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Working Party on the Transport of Dangerous Goods

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

Bern, 26-30 March 2007
Item 6 of the provisional agenda

REPORTS OF INFORMAL WORKING GROUPS */

Report of the informal working group on the reduction of the risk of a BLEVE

Transmitted by the Government of the Netherlands

1. The working group held a first session from 8 to 10 November 2006 in The Hague, the Netherlands under the chairmanship of Mr. P. de Leeuw (Netherlands). The meeting was attended by representatives of Belgium, Canada, France, Germany, the Netherlands, Norway, Poland and the United Kingdom and the following non-governmental organisations: European Liquefied Petroleum Gas Association (AEGPL), International Technical Committee for the Prevention and Extinction of Fire (CTIF), International Road Transport Union (IRU) and International Union of Private Wagons (UIP).

2. The documents on the agenda were as follows:

- report Joint Meeting March 2006, ECE/TRANS/WP.15/AC.1/102 (OCTI/RID/GT-III/2006-A), par. 5-12, 20 and 21 (report of the Joint Meeting on its March 2006 session);

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*/ Circulated by the Intergovernmental Organization for International Carriage by Rail (OTIF) under the symbol OTIF/RID/RC/2007/11.

- ECE/TRANS/WP.15/AC.1/102/Add.1 (OCTI/RID/GT-III/2006-A/Add.1), item 4 (report of the Joint Meeting Working Group on tanks (March 2006 session));

- ECE/TRANS/WP.15/AC.1/2006/8 (OCTI/RID/GT-III/2006/8) (Netherlands);

- Informal document INF. 3 (Netherlands) (March 2006 session);

- Informal document INF. 26 (AEGPL) (March 2006 session).

3. Mr. J. Lintsen, Deputy Director-General of the Ministry of Transport, Public Works and Water Management of the Netherlands welcomed the participants. He explained the Netherlands' policy in the field of dangerous goods, which is not restricted to transport but takes the whole chain into consideration. A study in the Netherlands on risk analysis including a cost benefit analysis showed that the societal risk would be reduced significantly if the risk of a BLEVE and especially a hot BLEVE could be reduced. He wished the participants a fruitful meeting.

4. The Chairman referred to the key elements of the mandate given by the RID/ADR/ADN Joint Meeting:

(a) Prevention of a BLEVE;
(b) Reduction of the effect of a BLEVE;
(c) Hot BLEVE and cold BLEVE should be considered;
(d) Technical and other measures should be taken into account;
(e) Other matters of principle.

5. The theme of the first day was the question whether a BLEVE is a real problem or not. Presentations elaborating this issue were given by representatives of Canada, Netherlands, Norway, AEGPL and CTIF. A summary of the presentations and reactions can be found in annex 1 of this report (English only). The full presentations will be made available to all participants of the informal working group.

6. All participants agreed that a BLEVE is indeed a problem and that it is therefore necessary and useful to discuss how to prevent a BLEVE and how to reduce the effects of a BLEVE.

7. There was some discussion on the definition of a cold and hot BLEVE. All participants agreed that a distinction could be made between cold and hot BLEVE. However to agree of on an exact definition of both phenomena appeared to be complicated and time-consuming. The group therefore decided not to pursue this discussion, for the time being.

8. The theme of the second and third days was how to reduce the risk of a BLEVE. On this issue presentations were made by representatives of the Netherlands, AEGL, Canada, CTIF and Germany. A summary of the presentations and reactions can be found in annex 1. The full presentations will be made available to all participants of the Working Group.

9. With respect to measures to be taken, some participants argued that RID, ADR and ADN only deal with normal conditions of transport and not with measures in case of an accident and therefore only preventive measures should be considered. Others were of the opinion that many of the regulations in RID/ADR/AND deal with accident situations and that all measures to avoid a BLEVE should be taken into account. After a lengthy discussion it was agreed to make an inventory of all kinds of possible measures to prevent a BLEVE with the associated advantages and disadvantages. The result of this first scan can be found in annex 2. Participants agreed that this list of possible measures was just a first step and should be refined, amended and restructured at later meetings.

