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Joint Meeting of the RID Committee of Experts and the Working Party on the Transport of Dangerous Goods

Bern, 16–20 March 2020

Item 6 of the provisional agenda

Reports of informal working groups

Report of BLEVE Working Group meeting held on 22-24 October in Madrid

Transmitted by the Government of Spain on behalf of the Informal
Working Group on the reduction of the risk of a BLEVE*, **

Summary

Executive summary: Report of the Working Group meeting.

Action to be taken: Decisions to be taken on different measures proposed.

Introduction

1. The Informal Working Group on the reduction of the risk of a BLEVE held its fourteenth session, hosted by the Spanish Ministry of Public Works and Transport on 22 to 24 October 2019 in Madrid, Spain, under the chairmanship of Mr. Claude Pfauvadel (France).
2. The meeting was attended by representatives of contracting parties/member states, non-governmental organisations and industry as mentioned in the enclosed list of participants (see Annex 1).
3. The following agenda was approved, with the addition of a brief review of the key points raised at the last meeting of the working group:
 - Tuesday afternoon: discussion of the INERIS conclusions and the RISE document sent by Norway.
 - Wednesday morning: Discussion on "Expanded Aluminium foils" with presentations from CEFIC and Technokontrol.

* 2020 (A/74/6 (Sect.20) and Supplementary, Subprogramme 2).

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- Wednesday afternoon: Visit at Technokontrol.
- Thursday: Discussion on and assessment of concrete measures that could be implemented in a short or longer time and the way to produce such proposals.

Brief review of key points raised at the last meeting of the working group

4. The following comments were made, in regards to pending topics discussed at the last meeting:

- No additional information had been made available on the two incidents that had occurred in Italy.
- Fire extinguishing systems for parked vehicles were considered to be too large, complex and heavy to be a practical solution.
- No additional funding had been received from participants of the working group for the modelling calculations being carried out by INERIS.
- There were thought to be no new issues or prevention measures that should be considered by the working group.

Presentation of calculation results by INERIS

5. INERIS presented the last results of their calculations (see Annex 2). The following points were highlighted:

- Presentation including results from previous studies.
- The same modelling and calculations as before but with other filling ratios and “jet fire” scenarios being considered.
- Key points of the modelling are:
 - Tyre fire: no BLEVE occurred when different tank filling ratios were modelled.
 - Pool fire coming from the fuel tank: BLEVE can occur in cases when the pool is concentrated in a small area and the fire has a long duration. In cases where the fuel from the tank is spread over a larger area, provided there is no propagation to the cabin and the tyres, no BLEVE occurs.
 - Cabin fire: BLEVE occurring with all filling ratios.
 - Jet fires: localized intense heat, leading to tank failure (and BLEVE) through the very high tank wall temperature.
- General conclusions from the analysis.
 - with less than 500 °C of flame temperature no BLEVE occurs.
 - when only lower part of the tank is exposed to the fire, safety valves ensure that there is no BLEVE when the filling ratio is 85%.
 - protection against self-induced BLEVE:
 - tyre fire: protection of tyres is important not to avoid tyres burning, but to avoid spreading the fire.
 - cabin fire: very important to protect the cabin, potentially very dangerous.
 - pool fire coming from the fuel tank is only potentially dangerous under certain circumstances.

- thermal coating/aluminum alloy would be an alternative solution to protect against the before mentioned fire sources.

Presentations of testing at RISE (Norwegian Defense Research Establishment)

6. In the absence of the Norwegian delegate, Spain presented the results of the tests done at the Norwegian Defence Research Establishment (see Annexes 3 and 4):

- Two tests were carried out, using a tandem axle configuration (one axle being fitted with twin tyres and the other having single tyres) which was protected by a steel mudguard; in one of the tests the mudguard was fitted with a thermal coating.
- No significant differences in the results measured in both cases.
- Steel protection by itself limits the temperature increase in the tank (small size tank, around 1.5 m³) to 30 °C. Very favorable in comparison with the air temperature below the fender (800 °C).
- In the experiment reported, further insulation does not improve the performance with the coating tested. Coating may have burnt in the test.
- Temperature increase of 30 °C, under certain initial conditions, would be over the flashpoint of diesel-it needs to be checked if fuel tanks are designed to withstand this.
- It may be interesting to do further tests with other insulation, and with a plastic fender, to get comparable values.

