

TRANSIT ROUTES FOR TRANSPORTATION OF DANGEROUS GOODS IN THE CITY OF BRATISLAVA

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Abstract: National and international transport of dangerous goods in Slovakia is exercised by the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). All shipments covered by this agreement remain subject to national and international road traffic regulations, international road transport and international trade.

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1. Introduction

Bratislava with a strategic location near the border with Austria and Hungary is a transport junction to or from these countries (significant border crossings are listed in Table 1), as well as to Czech Republic and farther to the east. Within the capital of the Slovak Republic there are two major traffic arteries, highways D1 and D2, allowing transit through the territory of the city. Subject to certain cases of entry ban and mandatory transport direction for vehicles carrying dangerous goods or carrying substances that may pollute water sources, located just on these two highways in Bratislava, it is necessary to analyze transit road network of the city for the transport of dangerous cargo. As a result of such prohibitions and entry bans for trucks it is necessary to look for alternating tracks in the process of route planning, as these tracks are often channeled through via lower class roads, for which the probability of accidents is higher, also through the city center or even through the densely populated areas.

Table 1: Border crossings in Bratislava.

with weight limit up to 3,5 tons	Slovakia – Austria	Petržalka	Kittsee	Road (MK)
		Petržalka	Berg	Road (I/61)
	Slovakia – Hungary	Rusovce	Rajka	Road (I/2)
without limitation	Slovakia – Austria	Jarovce	Kittsee	Highway (D4)
	Slovakia – Hungary	Čunovo	Rajka	Highway (D2)

No weight limits are two motorways crossings, located to the south of Bratislava and leading to Austria and Hungary. Therefore, where dangerous goods are being carried to this countries through the territory of Bratislava, the route will be scheduled just this way.

In the city of Bratislava there are plenty of road signs to direct the possible routes of trucks, especially those carrying dangerous goods in the area, therefore it was necessary to investigate their location. Analysis of road signs was carried out on roads suitable for such transit routes in the directions D2-D4-Austria, D2-Hungary and D1-D2-D4-Austria and D1-D2-Hungary.

Road signs B21, B22 and C19 prevent entrance of vehicles carrying dangerous goods on a section of motorway D2 regarding to the tunnel Sitina, and vehicles carrying substances that may pollute water sources on a section of motorways D1 and D2 regarding to existing water sources placed in this area.

The sign B 21 – No entry for vehicles carrying dangerous cargo – prohibits any entry for vehicles transporting explosives, high flammable or otherwise hazardous cargo. In the case of prohibition of passage for these vehicles through the tunnel this sign will be supplemented by additional table N. E 14 (category tunnel).

The sign B 22 – No entry for vehicles carrying loads that may pollute water sources – prohibits any entry for vehicles carrying substances that may pollute water sources, e.g. vehicles transporting

crude oil, petroleum materials or other pollutants. The quantity as well as type of cargo can be marked on supplementary tables.



Fig. 1 Red zone, where it is not possible to transport dangerous cargo, and blue zone, where it is not possible to transport substances that may pollute water sources. Source: Authors

The sign C 19 – Mandatory transport direction of vehicles and cargo – instructs drivers of vehicles transporting explosives, high flammable or otherwise hazardous cargo, or drivers of indicated types of vehicles drive only the direction shown by the arrow (or arrows) marked on the sign. If using the sign N. C 19 in combination with supplementary table N. E 14, it instructs drivers of such vehicles limited by the supplementary table N. E 14 only drive in that direction the arrow, or arrows are pointing.

Detailed specification of substances that transport is on individual prohibition sign is shown in the figure N. 2.

Energy of the laser beam locally melts the metal powder¹ only in contour of the cut which is defined by the intersection of the plane (layer) of the product body (3D CAD model). A correct position of the part is very important during a fabrication. The supporting structure (anchored on the base steel platform) is used to ensure the correct part position. Metal powder is thoroughly melted by the laser and ensures a perfect close coupling of deposited layers. Powerful 200 Ytterbium (Yb)-fiber “dual-spot” laser is able to produce even small construction features in fine resolution, fabrication of the physical model is faster thanks to the higher energy density of the laser beam. The laser beam is precisely driven in the X and Y coordinates, Z-axis is controlled by shifting of the platform layer when the layer is created. This system allows accordance with geometrical tolerances of shape in the range of ± 0.1 mm. Workspace of 3D printer EOSINT M270 is 250 x 250 x 215 mm.