10. The informal working group therefore recommends that an additional session be held. It could be held after the March 2007 Joint Meeting session. The Government of Norway is prepared to host it.

Annex 1

Presentations and reactions

(English only – Text not edited, reproduced as transmitted)

Presentations on the question: "What is the problem or the risk of a BLEVE?"

Introduction by the Netherlands

Introduction Dutch policy on the transport of dangerous goods.

The deputy DG of the Ministry of Transport of the Netherlands elaborated on Dutch policy regarding the safety of the transport of dangerous goods over the past few years. This policy is influenced by the Enschede disaster in 2000 where a storage of fireworks exploded, devastating the whole neighbourhood. This policy resulted in a study on measures to enhance the safety of the use, storage, production and transport of the (most) dangerous substances: ammonia, chlorine and LPG. One of the results was that the application of a heat resistant material on a LPG-tank would cut back the risk of a hot BLEVE by 85%. The necessary investment involves a large amount of money, but seems realistic and economically feasible when related to price per litre/km transported during the life time of the tank. The Dutch policy will continue a systematic approach to activities with dangerous goods and the risks involved for the society.

Presentation by Canada

In Canada and the USA the use of thermal protection systems against fire and safety valves on rail-tank wagons with all liquefied gases, with the exception of refrigerated gases are compulsory since the early 1980's. This policy is due to many accidents between 1958 and the late 1970's with non-insulated tanks. Since 1980 the occurrence of hot BLEVEs was reduced considerably. Continuous research resulted in a combination of measures and permanent adaptations of those measures. The compulsory thermal protection system combined with a safety valve for a given loaded tank car must prevent the release of any dangerous goods from the tank car, except through the safety valve, for a minimum of 100 minutes in a pool fire and 30 minutes in a torch fire. For the transport of chlorine there are additional considerations.
Since 1980 3 hot BLEVEs have occurred and 1 cold BLEVE in Canada and the USA. Nowadays that is related to 800.000 transport movements daily with dangerous goods.

Reactions:

The representative of Germany reminded the meeting that few BLEVEs have occurred in Europe and that a systematic approach to the problem is necessary in this situation.

Presentation by the Netherlands

The Netherlands uses a systematic risk analysis to calculate the risk of the transport of dangerous goods for the people present in the surroundings of the infrastructure [railways and roads]. The risk for a specific good like LPG is compared to the risk of other dangerous goods. Due to the great effects of a hot BLEVE the societal risk of the transport of LPG is dominant for the calculated risk along roads and railways. This method uses incident casuistry on all goods and not merely on dangerous goods. Therefore in the Netherlands the occurrence of incidents with the transport of LPG is not determinant for the calculated risk.

Reactions:

The representative of AEGPL pointed out that there were few incidents with low fatalities over the past 50 years.

The representative of Germany pointed out that the cold BLEVE in Los Alfaques in Spain (1976) resulted in 200 lives lost due to open fire on the camping near the tank vehicle. A few years ago there was a cold BLEVE in Germany; there was no ignition-source and fortunately no casualties. The representative of France said the issue of this meeting is the prevention of many victims. The prediction and comparison of the risks is very difficult with few incidents. This meeting should try to cope with the uncertainties and the effects of possible measures.

Presentation by Norway

The representative of Norway explained about a railway-accident in Lillestrøm in the year 2000. Two rail tanks with LPG were involved in a fire after a collision at the railway station of Lillestrøm. For 3 till 5 days 2000 people were evacuated from their homes near the railway station. The cause of the accident was a failure of the brakes of the train. Politicians in Norway find these consequences of an accident with a train unacceptable and want measures to be taken. The German rail tanks involved in the accidents were provided with a sunshield and were not equipped with a safety valve. In Norway a safety valve is compulsory. The fire brigade in Norway is against the use of sunshields because it hinders the fire fighting. A commission that investigated the accident recommended the use of safety valves and also the thermal insulation to prevent the overheating of dangerous gas.