Presentation on expanded aluminium foils by CEFIC and research institute Mines d'Alés

7. Mr. Heymes from the research institute Mines d'Alés presented a study on expanded aluminium foils (see Annex 5):

- Analysis of historical data available on different tests carried out by different authors using aluminum foils produced by different companies.
- Expanded Aluminum (EA) partially installed filling the whole tanks and partially only as a ring next to the shell.
- Data very little systematic, normally not enough data to be able to compare effect of EA with the situation of no EA.
- Key finding of this research is that no clear conclusions could be drawn as to whether EA is effective in preventing a BLEVE.

Vehicle of the future (Liquid Gas Europe)

8. Liquid Gas Europe presented a study on the vehicle of the future for carriage of LPG (see Annex 6):

- Liquid Gas Europe working on initiatives to improve general vehicle safety and including active and passive systems into the trucks as technology evolves.
- Code of best practices encourages the companies to introduce systems.
- Some of the safety systems being introduced by the World Forum WP.29 could be applied to selected types of dangerous goods vehicles prior to the mandatory application dates that have been determined for mainstream goods vehicles. Liquid Gas Europe could support this approach.

Telematics

9. Different tools related to telematics may help to avoid accidents, and therefore prevent BLEVEs effectively. The Chair gave some information about the developments of intelligent transport systems going on in the European Union (EU) and other forums:

- Electronic transport document: first interchange of information in between users and authorities. With the electronic Freight Transport Information (eFTI), accepting electronic transport documents may become mandatory in the EU. The transport document by itself does not provide any solution against BLEVE, but the information could be interesting and easily available in case of an accident.
- Future in cooperative intelligent transport services: connections in between different vehicles, and connections from vehicles to infrastructure.

Presentation and small scale tests by Technokontrol

10. Technokontrol made some small scale tests to demonstrate the efficiency of their EA. Videos were shown of further large scale tests, and information on tests with and without EA were shared (see Annex 7). Technokontrol underlined the need to fill the tank at least to 90% with their product; they or their partners are directly filling the tanks each time.

11. Discussion points were:

- Difficulties in distinguishing an EA with good effects from another one. Need to define material or by describing the material (problems with copyright?) or by defining tests to be passed by this material (general ones for the material or specific for each tank/pressure receptacle to be protected).
- Need to prove this system does not only work well the first day, but until the next inspection, including filling, emptying processes, and taking into account the vibrations to which the product would be subject.
- Only interesting in dedicated tanks. Cleaning the EA from product rests is very complicated.
- For LPG tanks alternative testing methods are already admitted. Perhaps no need to remove the EA from the tanks each 6 years.
- The large scale tests shown are representative only for specific conditions; behavior under other conditions is unknown. Behavior without EA under the same conditions has to be checked comparing the Bureau Veritas report with the INERIS calculation to check if a BLEVE would have produced without EA. Additional documentation is needed to assess the tests.
- On smaller receptacles tests showed comparative results with and without EA.

Conclusions and proposals for the Joint Meeting

12. The working group has concluded that it will propose to the Joint Meeting the inclusion of some measures to prevent the appearance of BLEVEs. These measures are partially of a preventive nature, that will avoid the accident happening at all, and some are of a mitigating nature, mitigating or minimizing the effects of the accident once it has happened (seeking to prevent the accident progressing to a BLEVE).

13. The following measures are recommended to be developed for inclusion into RID/ADR:

- A. Installation of metallic mudguards

14. Metallic mudguards have been seen to prevent propagation of the tyre fires to other areas of the vehicle. It has also been shown that a fire affecting only tyres, and which does not propagate to the fuel tank and/or cabin, does not result in a BLEVE. Therefore, the recommendation is for a requirement to be introduced into ADR for mudguards constructed of metallic materials to be mandatory.

