent conditions than the ADR. The ADR itself is applied to domestic transport with certain derogations, which are made possible by the additional provisions of the so-called "nationalization" regulation. [5]

Within the European Union, the Directive on the inland transport of dangerous goods and its Annex I contain further restrictions on domestic derogations and their application. For shipments between EU Member States, ADR is not applied directly, but through Directive 2008/68 / EC. If there is a discrepancy between the requirements of the ADR and the standards referenced by the ADR, the provisions of the ADR shall prevail. However, the ADR allows contracting parties to require certain additional requirements. [6]

4. CLASSIFICATION OF FLAMMABLE DANGEROUS GOODS

The rules for the road transport sector, as mentioned above, are summarized in the ADR Regulatuions and its sections are based on the sections of the UN Recommendations. In the following, we briefly present the sections within which we can also find flammable dangerous goods. Flammable materials can be found in division 1.3, 1.4 and 1.5 within **Class 1 Explosive** substances and articles. [5]

Division 1.3 Substances and articles which have a fire hazard and either a minor blast hazard or a minor pro ject ion hazard or both, but not a mass explosion hazard:

- combustion of which gives rise to considerable radiant heat, or
- which burn one after another, producing minor blast or pro ject ion effects or both.

Division 1.4 Substances and articles which present only a slight risk of explosion in the event of ignition or initiation during carriage. The effects are largely confined to the package and no pro ject - ion of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package.

Division 1.5 Very insensitive substances having a mass explosion hazard which are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of carriage. As a minimum requirement they must not explode in the external fire test. [5]

In **Class 2** Gases, flammable gases are found in Division 2.1. These are *flammable gases* which at 20 °C and a standard pressure of 101.3 kPa:

- are ignitable when in a mixture of 13% or less by volume with air; or
- have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit.

The other group is *oxidizing gases* which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does. These are pure gases or gas mixtures with an oxidizing power greater than 23.5%. [5]

Class 3 covers substances and articles containing substances of this Class which:

- are liquids according to subparagraph of the definition for „liquid“.
- have at 50 °C a vapour pressure of not more than 300 kPa (3 bar) and are not completely gaseous at 20 °C and at standard pressure of 101.3 kPa and
- have a flash-point of not more than 60 °C.

The heading of Class 3 also covers liquid substances and molten solid substances with a flash-point of more than 60°C and which are carried or handed over for carriage whilst heated at temperatures equal to or higher than their flash-point.

Flammable liquids shall be assigned to one of the following packing groups according to the degree of danger they present for carriage:

Packing group	Flash point (closed cup)	Initial boiling point
I	–	≤ 35 °C
II[a)]	23 °C	> 35 °C
III[a)]	≥ 23 °C ≤ 60 °C	> 35 °C

Figure 1. Flammable liquid packing groups [5]

Class 4.1 Flammable solids are readily combustible solids and solids which may cause fire through friction. Readily combustible solids are powdered, granular, or pasty substances which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly. The danger may come not only from the fire but also from toxic combustion products. Metal powders are especially dangerous because of the difficulty of extinguishing a fire since normal extinguishing agents such as carbon dioxide or water can increase the hazard. [5]

Class 4.2 Substances liable to spontaneous combustion

The heading of Class 4.2 covers:

- Pyrophoric substances which are substances, including mixtures and solutions (liquid or solid), which even in small quantities ignite on contact with air within five minutes.
- These are the Class 4.2 substances the most liable to spontaneous combustion; and

- Self-heating substances and articles which are substances and articles, including mixtures and solutions, which, on contact with air, without energy supply, are liable to self-heating. These substances will ignite only in large amounts (kilograms) and after long periods of time (hours or days). [5]

Class 4.3 Substances which, in contact with water, emit flammable gases

Class 4.3 covers substances which react with water to emit flammable gases liable to form explosive mixtures with air, and articles containing such substances. [5]

Class 5.1 Oxidizing substances

This class covers substances which, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material, and articles containing such substances. [5]