The representative of Norway pointed out that severe accidents can be the result of silly mistakes and that it is task of the working group to prevent a BLEVE from happening. Norway also pointed out that tanks with LNG are already thermally protected and therefore this is an existing preventive measure.

Presentation by AEGPL

The representative of AEGPL said that his organisation wants to share all relevant information based on the experience and expertise of its members. He appreciated the broad approach taken by the working group and presented lists of preventive measures in the area of equipment (means), procedures (methods) and workers (persons). He also claimed there had been only 6 BLEVEs in Europe for the past 50 years and that the causes of those BLEVEs have been excluded by measures taken since. AEGPL showed a film of a modern road vehicle for the carriage of LPG and its precautionary measures. AEGPL also showed an event tree and said it is most important that measures should prevent the LPG from leaving the tank. The position paper of AEGPL for the Joint Meeting was already available to the working group.

Reactions:

In addition to the casuistry the representative of France told about an accident in 2003 that resulted in a BLEVE within 20 minutes after the collision of a LPG tank vehicle with an other truck followed by a fire. The rupture of the tank was due to the temperature which damaged the welding and not due to the collision. It was an old tank and the pressure was not so high. The tank was deformed by the collision. The representative of France concluded that a BLEVE can be initiated by a fire of the truck when the tank is deformed. A report on the incident in French is available for anyone interested. France was lucky this accident did not occur on a highway through a city and that the police was able to prevent other vehicles to come near the place of the accident. It was also fortunate that the fire brigade arrived after the BLEVE.

The representative of France was in favour of protective measures to prevent a BLEVE but was not convinced that thermal protection would have prevented this BLEVE.

The representative of the Netherlands pointed out that the event-tree of AEGPL excludes an external fire, but that these fires do occur in real life.

The representative of AEGPL agreed that an external fire cannot be excluded completely.

The representative of the United Kingdom suggested that depending on circumstances the available time before a BLEVE could better be used for evacuation of the public than for fire fighting.

Presentation by CTIF

The representative of CTIF presented information on the four BLEVEs in USA en Canada that occurred since 1980 and the casualties involved in these accidents. This issue is very important for the CTIF because the fire fighters bear the greatest risk of being killed by a BLEVE. The goal of CTIF is that there should be no fire fighters killed by accidents whatsoever. All necessary measures to guarantee the safety of fire fighters and others should be taken.

General reactions on the question: "What is the problem or the risk of a BLEVE?"

The Netherlands has a problem related to the societal risk and is of the opinion that measures should be taken to prevent a hot BLEVE. The Dutch public expects a solution to this problem.

AEGPL agreed that the Netherlands has a problem with many roads and railways crossing densely populated areas, but that other solutions might be more effective elsewhere.

The representative of France agreed there is a problem but thought a single solution is too easy. The problem is complex and causes differ. Some causes are easily tackled, but the efficiency of measures is hard to define. Investigation in France pointed out that there had been 59 fires with trucks in 6 months (all trucks, not limited to dangerous goods). There is a discussion on the time available for fire fighting and how to ensure that that time will be available. The measurement of the temperature inside the tank for example can give certainty about the risk of a BLEVE. The tracking of vehicles carrying dangerous goods is a measure that shows promise. The representative of France was of the opinion that if the risk calculation method of the Netherlands would be accepted for the risk of a BLEVE this should also have consequences for other risks.

The representative of Norway pointed out that, although Norway is not a densely populated country, roads and railways tend to cross cities and that this causes problems. The public perception of the risk of dangerous goods is changing and the safety of the general public has to be ensured. Trucks should be fireproof but fires will always happen. He asked for measures that are already standard in USA and Canada and at sea. The investigating commission in Norway also advised the measurement of the temperature in the tank, but Norway did not ask for that measure in the Joint Meeting because it is not a standard.

The representative of CTIF is aware that there are few accidents, but wants to ensure that sufficient time would be available for action by the fire brigade. In most circumstances evacuation is not a solution because it takes a lot of time to evacuate buildings. The necessary water supply is a problem along roads and railways.