15. Requirements for metallic mudguards may be taken from the requirements set up for MEMUs, and should be applicable to tank vehicles transporting flammable gases, flammable liquids and also to vehicles transporting cylinders containing flammable gases.

B. Installation of engine fire suppression systems

16. Cabin fires induce a BLEVE in all cases, according to the calculations produced using the INERIS Finite Element Method (FEM) program. Therefore, and as most fires starting in the cabin are initiated in the engine, the recommendation is that the fitment of engine fire extinguishing systems should be a mandatory requirement that is applied by ADR.

17. Requirements for engine extinction systems may be taken from the requirements set up for MEMUs or the requirements set up for M category vehicles in Annex 13 to UN Regulation No.107, and should be applicable to tank vehicles transporting flammable gases, flammable liquids and also to vehicles transporting cylinders containing flammable gases.

C. Installation of safety valve

18. In all the calculations realized using the INERIS system, and also according to the experimental data available, the use of a safety valve (pressure relieve device) is very positive. The modelling shows that safety valves are effective in preventing a BLEVE, with the exception of cases where the tank is subject to a very intense localized heat source. Even in cases where the tank is subjected to an intense localized heat source, the safety valve can provide additional time for the area to be evacuated or external cooling to be applied which may also prevent a BLEVE occurring.

19. Therefore, the recommendation is for Chapter 6.8 of RID/ADR to be amended to require the mandatory fitment of safety valves to gas tanks.

20. The installation of safety valves has to be related to the previous measures, intended to keep the fire at a low level. All other calculations related to the other measures have been done for tanks equipped with safety valves, and the safety valves have contributed to help the tanks resist.

D. Introduction of technical devices for general traffic safety

21. WP.29 has developed provisions for the introduction of technical devices that improve the safety of all heavy vehicles. As most accidents involving dangerous goods start as normal traffic accidents, it is recommended to introduce some of these requirements as soon as possible for tank vehicles transporting flammable gases, flammable liquids and also to vehicles transporting cylinders containing flammable gases.

22. Specifically, the introduction of the Advanced Emergency Braking Systems (AEBS) and the Lane Departure Warning Systems (LDWS) for these vehicles would likely be beneficial, as some accidents, such as the one happening recently in Bologna might be avoided completely.

23. These systems are already introduced into the vehicle regulation and mandatory for new vehicles of more than 8 tons (since 2017), but the WG proposes to study making these systems mandatory for tank vehicles transporting flammable gases, flammable liquids and also to vehicles transporting cylinders containing flammable gases after a suitable transitional period.

24. This would imply an advance application of measures that will be implemented any way for general safety in ADR, and there are precedents of taking similar measures in the past, such as when ABS systems were made mandatory for vehicles carrying dangerous goods.

25. Additional information on the timeframe of the introduction of these systems into the vehicle regulation, and the possible timeframe for use according to ADR for tank vehicles

transporting flammable gases, flammable liquids and also to vehicles transporting cylinders containing flammable gases will be given in an additional informal document.

26. The applicability of this measure for vehicles transporting explosives should also be studied.

27. The following measures (E and F) need some further study, but the working group would also like to hear the opinion of the Joint Meeting on these subjects, to see if there is support in principle for these measures, to allow prioritizing the work in the Working Group:

E. Screening in between cabin and tank

28. As mentioned before, cabin fires may potentially produce a BLEVE in all cases. Additional calculations using the INERIS FEM model will be done with different cabin fires, to search for the limit of heat load coming from a cabin that would not induce a BLEVE. Once this value is known, it may be possible to consult manufacturers if it would be possible to produce vehicles with such cabins, or to alternatively include a heat resistant screen between the cabin and the tank.

