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# ASSESSMENT OF THE MOBILE RISK SOURCE IN ROAD TRANSPORT

*Assessment of the mobile risk sources is not yet established in the European Union by law and therefore there is not enough pressure to manage and reduce risks. However, the transport of dangerous goods poses a special risk in terms of the nature of the transported material, especially for densely populated urban areas. The release of toxic or flammable substances into the air may endanger the health and life of many inhabitants. The assessment of consequences of the mobile accident hazards has been dealt with only seldom and not in details. The aim of this paper is to assess the risks associated with the transport of dangerous flammable substance. Authors would like to point out that the mobile resources represent a significant source of risk through the transport of dangerous goods in the event of an emergency occurrence associated with their leakage.*

***Keywords:*** *risk assessment, dangerous goods, emergency accident, mobile risk source, road transport*

## 1. Introduction

The road transport is becoming increasingly important in the transport system of developed countries. One of the trends of the last decade is a marked increase in road traffic intensity. Approximately 1.8 million tons of gasoline use the petrol-powered cars in the Slovak Republic; passenger cars with diesel engines and trucks consume an additional 2.3 million tons of diesel per year [1].

The growth trend of product transfers between sites of production, further processing and consumption, also affects the transport of products, which are called dangerous goods or dangerous substances. Transit routes are run by industrial agglomerations and storage and spending facilities are located in areas densely populated by the population. Traffic accidents associated with leakage of dangerous substances occur more and more frequently and can pose a serious threat to the population or cause environmental pollution. Every day we are through various media informed about road traffic accidents and their various consequences - the number of injured and killed people, escaped amounts of hazardous substances, damage of property and the environment.

## 2. The legal framework for the transport of dangerous goods

Dangerous Goods or Dangerous Substance are substances or articles, which by their properties such as flammability, toxicity, etc. may endanger human health, even cause death or seriously endanger the environment [2]. For this reason, their carriage is a subject to special conditions governed by international agreements and conventions for the road, rail, inland waterway, maritime and air transport.

Those agreements and conventions are valid not only for international transport but are implemented into the national legal environment through the laws that refer to these agreements and conventions and apply also to national transport [3].

## 2.1 The legal framework for the transport of dangerous goods in European Union

The EU's basic legal instrument governing the carriage of dangerous substances in the road transport The European Agreement on the International Carriage of Dangerous Goods by Road (ADR Agreement) [4]. The ADR Agreement prescribes the conditions for the transport of dangerous goods. It breaks down freight by hazard classes; identifies and classifies hazardous substances and articles according to their hazardous properties; determines the conditions for their transport, packaging and marking and prescribes the use and completion of specified accompanying documents. It lays down the requirements for entries in transport documents, means of transport, including technical requirements for the vehicle by class and further provides for additional rules, such as restrictions on the number of items carried, supervision, mode of parking, etc. [5].

In addition to international agreements and conventions, there are directives and regulations of the European Parliament and the EC Council, as well. The basic legal norms of this nature are:

- Directive 2008/68/EC of the European Parliament and of the Council on the inland transport of dangerous goods.
- Council Directive 95/50/EC on uniform procedures for checks on the transport of dangerous goods by road.
- Regulation (EC) 1907/2006 REACH - Regulation on the Registration, Evaluation, Authorization and Restriction of Chemicals, sets out procedures for the collection and

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evaluation of information on the properties and risks of substances.

- Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). The REACH abbreviation includes the registration, evaluation, authorization and restriction of the chemical.
- Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures has sought to classify, label and package substances and mixtures. The CLP Regulation links past EU legislation to the GHS (Global Harmonized System of Classification and Labeling of Chemicals), the United Nations System for the Identification of Hazardous Chemicals and to inform users of these hazards. It also contains links to the REACH legislation.