Class 6.1 Toxic substances

Class 6.1 covers substances of which it is known by experience or regarding which it is presumed from experiments on animals that in relatively small quantities they are able by a single action or by action of short duration to cause damage to human health, or death, by inhalation, by cutaneous absorption or by ingestion. [5]

Class 8 Corrosive substances

Substances and articles containing substances of this class which by chemical action attack epithelial tissue - of skin or mucous membranes – with which they are in contact, or which in the event of leakage are capable of damaging or destroying other goods, or means of transport. The heading of this class also covers other substances which form a corrosive liquid only in the presence of water, or which produce corrosive vapour or mist in the presence of natural moisture of the air. [5]

Class 9 Miscellaneous dangerous substances and articles

The heading of Class 9 covers substances and articles which, during carriage, present a danger not covered by the heading of other classes. For example, the substances which evolving flammable vapour. The next table shows some example for flammable dangerous goods in different groups.

UN Number and Name	Label	UN Number and Name	Label
UN 0344 PROJECTILES with bursting charge		UN 1423 RUBIDIUM	
UN 1011 BUTANE		UN 1486 POTASSIUM NITRATE	
UN 1203 MOTOR SPIRIT or GASOLINE or PETROL		UN 1613 HYDROCYANIC ACID, AQUEOUS SOLUTION with not more than 20% hydrogen cyanide	
UN 1338 PHOSPHORUS, AMORPHOUS		UN1767 DIETHYLDICHLORO-SILANE	
UN 1380 PENTABORANE		UN 3314 PLASTICS MOULDING COMPOUND	

Table 1. Example for flammable dangerous goods

(Edited by the authors based on [5])

5. ANALYZING OF THE PROPORTION OF FLAMMABLE SHIPMENTS WITH AN INTERNATIONAL PERSPECTIVE

In order to get a comprehensive picture of the transport of flammable dangerous goods, it is essential that we process and present the available statistics. International and domestic statistics do not differentiate and it is not possible to filter out the number of specific flammable substances that appear during shipments. Consider the following Figure 2. as an example.

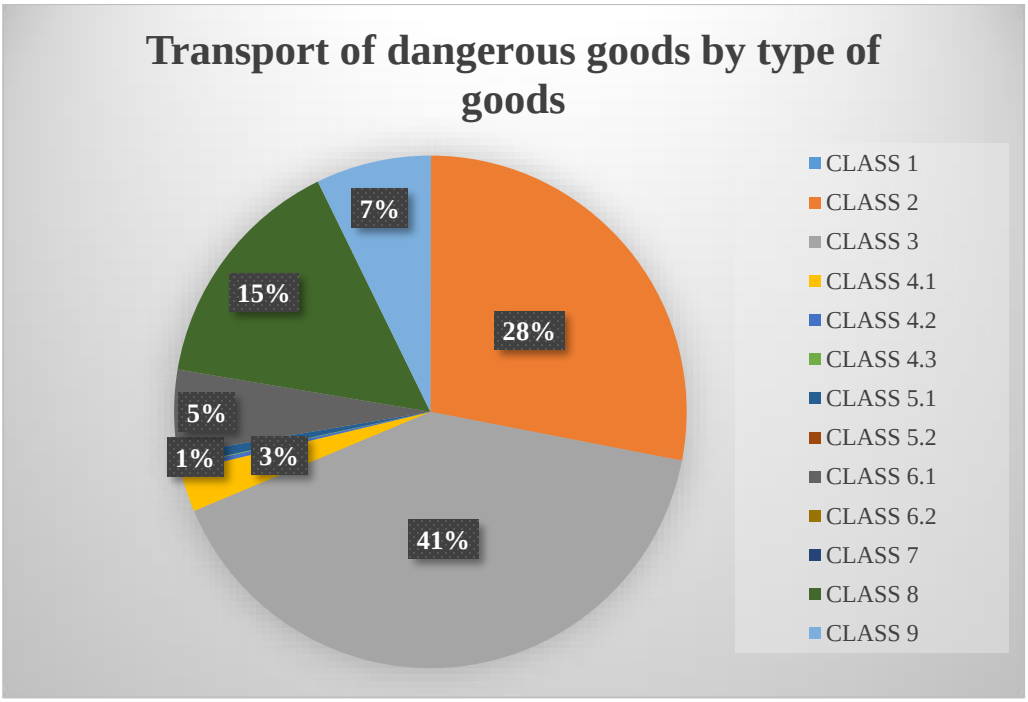


Figure 2. Transport of dangerous goods by type of goods

(Edited by the author based on [7])

It can be seen from the figure that the Hungarian international dangerous goods transportation for all classes of dangerous goods according to ADR, flammable liquid substances can be considered as the largest quantity of substances transported, with 41%.

