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Increase of amount of explosives per transport unit

Transmitted by the Government of Spain

Introduction

This document analyses the possibility of increasing the quantities of explosives that are authorized for road transport in EX III vehicles, which are currently limited to transport 16 t of explosives.

Analysis of current requirements

The current requirements for transport of explosives are limited to 5t for EX II vehicles, and to 16 t for EX III vehicles. These requirements have been in place since 1968, when the ADR entered into force.

Analysing the differences between the requirements of the ADR for EX II and EX III vehicles (basically electrical protection and braking systems) and the differences in the quantities that are authorized for one and the other (5 tons for EX II and 16 tons for EX III), it seems that the principal regulatory concern is focused on the possibility of a fire due to problems caused by electrical faults or problems deriving from the braking system; the rest of requirements are practically identical for EX II and EX III vehicles.

While the reasons for restricting quantities to 5 and 16 tons are unclear, they seem to be related to limiting the consequences of an explosion (affected area).

Nevertheless, it has to be remembered that the general requirements for vehicles have changed a lot in the past 50 years. The limit of 16 t for EX III vehicles has not been revised, but both the maximum capacity of the road vehicle and its technical requirements have changed completely.

Analysis of transported mass of explosives-range of affection-number of trips

When restricting the permitted mass of explosives to be transported per vehicle, the interaction of the transported amount, the range of affection in case of an explosion and the number of trips necessary to transport the explosives has to be analysed.

The limitation of the quantity of transported explosives has positive aspects (smaller affected area in case of an explosion) and negative aspects (the need to make a higher number of trips to transport a given quantity of product).

Given the same type of truck and the same route, the probability of the occurrence of an accident or incident of any type is directly proportional to the time spent on the road.

Calculation of affected area

The area affected by an explosion can be calculated using tables designed for this purpose, considering the amount of explosives transported.

The ATF (USA, Bureau of Alcohol, Tobacco, Firearms and Explosives) has tabulated quantities / distances of influence for the case of vehicle explosions (see Figure 1).

ATF	VEHICLE DESCRIPTION	MAXIMUM EXPLOSIVES CAPACITY	LETHAL AIR BLAST RANGE	MINIMUM EVACUATION DISTANCE	FALLING GLASS HAZARD
	COMPACT SEDAN	500 Pounds 227 Kilos *(In Trunk)*	100 Feet 30 Meters	1,500 Feet 457 Meters	1,250 Feet 381 Meters
	FULL SIZE SEDAN	1,000 Pounds 455 Kilos *(In Trunk)*	125 Feet 38 Meters	1,750 Feet 534 Meters	1,750 Feet 534 Meters
	PASSENGER VAN OR CARGO VAN	4,000 Pounds 1,818 Kilos	200 Feet 61 Meters	2,750 Feet 838 Meters	2,750 Feet 838 Meters
	SMALL BOX VAN *(14 FT BOX)*	10,000 Pounds 4,545 Kilos	300 Feet 91 Meters	3,750 Feet 1,143 Meters	3,750 Feet 1,143 Meters
	BOX VAN OR WATER/FUEL TRUCK	30,000 Pounds 13,636 Kilos	450 Feet 137 Meters	6,500 Feet 1,982 Meters	6,500 Feet 1,982 Meters
	SEMI-TRAILER	60,000 Pounds 27,273 Kilos	600 Feet 183 Meters	7,000 Feet 2,134 Meters	7,000 Feet 2,134 Meters

Figure 1: Influence of transported mass of explosives and range of influence (ATF)

Since the quantities included in the table cover large ranges intermediate segments can be easily calculated taking into account that the effects of an explosion are a function of the cube root of the quantity that explodes (D = K * Q 1/3), where D is the radius of the affected area, K a constant, and Q the quantity of explosive. Although the value that is normally assigned to the constant K differs significantly from one country to another, it is true that the values chosen by the ATF are very restrictive, or in other words, very high K values. For example, in Spain, the value used for the affected area is 34, and as shown in table 1, the ATF uses K values between 69 and 82.

It is interesting to note that the ATF table includes “lethal” and “evacuation” (damage) distances, which is not common in this type of table. This means that for the purposes of this study, there are two different distances to be analysed / compared.

Taking all of this into account, the K values used by the ATF in Figure 1 to calculate the range of influences for the explosions can de deduced and are shown in Table 1.