## 2.2 The legal framework for the transport of dangerous goods in Slovak Republic

The legal framework for the transport of dangerous goods has been given by the European Agreement on the International Carriage of Dangerous Goods by Road. In the legislation of the Slovak Republic it was promulgated by the Decree of the Minister of Foreign Affairs no. 64/1987 Coll. on the European Agreement on the International Carriage of Dangerous Goods by Road [6].

The transport of dangerous goods by the road transport in the Slovak Republic, in addition to the provisions of the international agreement ADR, is also a subject to the following legal standards:

- Act no. 56/2012 Coll. on the road transport, as amended, lays down the requirements of the ADR, regulates the conditions for the transport of dangerous goods and puts specific requirements on the consignor, the transporter or the consignee of the dangerous consignment.
- Decree no. 43/2016 Coll. on the road transport deals with the scope of controls on the transport of dangerous goods on the road. Specifies individual violations of ADR-related regulations.
- Act no. 106/2018 Coll. on the conditions for the operation of vehicles in traffic on roads introduces so-technical inspection of vehicles intended for the transport of dangerous goods.
- Implementing Decree No. 134/2018 Coll. of the Ministry of Transport and Construction of the Slovak Republic laying down details on the operation of vehicles in the road traffic.
- The Decree No. 533/2006 on details of the population protection against the effects of dangerous substances, which describes the procedure in the event of an emergency, provides details to ensure the protection of the population against the effects of hazardous substances in an emergency related to their escape during the production, with dangerous pollutants.
- Act no. 67/2010 Coll. on the conditions for placing on the market of chemical substances unifies the requirements for labeling of dangerous substances. It specifies packaging requirements as a basic assumption of the transport safety and use of the hazardous substances.
- Government Decree No. 176/2003 Coll. laying down the details of technical requirements and conformity assessment procedures for the transport pressure equipment.

- Road Traffic Act no. 8/2009 of 3 December 2008 Act no. Act No. 8/2009 Coll. on the Road Traffic Act and on the amendment of some laws.
- Government Regulation no. No 349/2009 on the maximum authorized dimensions and weights and special marking of vehicles and combinations of vehicles.

## 2.3 Authorities responsible for assessment of mobile risk sources in transport in Slovak Republic

The main authority responsible for risk assessment of mobile risk sources in the Slovak Republic is Transport Authority, it was established by the Act No. 402/2013 Coll. on Regulatory Authority for Electronic Communications and Postal Services and on Transport Authority and on amendments of several acts, coming into force on 1 January 2014 as a state administrative body with nationwide operation in the area of railways and other guided transport, civil aviation and inland waterway transport. The Transport Authority is a legal successor of the Railway Regulatory Authority, Civil Aviation Authority of the Slovak Republic and State Navigation Administration.

The assessment of the road transport risks at a district level falls within the competence of district authorities, namely the Road Transport and Road Transport Department.

## 3. Emergency accident by dangerous goods transport

In Slovakia, 17,439 road haulers are registered to 12.5.2015 under SK-NACE 6024. Of this quantity approximately 5,200 carriers are involved in transport of dangerous goods. Although there are no precise statistical data on volumes or transport performance associated with the transport of dangerous goods in the Slovak Republic, it is estimated that dangerous goods account for up to 30 % of the total freight transport over the long distances and over the shorter distances (up to 100 km) 60 % of the total freight transport volume. Road transport accounts for approximately 70 %, rail for about 10 % and the remainder for other modes of transport. Up to 80 % of the dangerous goods transported are flammable liquids that are transported by the tank transport [7]. Transport of dangerous goods by road differs from ordinary freight transport, in particular by the fact that a number of technical, operational, transport and safety conditions and requirements must be met.

Carriage of dangerous substances by tanks brings many risks, compared to freight transport. In addition to the possibility of explosion and fire products in the event of a tanker accident, there is a great deal of damage to the environment, human life or health [8].

The long-term statistics from different countries agree that the most common cause of traffic accidents is a human factor in approximately 85 % of cases, traffic is the primary cause in 10 % of cases, and the means of transport is the source of accidents for about 5 % of cases. There are many factors involved in the occurrence of accidents at the same time [7].