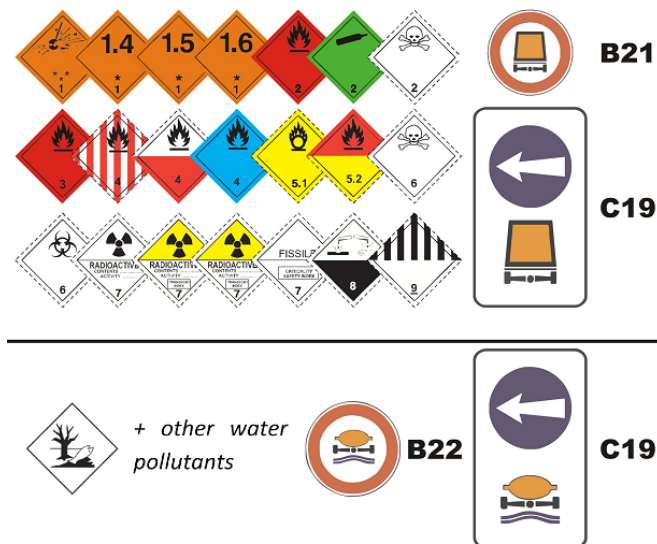


Fig. 2 Marking substances that transport is on individual prohibition sign Source: Authors

Based on placing of „No entry“ signs on the highway D1 and D2, the colour-coded zones have been marked in the picture. The red zone is no entry zone for vehicles carrying any dangerous cargo. This zone represents the area of the tunnel Sitina on the highway D2, where no entry zone begins for the vehicles transporting dangerous goods. From the tunnel to the south begins the zone of no entry for vehicles carrying substances that may pollute water sources (this zone is marked blue). The connection of the highways D1 and D2 is located in the area Pečniansky les where there are sources of drinking water.

2. Areas with water sources protection within the city of Bratislava

Under the law N. 364/2004 Collection of Acts on water resources, the water sources means the waters in surface water bodies and groundwater bodies used for the supplies of water for drinking water or usable to provide the population for more than 50 people, or allowing the use of water for this purpose, on average greater than 10 m³ per day, either fresh or treated. To guarantee the health safety and quality of water that are used, public authorities have specified protection zones. Protection zones may be intended for usable water sources and sources intended for drinking water with a capacity of less than defined water sources. Protection zones are divided into zones by degrees of protection (I., II., III. degree). It is essential that Slovakia protected, maintained and preserved its water as a precious and strategic resource. Thanks to the national conditions Slovakia has currently sufficient resources covering present and perspective needs of public and private sector. The quality of drinking water sources around Bratislava is excellent, sanitary control meets the requirements of Decree no.151 Collection of Acts on requirements for drinking water. The city of Bratislava is supplied with water drawn from large capacity sources Sihot', Pečniansky les, Rusovce – Ostrovné lúčky – Mokrad', Sedláčkov ostrov and Šamorín. Water resources Rusovce and Čuňovo were supplying the same name city districts in the past. Water resources Čuňovo was shut because of construction in the protection zone II. degree in 2013. Water resources Kalinkovo is connected to city water system, but since 1999 it is no more used to supply this district.

It is essential to protect these resources, and therefore transportation of goods that may cause water pollution should be diverted as much as possible from their protection zones. The large capacity sources Sihot', Pečniansky les and Sedláčkov ostrov are protected by entry bans. The road I/2 passes around the protection zone II.degree Rusovce – Ostrovné lúčky – Mokrad' and large capacity sources

Rusovce. Although the border crossing Rusovce – Rajka is restricted to vehicles with maximum weight of 3.5 tonnes, it is not suitable to keep following the route to Hungary along this road, but to divert it to the highway ahead of the village Rusovce. Water resources Šamorín is far enough from the road I/63 passing from Bratislava to Šamorín.

3. Transit routes for transportation of dangerous goods within the territory of Bratislava

After reflecting this situation alternate routes for vehicles transporting were incorporated into the map. In Figure 3 recommended routes for dangerous goods are marked green. Orange is the alternate route when driving from the direction of Pezinok towards Račianska, Pražská and Lamačská cesta (II/502, II/572, I/2). Yellow is for alternate routes for vehicles with maximum weight of 3.5 tonnes towards the border crossing points Petržalka-Berg (I/61), Petržalka-Kitsee (local road) and Rusovce-Rajka (I/2). Pink is for alternate routes Rožňavská, Dolnozemska cesta in the direction to Austria/Hungary (I/61, I/2). More detailed information are provided in the table N.2



Fig. 3 Routes for transportation of dangerous goods Source: Authors

Table 2: The recommended alternate route guidance through the city Bratislava for vehicles transporting dangerous goods. Source: Authors