Tons	Lethal K	Evacuation K
14	5.7	82.5
15	5.8	81.5
16	5.8	80.4
17	5.8	79.4
18	5.8	78.4
19	5.9	77.4
20	5.9	76.3
21	5.9	75.3
22	5.9	74.3
23	6.0	73.3
24	6.0	72.3
25	6.0	71.2
26	6.0	70.2
27	6.1	69.2

Table 1: Values of K used for Figure 1, deduced by inverse calculation

Probability of occurrence of an accident

As mentioned earlier, the probability of the occurrence of an accident will decrease or increase in the same measure as the time the vehicle spends on the road decreases or increases. Since EX III trucks are used for supply-deliveries between factories and magazines, or between magazines, they are normally fully loaded. Therefore the probability of occurrence of an accident will be reduced in the same measure as the number of trips needed to transport the same quantity. These values are shown in the table below (Table 2).

Increase of tons per trip	% decrease number of trips
from 16 to 17	5.88
from 16 to 18	11.11
from 16 to 19	15.79
from 16 to 20	20.00
from 16 to 21	23.81
from 16 to 22	27.27
from 16 to 23	30.43
from 16 to 24	33.33
from 16 to 25	36.00

Table 2. Decrease of probability of occurrence of an accident (directly related to the decrease of number of trips) with increase of the transported t of explosives

Influence of explosion

With the values specified in tables 1 and 2 above, and by applying the formula for the calculation of distances influences by a explosion (D = K * Q 1/3), the following figures are obtained.

Increase of explosives per transport unit	Radius of lethal area for 16 t (m)	Radius of lethal area for the increase (m)	Lethal area for 16 t (m2)	Lethal area for the increase (m2)	Corrected area for the increase	% decrease of lethal area
16 to 17	146	150	66972	70345	66207	1.14
16 to 18	146	153	66972	73714	65524	2.16
16 to 19	146	157	66972	77083	64912	3.08
16 to 20	146	160	66972	80454	64363	3.90
16 to 21	146	163	66972	83829	63870	4.63
16 to 22	146	167	66972	87210	63426	5.30
16 to 23	146	170	66972	90600	63026	5.89
16 to 24	146	173	66972	93999	62666	6.43
16 to 25	146	176	66972	97409	62342	6.91

Table 3. Lethal area for different increases in the mass of permitted explosives per transport unit

Increase of explosives per transpot unit	Radius of damage area for 16 t (m)	Radius of damage area for the increase (m)	Damage area for 16 t (m2)	Damage area for the increase (m2)	Corrected area for the increase	% decrease of damage area
16 to 17	2027	2042	12910158	13102743	12331993	4.48
16 to 18	2027	2055	12910158	13263100	11789422	8.68
16 to 19	2027	2065	12910158	13393215	11278496	12.64
16 to 20	2027	2073	12910158	13494894	10795915	16.38
16 to 21	2027	2078	12910158	13569795	10338891	19.92
16 to 22	2027	2082	12910158	13619447	9905052	23.28
16 to 23	2027	2084	12910158	13645265	9492359	26.47
16 to 24	2027	2084	12910158	13648573	9099048	29.52
16 to 25	2027	2084	12910158	13644145	8732253	32,36

Table 4. Damage area for different increases in the mass of permitted explosives per transport unit

In both tables, the following columns have been included, in table 3 for the lethal affection, and in table 4 for the damage affection:

1. Increase of explosives per transport unit
2. Radius (m) for the lethal/damage area for the specific case of transport of 16 t (maximum limit according to present ADR regulation)

3. Radius (m) for the lethal/damage in case the increase shown in column (1) would be permitted
4. Area (m^2) for the lethal/damage are for the specific case of transport of 16 t (maximum limit according to present ADR regulation)
5. Area (m^2) for the lethal/damage in case the increase shown in column (1) would be permitted
6. Corrected area (m^2) for the increase: area corrected with the factor obtained in table 2
7. Percentage of decrease of lethal/affected area per transported ton: decrease of area, compared to the case of transport of 16 t, expressed in %

To summarize the information above, the increase in transported quantities would, in statistical terms, decrease both the risk of lethality as well as of damage if an explosion were to occur.

Figure 2 shows the evolution of the decrease in the lethality and damage areas that correspond to increases of 1 ton in the quantity transported, with respect to the current maximum value of 16 tons.