The largest share in the occurrence of accidents in transport have traffic accidents with leakage of liquid hazardous substances

**Table 1** *Number of Emergencies with Occurrence of Dangerous Substances (2013-2018) [10]*

| Extraordinary events | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Chemical liquid | 446 | 631 | 604 | 529 | 615 |
| Gaseous chemical | 128 | 143 | 198 | 134 | 125 |
| Chemical substance solid | 7 | 13 | 7 | 8 | 11 |
| Powder | 43 | 22 | 25 | 25 | 19 |
| Biological material | 10 | 3 | 8 | 4 | 6 |
| Radioactive material | 0 | 1 | 1 | 0 | 0 |
| Other | 148 | 123 | 77 | 67 | 78 |
| Total | 782 | 936 | 920 | 767 | 854 |



**Figure 1** *Tank accident on D1 [12]*

[9]. Overview of numbers of incidents during the transport of dangerous goods by road in Slovakia in 2013-2015 is shown in Table 1.

## 4. Assessing the negative consequences of an emergency event related to transport of dangerous goods

Broadly speaking, a risk assessment is a combined effort of: 1) identifying and analyzing potential (future) events that may negatively impact individuals, assets, and/or the environment (i.e. risk analysis); and 2) making judgements "on the tolerability of the risk based on the risk analysis" while considering influential factors (i.e. risk evaluation) [7, 11].

To put in simpler terms, a risk assessment analyzes what can go wrong, how likely it is to happen, what the potential consequences are and how tolerable the identified risk is. As a part of this process, the resulting determination of risk may be expressed in a quantitative or qualitative fashion. The risk assessment plays an inherent part of an overall risk management strategy, which attempts to, after the risk assessment, "introduce control measures to eliminate or reduce" any potential risk-related consequences [7, 11].

Given the fact that 80 % of dangerous substances, transported on the roads, are flammable liquids, the case study was focused on assessing the risks associated with leakage of fuels during their transport in tankers.

Despite the fact that safety issues and compliance with the standards, rules and regulations for the transport of dangerous substances in road transport are handled by the authorities, carriers and drivers, we are occasionally informed of accidents involving the escape of dangerous substances [12]. Luckily, none of those accidents have passed into a disaster of catastrophic proportions, which would endanger the lives and health of population, infect large areas of land or water with toxic substances that act on the environment for a long period of time.

An example may be a recent tragic accident on the D1 motorway in the Slovak Republic (see Figure 1), where a 33-year-old driver died. The driver, for not identified reasons, went out of the way to the field, where he overturned the fully loaded tanker (30 000 liters of fuels). Transport on the D1 motorway, at the place where a tragic accident occurred, was diverted for safety reasons because there was a risk of explosion [12].

*Table 2 Risk source*

| Equipment | Volume [m³] | Dangerous good | Amount of substance [kg] |
|---|---|---|---|
| Tank | 30 | petrol | 24 000 |

*Table 3 Outflow frequencies for different road types [13]*

| Road Type | Outflow frequency [/veh.km] | |
|---|---|---|
| | Pressurized | Atmospheric |
| Motorway | $4.32 * 10^{-9}$ | $8.38 * 10^{-9}$ |
| Outside built-up area | $1.22 * 10^{-8}$ | $2.77 * 10^{-8}$ |
| Inside built-up area | $3.54 * 10^{-9}$ | $1.24 * 10^{-8}$ |

*Table 4 Probability of direct ignition for transport units in an establishment [13]*

| Source | Probability of direct ignition |
|---|---|
| Road tanker continuous | 0.1 |
| Road tanker instantaneous | 0.4 |

The next part of the paper will deal with modeling the consequences of the above mentioned traffic accident in Slovakia on D1. The focus was set on the impact of consequences to population, in the case if this accident happened in a densely populated area.