With regard to the flammable substances presented in the previous section, the reader is already aware that flammable substances may not only occur in Class 3, so to determine the exact percentage of flammable substances, it is important to consider Class 2, Gases, which is also significant, 28 Occurs in% shipping gold. Unfortunately, we do not have statistics on the

proportion of transport of flammable gases within Class 2, in the distribution of the three subclasses. The same is true of the other classes mentioned earlier, which we wrote about in the previous chapter.

As the appropriate amount of data is not available for the statistics, we will only deal with Class 3 material when presenting additional statistics. By showing the following figure, we would like to illustrate the proportion of class 3 deliveries, taking into account all sections.

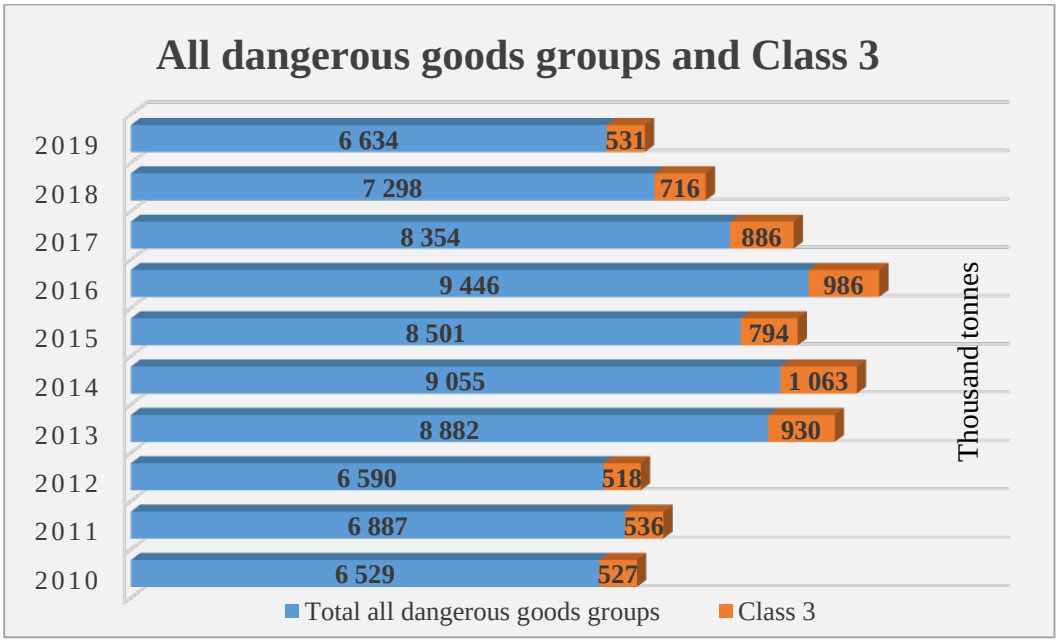
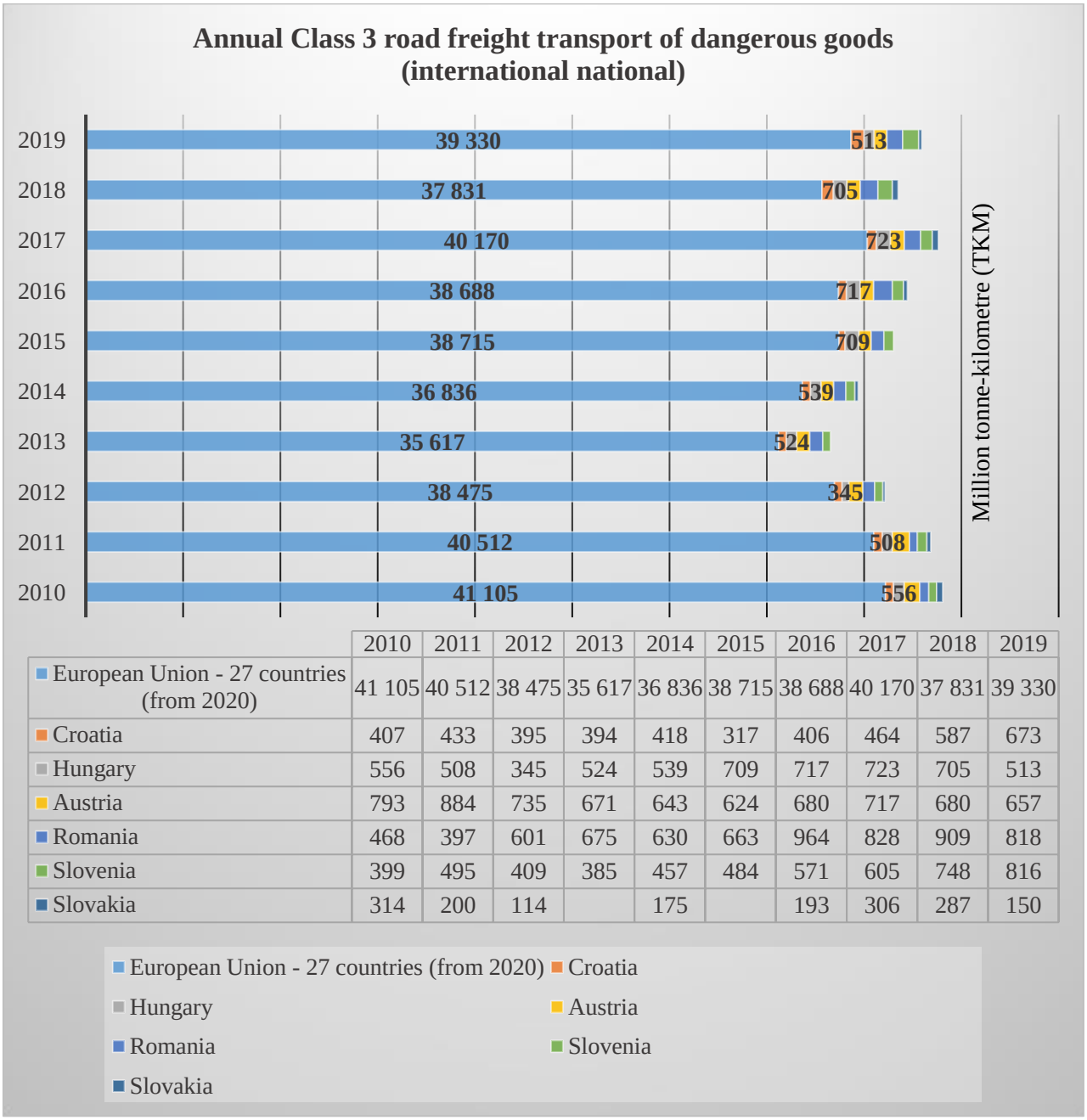


Figure 3. All dangerous goods groups and Class 3

(Edited by the author based on [7])

Based on the figure, it can be stated that after 2012, the volume of international dangerous goods transported increased significantly (including road, rail, inland water, air, marine sub-sectors), so also the total volume of Class 3 material transported. It can be seen that after 2017, the total quantity shipped fell to the value of 2013 and then shows a declining trend year by year. EUROSTAT data do not yet shows data for 2020, but presumably due to COVID there is a decrease in the total quantity transported and in the quantity of Class 3.