29. Further information on this subject may be forwarded through an informal document.

F. Use of expanded aluminum alloys (EAA)

30. The Working Group has studied this technology, coming to the following conclusions:

- From the information gathered since 1980 on this system, not including the last developments, it cannot be concluded that the use of EAA has a positive effect.
- According to the information provided by the manufacturer, a new type of EAA has however been developed which is claimed to have an improved performance over previous products. According to the manufacturer, this EAA will prevent a BLEVE under all circumstances, but the evidences presented by the manufacturer are still being checked by the working group.
- The new type of EAA has been tested in a large scale test with tanks in a pool fire, and did not have a BLEVE in this test. The report from Bureau Veritas with the data from their monitoring system is still being checked by the WG.
- There are some additional unclear points that have to be solved in order to be able to use this technology:
 - Costs: the current price of this technology would be several times higher than the value of the tank, around 10 euros per liter. According to information from Technokontrol, the price is linked to the protection project, and changes with the composition and the volume of the product sold. No general reduction in price for tank vehicles can be assured.
 - Operation issues like filling and emptying the tank from the EAA as well as functioning of internal components, level gauges, potential blockage of foot valve, increased truck weight, operational issues for maintenance have to be looked at and optimized to ease inspections.
- INERIS may study if it would be possible, starting from the test results obtained, to model this technology and include them into their FEM. This would allow to model further cases and applications, if the Joint Meeting should support such an approach.

31. For the time being, the Working Group considers it is not possible to make a decision on the effectiveness of this technology. According to the EAA manufacturer, this technology would have the effect of avoiding BLEVEs completely but the WG considered that it had to still verify this claim, perhaps needing additional data, and that there would likely be significant practical difficulties in using such technology and that the product had a high cost.

32. In addition, the working group was not in the position to verify the reasons why the new material presented improves its effectiveness above the level of the EEAs previously tested (results of the tests summarized in the study presented by CEFIC and Mines d'Alés).

33. However, it could be interesting to include the use of EAA as an option into RID/ADR, provided regulatory tests could be developed which defined the performance criteria such materials would need to meet in order to be used.
34. This would enable to avoid the use of EAA that have not proved to have a positive effect, and may indeed have a negative one by inducing the first responders to feel a false safety and expose their lives when acting on the tanks.
35. The inclusion of the option to use of EAA would be linked to the exemption of having to apply other measures, and could be interesting in some very specific cases.
36. The working group would like to hear a first opinion of the Joint Meeting on the use of this technology, as regulating the use of EAA would involve a considerable amount of work, and probably some further testing, and should be only done after an initial support of the Joint Meeting.
37. Finally, the working group recognizes that it has not seen the possibility to clearly propose protective measures for the case of BLEVE caused by fuel tank fire. By protecting the tyre fires from spreading through metallic fenders the fuel tank is also protected. However, a BLEVE may occur in case the fuel tank of a vehicle fails and the fuel is released as a pool below the vehicle and it is ignited, depending on the geometry of the leak and of the pool below the vehicle.
38. The working group has not been able to design suitable measures that would avoid these cases of BLEVE when the tank fails and the fuel is released.
39. Further information on the different proposed solutions may be sent to the Joint Meeting as informal documents by diverse members of the working group.

Annexes

40. The annexes to this report have been published as informal documents INF.7:
1. Participants list to the meeting (INF.7/Add.1);
 2. Model for thermal response of Liquefied Petroleum Gas Tanks subjected to accidental heat input (INERIS) (INF.7/Add.2);
 3. Fire testing at RISE research on Thursday 7 March 2019 (RISE, Norway) (INF.7/Add.3);
 4. Impact of fire protection on a truck fender (RISE, Norway) (INF.7/Add.4).
 5. Expanded aluminum (EA) and BLEVEs (Institute for Risk Sciences) (INF.7/Add.5);
 6. Vehicle of the future (Liquid Gas Europe) (INF.7/Add.6);
 7. Information on a new design of Expanded Aluminium Alloy (EAA) (Technokontrol) (INF.7/Add.7).
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