From – To	Recommended routes for the transport of dangerous goods
Senec - CZ	D1 from the direction Senec ↔ Prístavný most (D1) ↔ Einsteinova (D1) ↔ a feeder D2 ↔ D2 - Lafranconi Bridge ↔ Road nr. I/2 (Mlynská dolina) ↔ Crossroad Patrónka ↔ Lamačská (road nr. I/2) ↔ D2 (direction CZ)
Senec - A	D1 from the direction Senec ↔ Prístavný most (D1) ↔ Continued D1 (Einsteinova) ↔ a feeder D2 ↔ D2 ↔ a feeder D4 ↔ D4 – Highway border crossing to AT
Senec - HU	D1 from the direction Senec ↔ Prístavný most (D1) ↔ continued D1 (Einsteinova) ↔ a feeder D2 ↔ D2 ↔ D2 Highway border crossing to HU
Senec - A up to 3,5 t	Prístavný most (D1) ↔ Cesta I/61 (Einsteinova) ↔ Road nr. I/61 (Viedenská cesta) ↔ Road border crossing to AT (up to 3,5 t)
Senec - HU up to 3,5 t	D1 from the direction Senec ↔ Prístavný most (D1) ↔ Road nr. I/2 (Dolnozemska cesta) ↔ Continued Rusovce Road nr. I/2 ↔ Road border crossing to HU (do 3,5 t)
CZ-A	D2 from the direction Malacky ↔ Lamačská cesta (Road nr. I/2) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynská dolina) ↔ D2 - Lafranconi Bridge ↔ a feeder D4 ↔ D4 – Highway border crossing to A
CZ-HU	D2 from the direction Malacky ↔ Lamačská (Road nr. I/2) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynská

	dolina) ↔ D2 Lafranconi Bridge ↔ D2 – Highway border crossing to HU
Alternatively routes	
Senec - A/HU	Highway D1 from the direction Senec ↔ Prístavný Bridge ↔ Road nr. I/2 (Dolnozemska cesta) ↔ Road nr. III/00246 ↔ a feeder to D2 or a feeder to D4 ↔ Highway D4 ↔ Highway border crossing to A ↔ Highway D2 ↔ Highway border crossing to HU
CZ - A/HU	D2 from the direction Malacky ↔ Road nr. I/2 (Lamačská cesta) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynska dolina) ↔ Lafranconi Bridge ↔ Road nr. I/61 (Einsteinova) ↔ Road nr. I/2 (Dolnozemska cesta) ↔ Road nr. III/00246 ↔ a feeder D4 ↔ Direction D4 Austria or D2 Hungary
Bypass D1	D1 from the direction Senec ↔ Road nr. I/61 (Rožňavská) ↔ Road nr. I/61 (Bajkalská) ↔ Highway D1

	Lamačská (road nr. I/2) ↔ D2 (direction CZ)
Senec – A/HU	D1 from the direction Senec ↔ Prístavný most (D1) ↔ Road nr. I/61 (Dolnozemska) ↔ Road III/00246 ↔ a feeder D2 or D4 Highway border crossing to AT or HU
Senec - A up to 3,5 t	Highway from the direction Senec (D1) ↔ D1 Prístavný Bridge ↔ Cesta I/61 (Einsteinova) ↔ Road nr. I/61 (Viedenská) ↔ Road border crossing to AT (up to 3,5 t)
Senec - HU up to 3,5 t	D1 from the direction Senec ↔ Prístavný most (D1) ↔ Road nr. I/2 (Dolnozemska) ↔ Continued Rusovce Road nr. I/2 ↔ Road border crossing to HU (do 3,5 t)
CZ-A	D2 from the direction Malacky ↔ Lamačská cesta (Road nr. I/2) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynska dolina) ↔ Road near the river Danube ↔ SNP Bridge ↔ Road I/2 (Dolnozemska) ↔ Road III/00246 ↔ a feeder D4 ↔ D4 – Highway border crossing to A
CZ-HU	D2 from the direction Malacky ↔ Lamačská (Road nr. I/2) ↔ Crossroad Patrónka ↔ Road nr. I/2 (Mlynska dolina) ↔ Road near the river Danube ↔ SNP Bridge ↔ Road I/2 (Dolnozemska) ↔ Road III/00246 ↔ a feeder D2 Road near the river Danube ↔ SNP Bridge ↔ Road I/2 (Dolnozemska) ↔ Road III/00246 ↔ D2 – Highway border crossing to HU
Alternatively routes	
via Petržalka	from Road nr. I/61 (Einsteinova) ↔ via Panonska road ↔ Road nr. I/2 (Dolnozemska)
Bypass D1	D1 from the direction Senec ↔ Road nr. I/61 (Rožňavská) ↔ Road nr. I/61 (Bajkalská) ↔ Highway D1

