Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

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Explosives and related matters: miscellaneous

Comments to ST/SG/AC.10/C.3/2017/23

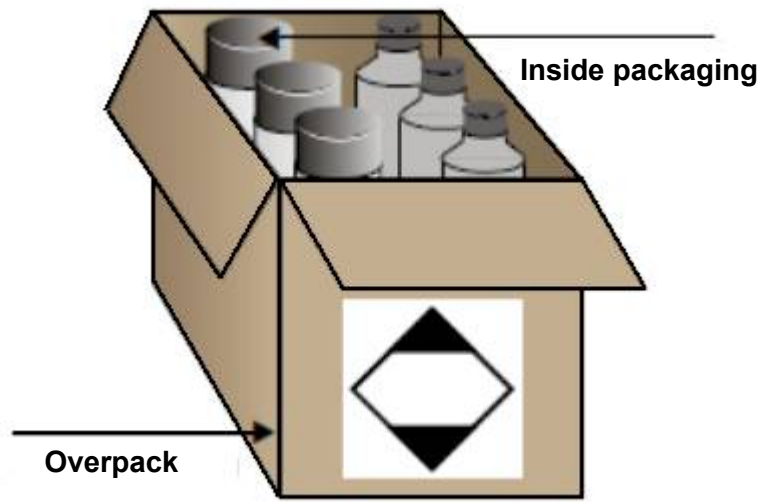
Transmitted by the expert from Switzerland

Arguments

To achieve a "limited quantity" LQ

for UN 0337 FIREWORKS, 1.4 S

Moor Safety Consulting



Content

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Abstract

For the goods under UN 0337 Fireworks 1.4 S there are products for which it is not to be understood that they have a limited quantity of 0 kg. They do not pose a particular hazard with respect to ignition, fire load or fire propagation.

Explosives

The explosives are actually slain by their substance designation. Most of them are only exploding under special conditions, as they are excluded in the classification 1.4 S by standardized tests.
They are characterized by special properties: They burn without oxygen (air) from the outside and can be ignited by mechanical stress such as impact and friction.

Requirements

If it can be shown that their "special properties" do not lead to an increased risk, i.e. no increased probability and no increase in the scope, a limited quantity (LQ) of ≤ 1 kg NEM should be possible.

Physical and chemical properties of all substances contained in a party bomb and their used quantities show that ignition can not be completely ruled out, a massive transport damage actually being the only conceivable scenario.

Energetic considerations and years of experience and the absence of accidents show that a fire spread in a singular event can be excluded and is thus no greater risk than in a clothing in mail order.

Fire behavior

As early as 2005, L. Kurth, head of the working group "Pyrotechnics" of the BAM wrote in a work for the storage of fireworks of classes I and II: According to the assignment 1.4 G and 1.4 S, the substances essentially represent a fire load. A simple ignition and the rapid transmission of reactions or fire nests is not given. In this work, we limit ourselves only to UN 0337, firewoks, 1.4 S..

Two groups

In the case of a "ordinary" transport damage, such as dropping with the damaging of the package corners or light clamps, ignition of all products with the marking UN 0337 can be excluded.

In the case of a massive package damage, the products can be roughly divided into two groups due to their energy content.

Group 1: Ò10 g NEM-Content
Ignition and fire spread unlikely

Group 2: > 10 g NEM-Content
Ignition and fire spread probability increases with increasing NEM share.

In regard to the frequency of transport damage, Swiss Post declares:

Slight transport damage: possible

Strong transport damage, such as destruction of the package: practically excluded

With the these da, an LQ quantity of 250 g NEM per packaging for fireworks UN 0337, 1.4 S should if not for all for those up to 10 g NEM per article.

1. Task

Creation of an argument to obtain a limited quantity > 0 kg for UN 0337, FIREWORKS, 1.4 S, or a part thereof, so that these products may be legally transported by post

2. Energetic properties

The explosives used in the mentioned fireworks are:

Nitrocellulose: 1 g and less are used for a party bomb.

Heat of Combustion : **3.991 kJ/g** (1)

The reaction of the nitrocellulose is a very fast combustion (deflagration).