The CPR 18E methodology for modeling the consequences was used [13]. The CPR 18E methodology, known as the "Purple Book, is a recognized approach for a comprehensive risk assessment and includes two parts - the assessment of the risks of stationary equipment and the assessment of the transport of dangerous substances. It is used to determine the risks in the operation, handling, transport and storage of dangerous substances.

The first step in determining the negative consequences is to identify the risk sources, Table 2.

Determining the most unfavorable situation, where the effects of explosion, toxicity or fire of leaked fuel threaten the people and the environment, is based on estimate and determination of emergency scenarios. The selection of possible emergency scenarios is based on: the projected escape of the maximum amount of individual hazardous substances, the largest area of the fire, the potential threat to the environment by explosion and the radiated heat and the number of persons at risk in the affected areas [14].

### 4.1 Quantification of total frequency of emergency scenario

Determination of total frequency of an emergency scenario in the fuel transportation process estimates of representative events for leakage of dangerous goods from the Purple Book is shown in Tables 3 and 4 [15].

Total frequencies of the emergency scenario were determined to be the product of the outflow frequency and the probability of direct ignition.

$F_t = F * P$

$F_t = 1.24 * 10^{-8}$ vehicle. km*170 km *0.4      (1)

$F_t = 8.42 * 10^{-7}$ vehicle

with:

$F_t$ - total frequency of emergency scenario

$F$ - outflow frequency

$P$ - probability of direct ignition.

### 4.2 Determination of severity of the accident and the societal risk

The modeling of the emergency scenario consequences showed that, in the case of air stability class F, the impact of the fatal consequences on the population in the event of a fire is in the vicinity of 66 m from the point of escape, which represents an area of 1.4 ha [13]. At an estimated population density of 80 people / ha (according to the Decree of the Ministry of the Environment No. 489/2002 as amended), the number of people on the affected area is about 112 people (1.4 ha x 80 people / ha).

The acceptability of risk is currently set only for the stationary risk sources, yet thus recommended risk acceptance limit was also used for the resulting fuel transport risk. According to the Purple Book, the acceptable risk limit is given by the following equation:

$$F = \frac{10^{-3}}{N^2} \quad \text{for } N \geq 10 \qquad (2)$$

with: N = number of fatalities.

Societal risk is defined as the relationship between the number of fatalities in the case of accidents and the probability that this number will not be exceeded [13, 16].

The societal risk for the selected emergency scenario was determined from the probability and consequence matrix (Figure 2). For the activity analyzed, a pair of numbers was determined - the total frequency of the emergency scenario and the number of fatalities. The societal risk for the population was estimated by combining both values (Figure 2).
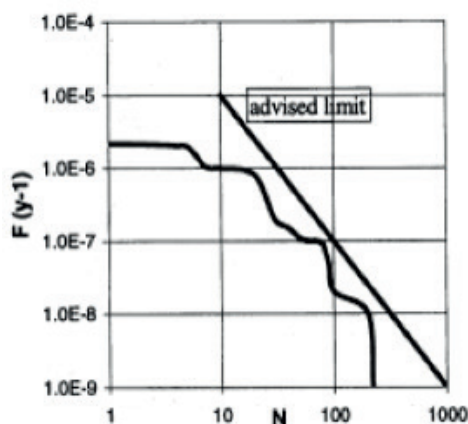
*Figure 2 Societal risk curve. Abscissa axis represents the number of fatal cases of persons, the ordinate shows the frequency of events per year [13]*

dangerous goods in terms of the likely outcome of an accident. The presented study presents a detailed assessment of the risks of transporting dangerous substances on the roads, which is a prerequisite for reducing the risks. The results could be useful for various societal and environmental risk studies related to the accidental release of dangerous goods into the air when measures for prevention or mitigation of consequences are to be proposed.

In view of the increasing number of hazardous substances transported and the preparation of legislation on the prevention of accidents involving the transport of dangerous substances in the European Union, this issue will need to be dealt with in more detail.

## 5. Conclusion

The objective of this contribution was to provide practical guidance in the assessment of risks related to the transport of

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