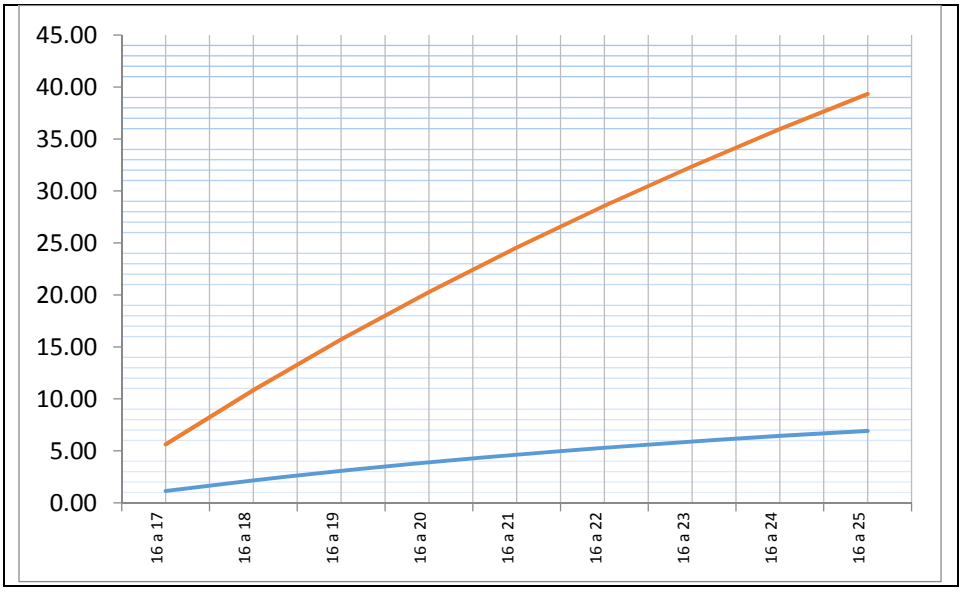

Figure 2: Evolution of the decrease in the lethality (lower curve) and damage areas (upper curve) (%) against the increase of transported mass of explosives per transport unit (t)

The aforementioned means, in other words, that an increase in transported quantities per truck decreases the level of risk in overall terms.

In the last international meeting of Chief Inspectors of Explosives (CIE), which was held in Bern on April 2016, the authorities of Canada and UK confirmed that they had reached the same conclusion after the completion of similar studies. Also, during this meeting a general consensus in supporting the increase in the transported maximum mass of explosives per transport unit was expressed, after a presentation of this issue.

Analysis of current transport limits in non-ADR countries

Many non-ADR countries have limits on transported quantities of explosives that are much less severe than the ones imposed by ADR; examples

- In the US, there is no limit on quantity; there are general limits, but these refer to the vehicle and its maximum load.
- In Canada, the limit is 20 tons (1.5 tons during seasonal thawing).
- In Australia, it is limited to 25 tons for divisions 1.1, 1.2 and 1.3, and to 40 tons for 1.5 and 1.6.
- Japan also has no limits, aside from general ones (like the US).

The requirements for vehicles for transporting explosives in all these countries are not as severe as those in the ADR

Influence of limitation of quantities of transported explosives by road in the overall transport chain

Explosives are shipped to different parts of the world using closed containers transported according to the IMDG regulation. IMDG does not impose specific limits per container for explosives (different limits than the ones for containers in general). Also, in many cases, the countries of destination have no limit on the amount of transported explosive per truck.

As explosives cannot be rearranged into different configurations or containers on arrival to a port of an ADR-country, containers are shipped as prepared for road transport. This gives countries with a higher limit for the transport of explosives by road a certain advantage in regards to the transport costs. Transport of explosives by ship from an ADR country can be almost twice as expensive as transport from a non-ADR country.

Summary

Based on the analysis of the interaction of the transported amount, the range of affection in case of an explosion and the number of trips, it can be said that an increase in the transported quantities per truck decreases the level of risk in overall terms.

In addition, other aspects may also be considered, which would provide additional support for the increase in the authorized quantities for transport:

- Higher limit for the transport of explosives in other no-ADR countries.
- Reduction of emissions with fewer trips, benefit for environment.
- Reduction of the risk of “theft” due to the decreased presence of vehicles on the highways.
- Increase of the general limit for cargo by road in the last 50 years. Evolution of the quality of the highways in the last years in the vast majority of ADR countries.
- Change in technical requirements in road vehicles over the years, such as new ADR requirements for approval of trucks, location systems, or response times in case of emergency have improved transport conditions significantly.

Proposal

In light of all of this, Spain would like to know if the WP15 could consider an increase of the authorized quantities for transport of explosives in EX III vehicles up to the authorized capacity limit for the corresponding type of truck. Spain and Germany would, in that case, be prepared to submit a formal proposal for the next meeting further developing this proposal.