The representative of AEGPL agreed on managing the risk but preferred a globally standard measure. AEGPL pointed out the risk of 5% more transport movements as a result of the weight increase by application of thermal protection on the tank.

The representative of Germany wants a complete insight of the advantages and disadvantages of possible measures before deciding on this matter.

Presentations on the question: “How to reduce the risk of a BLEVE?”

Presentation by the Netherlands

In the Netherlands the societal risk will be considerably reduced when measures are taken to prevent a hot BLEVE. A large number of possible measures were investigated by means of a Societal Cost Benefit Analysis (SCBA). Copies of the SCBA in English were available at the meeting. The Netherlands presented the causes of a hot and a cold BLEVE and the consequences in lethality of people when a 60 m^3 LPG tank vehicle or a 110 m^3 tank wagon explodes. The measures to prevent a hot BLEVE were also presented and the decision of the Dutch government to proceed in this matter.

The Netherlands showed a film of a test of a 3 m^3 stationary tank with a heat resistant coating and a safety valve in a pool fire. The test showed that the tank resisted the fire for at least

80 minutes. The temperature of the tank and the liquid/gas in the tank was measured during the test.

Reactions:

The representative of AEGPL asked how the coating would react in a collision.

The representative of the Netherlands answered that the producer of the epoxy coating was testing that, but that the coating seems very strong.

The representative of the United Kingdom shared the worry about damage of the coating in a crash.

The representative of Germany said that a coating only had merits in a fire without impact. Human behaviour and organisational aspects were important to prevent a BLEVE. BAM had also tested tanks with and without coatings and safety valves.

The representative of France said that a coating that can withstand an impact might be an effective solution. But a coating could also be an extra problem for the fire brigade when the delay effect would not be reliable.

The representative of the Netherlands said that a coating would be effective in many situations according to the experience of Canada and the USA.

Presentation by AEGPL

The representative of AEGPL told the meeting about measures taken by private enterprises to ensure there is no LPG release at an incident. It is a line-management responsibility for material, procedures and workers to prevent LPG release from the tank. The representative of AEGPL wants barriers to prevent an incident rather than measures to reduce the effects of an incident. A coating is a barrier after an incident. He presented a list of pro-active barriers and a list of re-active barriers.

Reactions:

The representative of CTIF stated that the AEGPL measures are very dependent on human behaviour.

The representative of AEGPL agreed that technical measures like a coating in Hong Kong and a safety valve on Shell-tanks can be of value globally.

The representative of Norway pointed out that re-active barriers are important, because Norway had a serious accident and was very near to a BLEVE in Lillestrøm. Management in the pro-active phase however is not enough.

The representative of AEGPL insisted that preventive measures are of primary importance.

The representative of Norway said that many pro-active measures are already part of ADR/RID rules, but that accidents still happen. Therefore re-active measures should be discussed.

Presentation by Canada

Vessel failure is a point of concern in Canada and many measures were taken to avoid that. Cold BLEVEs however call for different measures than hot BLEVEs. There was a definite reduction of hot BLEVEs after the introduction of the thermal protection combined with PRV. However every measure can have disadvantages in the extreme situation of an accident.

After recent accidents with tank wagons carrying chlorine and anhydrous ammonia there is a strong pressure to increase the puncture resistance of those tank wagons. Canada has the experience that detailed regulations requiring thermal protection and PRVs on rail tank cars are necessary and successful contributors in reducing the occurrence of BLEVEs.

Reactions:

The representative of France asked how the external tank inspections are done.

The representative of Canada answered that part of the external jacket and protection is removed and restored afterwards.

Presentation by CTIF

The representative of CTIF stressed that prevention is always better than reaction. He emphasized the importance of learning from accidents and recommended two sites: http://www.ntsb.gov/ and a http://www.csb.gov/. The response of the fire brigade includes: planning, personnel, equipment resources, training and water supply. He suggested the water supply at roads, railways and at tank stations should be improved. That would decrease time needed for effective fire fighting. Zoning law on dangerous places can also be helpful to prevent casualties from accidents.