Nitrocellulose reacts during decomposition into pure gaseous products such as carbon dioxide, carbon monoxide, nitrogen and water vapor. 1 g of nitrocellulose give approx. **7 liters** of hot gases. Cooled down and the water condensed remains just about 1 liter of gas.

Pyrotechnic Composition : In the rest of the fireworks there are pyrotechnic compositions of different kinds of effects such as color, sound, smoke or stars.

Heat of Combustion : about **2.6 kJ/g** (1)

The reaction speed ranges from a relatively slow combustion, such as in volcanoes, bengal woods, torches etc. to fast, as with lady crackers, bangdrops, etc. Basically, the reaction speed is about the same for all sets (about 0.1mm / s). It is the shaping like in torches and matches and the confinement, as with in crackers, bangdrops, etc. which can accelerate the reaction.

Cardboard / Wood: A not insignificant part of the weight is cardboard or wood.

Heat of Combustion: 16.5 to 18.7 kJ/g (2)

As a rule, the cardboard or the wood is merely a carrier or envelope for the fireworks and is retained during operation. Only in case of fire of the dangerous goods it contributes a not inconsiderable share of the energy production with its 5 to 6 times higher combustion heat compared to nitrocellulose and pyrotechnic compositions. For an energetic consideration for the ignition of cardboard occuring by heat. (see in 4.1.1.)

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(1) : Meyer R., Köhler J. Explosives, Wiley-VCH, 2007

(2): Brandschutzerläureungen, VKF, 2007

3. Possibility of inflammation

In principle, all explosives can be ignited by classical inflammation methods such as fire, hot surfaces, mechanical, electrical sparks and electrostatic discharges. It is intrinsic to them that they can also be ignited by mechanical stress, such as impact and friction, which may occur in the event of damage to the material being transported by clamping, breaking or some other process.

It is also known that nitrocellulose can ignite by instability. In the slow decomposition of unstable nitrocellulose, heat is released as in any exothermic process. In case this heat can not flow out, e.g. In a large stack, the temperature inside can rise until it is sufficient to ignite. In small quantities as in the present case, the temperature flows to the environment. Thus, the ignition of a table bomb by instability of the nitrocellulose can definitely be excluded.

In the case of the pyrotechnic compositions, the possibility exists that, because of their hygroscopic properties, they bind water from the atmospheric humidity and lose more and more energy.

The probability of a spontaneous inflammation can practically be excluded. Ignition by light transport damage such as dropping, lightly pressing or shaking is extremely unlikely. A very strong transport damage, such as breaking or destroying of the package, can be sufficient to ignite pyrotechnic charges.

An ignition by impact or friction is all the more probable the longer and wider the shape and the greater the proportion of the net mass of explosives (NEM) on the transport material.

The larger the NEM weight fraction in a package, the more likely it is to transfer the fire to the whole package. In any case, it can be inferred from the statement by L. Kurth (BAM, 2005) that the fire brigade is to use, all the resources without restriction.

4. Evaluation

Roughly, the products under UN 0337 can be divided into 2 groups

Group 1: NEM - share up to 10 g:

Party Bombs, Crazy Chicken, Squatter Sticks, Bangles, Smoke Balls, Color Sprayers

Group 2: NEM - share > 10 g:

Whole rest.

As a result, it is important to assess for each group whether a combustionof a single body can extend to all elements of an inner packaging or even to the entire shipping package.

4.1. Group 1

NEM content up to 10 g: table bombs, crazy chicken, cricket sticks, bangles, etc.

In the group up to 10 g, inflammation can be practically ruled out even in the rare case of a very severe baggage destruction (shredding). If, nevertheless, an ignition of an individual body occurs, the fire would not spread further

Ignition during severe baggage destruction (shredding) virtually impossible

Fire spread in the inner packaging not to be expected

4.1.1 Party Bombs

The cover consists essentially of cardboard. The cellulose in it is probably the best burning constituent. For spontaneous ignition, cellulose must be exposed to a heat of > 37 kW/m^2 for 8 min (480 sec) (3) or 35 kW/m^2 during 15 min (900 sec) (4).