The following figure shows only the distribution of Class 3 material transported in the road subdivision, in relation to Hungary and the neighboring states. EUROSTAT does not have data on Ukraine and Serbia (although they have acceded to the ADR Convention) as they have not acceded to the European Union, so we do not analyze the transport of these states.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
European Union - 27 countries (from 2020)	41 105	40 512	38 475	35 617	36 836	38 715	38 688	40 170	37 831	39 330
Croatia	407	433	395	394	418	317	406	464	587	673
Hungary	556	508	345	524	539	709	717	723	705	513
Austria	793	884	735	671	643	624	680	717	680	657
Romania	468	397	601	675	630	663	964	828	909	818
Slovenia	399	495	409	385	457	484	571	605	748	816
Slovakia	314	200	114		175		193	306	287	150

Figure 4. Annual Class 3 road freight transport of dangerous goods (international national)

(Edited by the author based on [7])

Before describing the figure, we consider it important to note that the volume of Class 3 presented includes both international and national shipments. Based on the figure, it can be stated that for the current Class 3 transport of the 27 countries of the European Union, the transport activities are carried out by road in almost the same gold (except Slovakia). With

regard to Hungary, it can be stated that compared to the proportion of the 27 EU member states, Hungarian Class 3 deliveries account for only 0.9-1.85%, which cannot be said to be significant. However, it can be seen that these figures also represent an extremely high volume of transport, which must be control for safe transport.

It can also be seen from the figure that between 2010 and 2013 there was a decreasing trend in the volume of class 3 deliveries. This is presumably due to the global economic crisis. Analyzing the data of the EU-27, we can be aware of a leap from 2014 onwards, which until 2019 kept Class 3 deliveries at almost the same level. [7]

We consider it important to mention that the control of the regularity of Hungarian international and domestic shipments of dangerous goods, such as Class 3, poses a serious challenge to the participating authorities, regardless of the extent to which the quantities transported change from year to year. Four authorities are involved in the control of international and domestic shipments in Hungary. Following the amendment of the legislation in 2007, disaster management was named as a "*disaster protection authority*" acting as an independent authority in the control of the transport of dangerous goods by road. [8]

Incidentally, the professional bodies for disaster management have been involved since 18 June 2001 in designating transport routes and inspecting these vehicles, although only as co-authorities. [9]

The following figure shows that over the years, the number of shipments of dangerous goods inspected by the disaster management authority has also increased. The data presented show the dangerous goods transported in all sections. No statement on specific flammable substances is available. Nonetheless, starting from the data in Figure 2, more than half of the hazardous materials transported were flammable materials.

Figure 5. The number of consignments of dangerous goods by road inspected in Hungary

(Edited by the author based on [8])

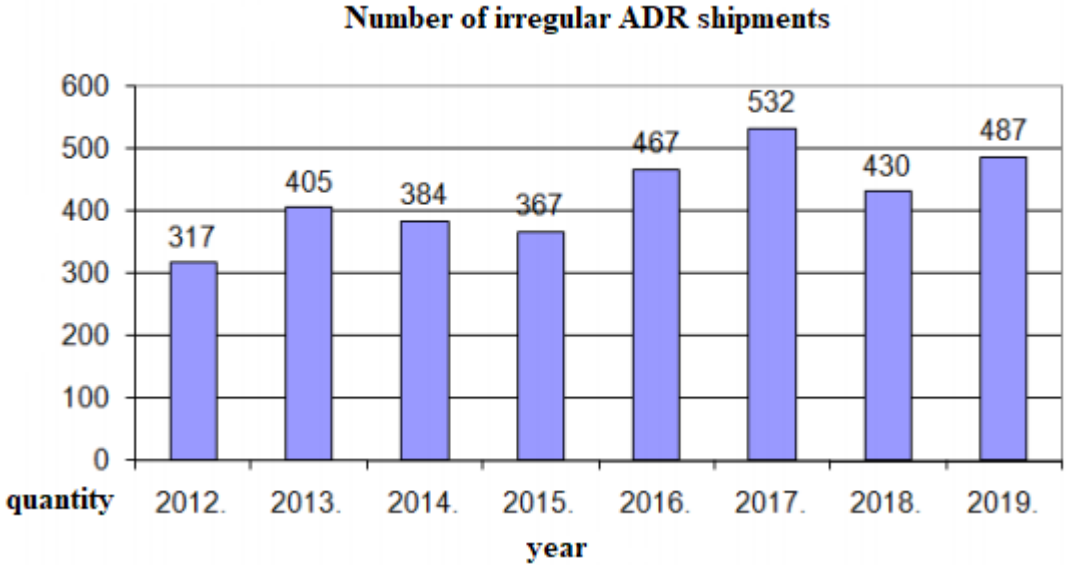


Figure 6: Number of irregular ADR shipment

(Edited by the author based on [8])