Presentation by Germany

A test of a 45 m^3 rail wagon filled with propane for 22 % of its capacity, without insulation and pressure relief device in a pool fire was presented. A BLEVE occurred in 17 minutes. In another test a 5 m^3 storage tank with pressure safety devices failed in a pool fire after 7 minutes.

The representative of Germany presents a diagram of the tests showing the time-pressure characteristics of unprotected, water protected and insulated vessels for LPG. It shows that the use of a pressure relief device only is not enough to prevent a BLEVE. In combination with a water protected or insulated vessels however no BLEVE occurred

Annex 2

(English only – Text not edited, reproduced as transmitted)

I. Identified technical and operational measures to reduce risk / avoid BLEVEs during road and rail transport.

Table A1	Road and rail - technical measures
A1. 1	Pressure Relief Valve
A1. 2	Complete thermal protection
A1. 3	Thermal insulation
A1. 4	Sun shield
A1. 5	Aluminium foils / balls inside tank to prevent BLEVE
A1. 6	Protection against overfilling
A1. 7	Additional mechanical tank protection
A1. 8	Increased wall thickness tank
A1. 9	Apply normalised carbon steel
A1.10	Heat treatment after welding
A1.11	Higher integrity (foot-valve) vessel closure; interlocked transfer
A1.12	Thermal system to close foot valve
A1.13	Excess flow valves
A1.14	Control systems breaks
A1.15	Use of telematics
A1.16	On-board fire extinguish equipment
A1.17	Sufficient water supply near road/rail

Table A2	Road and rail - Organisational measures
	Operational measures
A2. 1	Additional inspection
A2. 2	Periodic inspection
A2. 3	Daily inspection + pre-shipment inspection
A2. 4	Modal shift road/rail/pipeline/ship
A2. 5	Routeing
A2. 6	Day time / Night time transport
A2. 7	On-line monitoring on-board computer + GPS
A2. 8	Tank size limit
A2. 9	Speed limitation
A2.10	**Safety management system**
A2.11	Journey management / route management
A2.13	Company control of rule violation
A2.14	Pre-start alcohol control
A2.15	Driver health/drugs/alcohol abuse
A2.16	Maintenance
A2.17	(Near) accident investigation / reporting
A2.18	(Internal) company audit program
A2.19	Quality assurance and quality management
A2.20	Emergency planning and preparedness
A2.21	Fire brigade education and training

Table B	Road measures
B1	**Technical measures**
B1. 1	Vehicle design
B1. 2	Accept only LPG tank vehicle or LPG semi-trailer
B1. 3	Improve Bumper/Side/Rear impact resistance
B1. 4	Electronic vehicle stability control to avoid overturning
B1. 5	Control systems brakes
B1. 6	Reduction of sources of fire
B1. 7	Automatic engine fire extinguisher
B1. 8	Limit capacity fuel tank
B1. 9	Aluminium foils/balls inside fuel tank
B1.10	Protection of fuel tanks
B1.11	Design and construction of fuel tanks
B1.12	Avoiding of sources of heat and ignition
B1.13	Tyre control + inflate with nitrogen
B1.14	Automatic battery master switch
B2	**Operational measures**
B2.1	Lane departure warning / distance warning
B2.2	Defensive driver training

Table C	Rail measures
C1	**Technical measures**
C1.1	Wagon design
C1.2	Improve Side/End impact resistance
C1.3	Over buffering tank wagons flammable gases/flammable liquids
C1.4	Crash elements tank wagons flammable liquids/flammable gases
C1.5	Derailment detection
C1.6	Hot box detection
C2	**Operational measures**
C2.1	Dedicated trains for flammable gases only
C2.2	On train segregation / protection wagons