4. Transit routes for transportation of cargo which may cause water pollution

Transportation of dangerous cargo that may pollute the environment, especially water, is more complicated than transportation of other dangerous goods, as it should be to diverted from highways D1 and D2 because of entry bans into the areas with location of water resources for the city Bratislava (Pečniansky les). In Figure N.4 there are blue marked recommended routes for transportation of cargo that may cause water pollution, green and orange are alternative routes for these cases. When driving to the Czech republic from the direction of Senec, it is recommended to use the highway D1, along Einsteinova and “Most SNP”, then by the local road along the Danube embankment, across Mlynska dolina to Lamačská and finally connecting to the highway D2 (D1, I/61, I/2, D2). Suggested route for the direction to Austria or Hungary coming from Senec shall be Prístavný most, Dolnozemska cesta, III.class road with connection to the highway D2 to Hungary or D4 to Austria ((D1, I/2, III/00246, D4 or D2). When coming from the Czech republic we suggest the route D2, Lamačská cesta, Mlynska dolina, local road along the Danube embankment, “Most SNP”, Panónska, Dolnozemska, the road III/00246 connecting to the highway D2 to Hungary or D4 to Austria ((D2, I/2, MK, I/2, III/00246, D2 or D4). Alternate routes for these routes are given in the Table N.3.



Fig. 4 Routes for the vehicles, which may cause water pollution. Source: Authors

Table 3: The recommended and alternate route for the vehicles, which may cause water pollution. Source: Authors

From – To	Recommended routes for vehicles carrying water pollutants
Senec - CZ	D1 from the direction Senec ↔ Road nr. I/61 Einsteinova ↔ SNP Bridge ↔ Road near the river Danube ↔ Road nr. I/2 (Mlynska dolina) ↔ Crossroad Patrónka ↔

The passage of trucks carrying cargo which may cause water pollution on the road III/00246 in the direction from Bratislava to Austria and Hungary.

Given that there is no other possible way for such vehicles to transit, a problem arises when passing the road III/00246 toward Austria and Hungary because in our opinion, this is contrary to §39, section 4 and 5 of the Law N. 8/2009 Collection of Acts on Road Traffic and on amendments to certain laws and refill where it is defined that driving on the III. class road is prohibited to a vehicle with a maximum permissible weight exceeding 12 000 kg or to vehicle combinations with a maximum permissible weight exceeding 12 000 kg, except of motor vehicles and combinations of vehicles:

- a) which ensure loading or unloading of goods or other cargo, repair, maintenance services, municipal services and the like on the III. class road or in a place to which access is possible only by this road,
- b) whose drivers or operators are residents or possess a garage or operating structure in a place accessible only by this road
- c) whose passage or transport is carried out for repair, servicing, technical inspections, emission checks, originality check of the vehicle or the passing OBU
- d) which drive on the III.class road or in a place accessible only by this road as training vehicles for driving schools or due to the aptitude test for participants

Under the Law on Road Traffic, §39 section 5, driving ban does not apply (as for sec.4) for vehicles listed in section 3, as mentioned in letters a), b), c) and from f) to l).

Exemption from the prohibition, as provided for in § 5, section 3, does not apply to driving vehicles carrying dangerous goods (as in letter e) sec.3 §39, or for vehicles carrying substances that may pollute water sources, thus respecting this provision would not be possible to transit these substances by vehicles and vehicle sets with a gross weight of over 12 tonnes by the direction from the city territory of Bratislava to Austria and Hungary.

5. Conclusions

The analysis of the road network in Bratislava with reference to the possible transport of dangerous goods has shown a large number of higher category roads leading through the populated areas of the

city with a lot of intersections and a high frequency of bus stops. The main transit route is made of highways D1 and D2, which in most cases are optimal for transporting all kinds of goods. In the city of Bratislava, however, both highways are crossing water sources Pečniansky les and therefore can not be used to its full length in the city goods transport that may pollute water. In addition, the D2 highway passes through the tunnel Sitina, which is categorized as E, and therefore is excluded from the transportation of dangerous goods. Trucks should avoid the tunnel on the road I /2. Another factor that complicates planning the transport routes of these cargoes is the fact that in Bratislava is a large number of no entry signs for trucks (especially in the city). Suggested routes are then kept as much as possible on first class roads and motorways. As this was no longer possible for alternate routes, it is appropriate to use these routes in such cases where a shipment can not be carried out on the recommended route.

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