(3): Kemper, Lemke, Handbuch Brandschutz, Kap III Wissenschaftlicher Brandschutz, ecomed Verlag, Loseblattwerk

(4): Koinig H. et.al., Referenzszenarien zur Richtlinie 96/82/EG, Wien 1999

The energy impulse necessary for ignition is calculated from the product of heat radiation and exposure time. To be on the safe side, we use the two smaller values.

35 kW/m^2 x 8 Min = 35 kJ/sm^2 x 480 s = 16800 kJ/m^2

A smaller party bomb has an inner surface of about 0.05 m^2, a larger one of about 0.1 m^2. For the small party bomb a necessary energy quantity of 840 kJ is calculated and for the larger one of 1680 kJ.

The strong separation of the nitrocellulose contributes to the great safety of the party bombs. For example, only 0.5 g to 1 g of dry nitrocellulose are used in party bombs. The energy released during ignition is between 2 and 4 kJ. If we now compare the combustion energies with the energies of 840 and 1680 kJ necessary for ignition, we are worlds below. No one is astonished that there is no conflagration in a table-top fence, as is confirmed by the thousands of shot bombs. This calculation shows too that in case a party bomb, for whatever reason, is ignited, not even the bombs in the same innerpackage get ignited.

Nitrocellulose reacts during decomposition into pure gaseous products such as carbon dioxide, carbon monoxide, nitrogen and water vapor. 1 g of nitrocellulose give approx. 7 liters of hot powder gases. Cooled down and the water condensed remains just about 1 liter of gas. The reaction of a table bomb produces between 3.5 and 7 liters of powdered gases. It can be assumed that the inner packaging is torn open, the outer packaging should remain intact.

A package with party bombs is in no case a cause for an increased fire probability, i.e. is in no case a cause of ignition. It also does not contribute to increased fire spread and does not provide a problem for intervention in case of fire.

4.1.2. Crazy Chicken

After igniting the fuse, 3.6 g of a pyrotechnic set blow a balloon, which at the same time comes out of the rear opening of the crazy chicken like an egg.

The pyrotechnic compositions yield about 50% solid and about 50% gaseous products during the reaction. i.e. 1 g of a pyrotechnic kit gives about 3.5 liters of hot exhaust gases, cooled down it is just about 500 ml. This means the balloon contains about 1.8 liters of gas.

Depending on the tightness of the system, false air is already lost during inflation, and the time of emptying may differ.

As measured from a clip (https://www.youtube.com/watch?v=SKTiSlHuOGs), the process from the ignition to the fully inflated balloon takes about 6 s.

3.6 g NEM content is a very small quantity of charge which is also embedded in a relatively rigid cardboard sleeve. Even with a shredding of the package, it is quite unlikely that ignition will occur. A simple transport damage never will do. The small charge can not even ignite its own cardboard sheath, the more unlikely is inflammation of the remaining packaging material.

4.1.3. Squatter Sticks, Bangles, Smokeballs, Color Sprayers

The same statements as for the crazy chicken apply to products such as prank devils, smokeballs, cricket sticks and paint sprayers.

4.2. Group 2

NEM-share > 10 g : Pyro-Mix, Lady Crackers, Diabol Youth Range,
Magic Volcano, Pyro Fun, Action for Youngsters,
Pyro Toys, Pyro Mix, Halli Galli, Pyro Kids, Dream Stars

The group of > 10 g is likely to be very difficult to ignite even in the very rare case of very heavy baggage destruction (shredding). In the event of an ignition, however, the spread of the fire on the whole luggage, can not be excluded

Ignition in case of severe baggage destruction (shredding) can not be excluded

The probability of fire spread in the inner packaging increases with increasing share of NEM.