II. Discussion of advantages and disadvantages of the identified measures

A1.1 Pressure relief valve
Advantages: 1. Limitation of the burst pressure (at PRV set point) 2. Delays burst 3. Overfill protection 4. Some cooling during venting 5. Reduced inventory 6. Warning signal to emergency service
Disadvantages: 1. In case of overturning limited cooling tank wall in vapour space 2. Wrenching off in case of accidents? 3. Potential source of leakage due to malfunctioning (especially in tunnels + flammable gases) + ignition source of fire 4. Potential negative effects overturning (e.g. torch fire) 5. In case overturning lower cooling effect but better than no PRV 6. PRV does not prevent overheating vapour space wall 7. On 110 m^3 tank PRV enough capacity (exist and tested in C) 8. Risk from vented gas (fire + toxicity + etc) 9. Risk of gas vented in tunnels (Flammable gases?)
Remarks:
A1.2 Complete thermal protection
Advantages: 1. Protection for at least 100 min (pool fire) 30 min (torch fire) if combined with PRV and other tank features 2. Smaller size of safety valves needed 3. Sufficient time for safe fire brigade response to pool fire 4. Cost benefit 5. Additional mechanical protection for some systems 6. Improved emergency evacuation 7. Sunshield not required? 8. Reduced effect zone due to vented LPG gas
Disadvantages: 1. Reduced effect if damaged 2. Reduced external tank inspection 3. Water cooling hindered 4. Effectiveness not proven in road accident situations 5. For existing tanks maximum allowed width exceeded 6. May increase corrosion risk 7. Efficiency in case of small tanks unknown (torch fires?) 8. Reduced pay-load increase in trips increase risks 9. Higher centre of gravity 10. Rail decrease of pay load due to more wall thickness 11. Cost benefit 12. 30 min torch fire not enough for fire brigade response 13. Behaviour rocketing unknown
Remarks:

A1.4 Sunshield
Advantages: 1. Limits the heat input to solar radiation 2. Better inspection possible compared to full insulation 3. Increase in pay load
Disadvantages: 1. Problems when cooling down 2. Higher filling degree 3. Can be ripped off 4. Opposite no 2 advantage
Remarks:

A1.6 Protection against overfilling
Advantages:
Disadvantages:
Remarks: 1. Procedural 2. Electronic control 3. Mechanical

A1.7 Additional impact protection
Advantages: 1. Better impact strength
Disadvantages:
Remarks: 1. Tank protection/impact protection 2. Includes measures A1.8, A1.11, B1.1, B1.3, C1.1, C1.2, C1.3, C1.4

A1.9 Apply normalised carbon steel
Advantages:
Disadvantages:
Remarks: • Improve cold temperature properties of steel • Improving impact strength

A1.10 Heat treatment after welding
Advantages:
Disadvantages:
Remarks: 1. Measure for carbon steel tanks

A1.16 On-Board fire extinguishing equipment
Advantages: 1. Could prevent escalation of small fire
Disadvantages: 1. Reliability
Remarks:

A1.17 Water supply near rail/road
Advantages:
Disadvantages:
Remarks: 1. Water often not available on critical locations 2. Also water supply near loading and unloading facilities

B1.4 Electronic vehicle stability control
Advantages:
Disadvantages:
Remarks: 1. Measure reduces roll-over in curves

B1.6 Reduction of fire sources
Advantages: 1. Encapsulation engine 2. Keeping LPG in de tanks, all valves closed
Disadvantages:
Remarks:
B1.10 Protection of fuel tank
Advantages: 1. Reduce significantly external fire size
Disadvantages:
Remarks: 1. Must be applied to all vehicles? 2, Assess in combination with measures B1.8, B1.9, B1.11

B1.12 Avoiding sources of ignition
Advantages: 1. Encapsulation engine 2. Keeping LPG in de tanks, all valves closed
Disadvantages:
Remarks:

B1.13 Tyre control and inflate with nitrogen
Advantages:
Disadvantages:
Remarks: 1. Nitrogen results in lower tyre temperatures than air 2. This measure should include requirements for tyre quality

A2, B2, C2 Operational requirements
Advantages:
Disadvantages:
Remarks: 1. Include the measures in the tables A2, B2, C2

A2.1 Additional inspection
Advantages:
Disadvantages:
Remarks: Remarks periodic testing: Inspections + tests • Focus on critical safety components Include NDT + specific equipment inspections