It can also be seen from the two figures that the quantities delivered are directly proportional to the irregularities detected. After 2017, a slight decline in irregularities can be seen, however, this number is already showing an increase in 2019.

In our opinion, the figures presented highlight the importance of the control of shipments of dangerous goods, including the activities of disaster management related to dangerous goods. We must not forget that most of these quantities are flammable dangerous goods, so it is essential for the authority to check compliance with the rules described above in order to check this type of consignment.

6. CONCLUSION

In the first part of the article, we presented the basics of classifying flammable goods into dangerous goods, and we also presented an example in each section. During the elaboration of the topic, we highlighted that flammable substances are not only found in one class of ADR, but also in almost all classes of dangerous goods. This complicates the work of professionals involved in such transport activities because, in order to comply with the rules, they need to master the knowledge of ADR in detail in order to carry out safe transport activities.

In the next section, we have analyzed the available statistical data. Based on these, we can state that more than half of the transported dangerous goods are flammable materials. That is why we consider it important to draw attention to the fact that following and enforcing the rules for such substances is extremely important in order to avoid an accident. The statistical data also answered that the proportion of consignments of dangerous goods in Hungary is not outstanding among the 27 EU member states, however, by joining the ADR Convention, we undertook to comply with the rules during transport activities. That is why it is essential to continuously carry out its inspection activities where irregular shipments are sanctioned, thus assuming our obligations under the Hungarian and international conventions.

REFERENCES

[1] The tanker chassis caught fire on one of the driveways on the M6 motorway URL: https://fovaros.katasztrofavedelem.hu/26128/hirek/226239/tartalykocsi-futomuve-gyulladt-ki-az-m6-os-autopalya-egyik-felhajtojan%202020 (Downloaded: 10.02.2021.)

[2] Hermina Horváth, Lajos Kátai-Urbán, Gyula Vass, Sándor Kozma, György Sárosi: Industrial Safety II. Manual for tasks related to the transport of dangerous goods, Universitf of Public Service, 2019. 978-615-5680-36-6 (PDF)

[3] Understanding the CLP Regulation https://echa.europa.eu/hu/regulations/clp/understanding-clp (Downloaded: 10.02.2021.)

[4] Classification and labelling (CLP/GHS) https://ec.europa.eu/growth/sectors/chemicals/classification-labelling_en (Downloaded: 10.02.2021.)

[5] ADR 2019 European Agreement concerning the International Carriage of Dangerous Goods by Road, Budapest, HVESZ 2019.

[6] DIRECTIVE 2008/68/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 September 2008 on the inland transport of dangerous goods https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0068&from=EN (Downloaded: 10.02.2021.)

[7] Annual road freight transport of dangerous goods, by type of dangerous goods and broken down by activity https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do (Downloaded: 10.02.2021.)

[8] Gyula Vass, Róbert Balogh, Lajos Kátai-Urbán, Sándor Kozma: Supervision of transportation of dangerous goods in Hungary, Industrial Safety and Authority Professional Day, Scientific Conference, Szekszárd, 2020.

https://tolna.katasztrofavedelem.hu/application/uploads/documents/2020-04/70644.pdf (Downloaded: 10.02.2021.)

[9] Lajos Kátai-Urbán, Sándor Kozma, Gyula Vass: RELATED TO THE SUPERVISION OF DANGEROUS GOODS EVALUATION OF AUTHORITY EXPERIENCE, Hadmérnök, 10: (4), pp. 101-114. 2015.

http://www.hadmernok.hu/154_10_kataiul_ks_vgy.pdf (Downloaded: 10.02.2021.)

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