4.2.1. Lady Crackers, Magic Volcanoes

The fireworks belonging to these class are pure varieties (only one species). As in Group 4.2.1, however, they are microfiring bodies. An ignition can only be imagined at a massive transport damage. All materials are not mass reacting on there oun. During ignition, spreading in the inner packaging is likely. A fire should be accompanied by the crackling of the Lady Crackers. All the bangers of the boarders, the lady crackers and other bodies have hardly any explosive effect. In the event of a fire, the fire brigade can intervene without special measures. There are good chances that a spread of the fire can be prevented.

4.2.2. Whole rest

As the proportion of NEM mass increases, the probability of ignition and the probability of fire spreading in the inner packaging increases.

5. Conclusion

For the products with an NEM content below 10 g, **Party Bombs, Crazy Chicken, Chatter Balls, Bangles, Smoke balls and Paint Sprayers**, there is no increased risk of ignition, not even in the case of a strong package destruction. Also, there is no increased risk of fire transmission, not even on the body in the same inner packaging.

For fireworks with more than 10 g of NEM content, there is a slightly increased ignition risk in the case of a strong package destruction. However, in the event of an ignition, the fire should be restricted to the inner packaging. Whether the entire baggage item will be affected can not be excluded.

With the probabilities of transport damage delivered by the post, an LQ quantity of 250 g for fireworks UN 0337, 1.4 S should be possible, if not for all at least for those up to 10 g per inner packaging.

Islisberg, 18. 06. 2017

Robert Moor

Article-designation	Gross weight [kg]	NEM per pack [kg]	Pieces per pack	NEM per Gross weight [%]	NEM per LQ-Pack of 30 kg [kg]	picture
Maxi Tischbombe	0,270	0,0004	6	0,13%	0,0400	
Tischbombe kleine Grösse	0,130	0,0007	10	0,50%	0,1500	
Crazy Chicken	0,084	0,0036	48	4,20%	1,2644	 
Knatterstäbe	0,015	0,0054	400	32,70%	9,8182	
Knallteufel	0,022	0,007	300	28,90%	8,6777	
Rauchbälle, 6 Stk.	0,062	0,0072	200	10,60%	3,1672	

Article-designation	Gross weight [kg]	NEM per pack [kg]	Pieces per pack	NEM per Gross weight [%]	NEM per LQ-Pack of 30 kg [kg]	picture
Riesen-Knallteufel	0,100	0,008	144	7,30%	2,1818	
Color Sprüher 10 Stk.	0,033	0,008	160	22,10%	6,6116	
Group 2						
Zaubervulkan	0,055	0,011	200	17,10%	5,1163	
Wunderkerzen Carat	0,018	0,012	500	60,60%	18,1818	
Lady-Cracker, 400 Schuss	0,088	0,018	80	18,60%	5,5785	
Traumsterne, 4 Stk.	0,070	0,02	100	26,00%	7,7922	

Article-designation	Gross weight [kg]	NEM per pack [kg]	Pieces per pack	NEM per Gross weight [%]	NEM per LQ-Pack of 30 kg [kg]	picture
Riesenwunderkerzen Midi	0,072	0,025	100	31,60%	9,4697	
Gold- und Silberregen	0,077	0,026	50	30,70%	9,2090	
Lady Cracker, 700 Schuss	0,200	0,029	80	13,20%	3,9545	
Riesen-Sternfackeln 5 Stk	0,065	0,034	40	47,60%	14,2657	
Lady-Cracker Set	0,220	0,035	40	14,50%	4,3388	
Wunderkerzen Carat	0,100	0,036	160	32,80%	9,8182	

Article-designation	Gross weight [kg]	NEM per pack [kg]	Pieces per pack	NEM per Gross weight [%]	NEM per LQ-Pack of 30 kg [kg]	picture
Bengalfackeln 6 Stk.	0,062	0,036	40	52,80%	15,8358	
Riesen-Bengalfackeln 6 Stk.	0,076	0,041	30	49,10%	14,7129	
Bengalhölzerset 3x18	0,086	0,057	200	60,30%	18,0761	
Bengalhölzerset 3x12	0,087	0,058	200	60,60%	18,1818	
Ballonfackeln	0,111	0,06	30	49,20%	14,7420	
Traumsterne, 12 Stk.	0,180	0,066	20	33,40%	10,0000