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INLAND TRANSPORT COMMITTEE

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, 25-28 March 2008
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 on behalf of the working group

1. The working group held a third session on 27 and 28 November 2007 in Rome, Italy under the chairmanship of Mr. Arne Johansen (Norway). The meeting was attended by representatives of Belgium, France, Germany, Italy, Latvia, the Netherlands, Norway, Poland, Portugal, the United Kingdom and the following non-governmental organisations: European Liquefied Petroleum Gas Association (AEGPL), European Industrial Gas Association (EIGA) 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), para. 5-12, 20 and 21;
- Report Joint Meeting working group on tanks, ECE/TRANS/WP.15/AC.1/102/Add. 1 (OCTI/RID/GT-III/2006-A/Add.1), item 4.
- ECE/TRANS/WP.15/AC.1/2006/8 (OCTI/RID/GT-III/2006/8) (NL),
- Doc. March 06/ INF. 3 (NL)
- Doc. March 06/ INF. 26 (AEGPL)
- Doc. ECE/TRANS/WP.15/AC.1/2007/11 - (The Netherlands) Report of the first informal working group on the reduction of the risk of a BLEVE
- Doc. March 07/INF.22 (AEGPL)
- Report Joint Meeting March 2007 ECE/TRANS/WP.15/AC.1/106 (OTIF/RID/CE/2007-A), para. 62
- Doc. September 07/INF. 9 – (Norway) Report of the second informal working group on the reduction of the risk of a BLEVE
- Report Joint Meeting September 2007 ECE/TRANS/WP.15/AC.1/108 (OTIF/RID/CE/2007-B), para. 105.

3. The meeting was welcomed by Mr. Arne Johansen, Chairman of the working group session. 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.

4. The meeting continued on the work agreed upon at the first session of refining, amending and restructuring the list of possible measures that had been set up at the first and second meeting of the working group.

5. The representatives in the meeting finished discussion of the advantages and disadvantages of the measures. The result of the discussions can be found in annex 1. The revised list of measures and the revised list of advantages and disadvantages can be found in Annex 2.

6. The meeting agreed on a procedure to establish a method for ranking the measures with a good potential for reducing risks of BLEVEs and increasing safety in the transport of dangerous goods as a whole.

7. The informal working group therefore recommends that an additional session be held. The work of this session will be to prioritise the measures in order to present firm proposals for changes in the texts of RID/ADR.

8. The Netherlands invites the working group for the next meeting in The Hague. The meeting will be held in the period from 16 to 18 June 2008.

Annex 1 - Discussion on measures

Report of the last working group meeting (in Norway, June 2007)

Mr. J. Ludwig asks AEGPL for the information on road accidents involving a LPG tank-vehicle that is mentioned in the report of the last meeting. Mr. C. Monin will make the information available.

Presentation by the Netherlands (on progress coating implementation project)

The representative of the Netherlands presents the intermediate results of the 10 mm thermal epoxy coating implementation project in the Netherlands. On a national level approximately 35 LPG tank-vehicles will be thermally coated to reduce the risk of LPG-delivery at Dutch LPG refuelling stations. Without a thermal coating on the LPG tank-vehicles the risk is considered too high. Without additional risk reducing measures these stations have to stop the delivery of LPG. Also on request of the working group (see report WG Tonsberg, June 2007), the Netherlands investigates some feasibility questions with respect to a thermal epoxy coating. These questions are:

1. Define critical defect size that may not be exceeded.
2. Effectiveness after a collision.
3. How to coat the tank support.
4. How to inspect the critical parts of the tank for cracks and corrosion.
5. Can the coating also replace the sunshield?
6. Investigate the best abatement strategy for fire brigade (How to recognize coated tank included).
7. Define test criteria for new suppliers of a thermal coating.

The intermediate results of TNO research show:

- Scratches in the thermal coating up to 40 mm wide are no problem, because in a fire the coating will expanded (from 10 mm to 40 mm) and will protect the defect. Larger defects are not expected during LPG delivery at a station. During transport accidents larger defects might be possible. The damage due to transport accidents will be further investigated.

- Some tank supports are subject to material stress and require regular visual inspection. Therefore these tank supports should not be coated. It will be investigated if these critical tank supports can be protected with a removable heat protection. Heat transfer calculation will be performed to determine if these tank supports can remain unprotected.

- New tank-vehicles in the Netherlands can be coated relatively easy, but some old tankers give more problems due to the limited space between the tank and wheel construction.

- The ADR-regulations 6.8.3.2.14 and 4.3.3.2.2 allow the use of thermal insulation or a sunshield on a tank-vehicle with liquefied gases. The maximum operating

temperature of the tank may be lowered from 65 °C to 55 °C if the tank is insulated or equipped with a sunshield. Presently the Dutch LPG tank-vehicles are equipped with a sunshield. It has been assessed if the thermal coating gives enough insulation to prevent a temperature higher than 55 °C. For purpose of comparing the effectiveness of the sunshield with a specific thermal coating, the Netherlands calculated the gas temperature in the tank-vehicle with an epoxy coating at 2 weather conditions:

- A North Europe like weather type (day-time temperature 35 °C and solar radiation 800 W/m^2, night temperature 25 °C and no solar radiation)

- A Southern Europe weather type, with 90% and 10% load and at daytime and nighttimes (day-time temperature 45 °C and solar radiation 1200 W/m^2, night temperature 35 °C and no solar radiation)

Even for the South Europe weather time the maximum temperature was not exceeded in a 10% loaded tank. It seems that the sunshield (ca. 800 kg) can be replaced by the specific thermal coating (ca. 1500 kg). The report will be ready in a few weeks and made available for the working group.

The representative of AEGPL says that loading conditions in Southern Europe are sometimes different than in the Dutch investigation. A remark is that many tanks have no sunshield and are not similar.

The representative of the United Kingdom asks if only one type of coating has been tested. The answer is yes.

The representative of Portugal asks if the temperature in the tank had been monitored. The answer is no, the temperature has been calculated.

The representative of Germany asks for all available technical reports on the matter. The Netherlands will also send the technical reports of the USA to the representative of Germany.

Presentation by AEGPL (road transport safety management)

The representative of the AEGPL presents a list of elements to monitor road transport safety management with references to standard EN 12798: 1999 Transport Quality Systems – Road, rail and inland navigation transport – Quality system requirements to supplement EN ISO 9002 for the transport of dangerous goods with regard to safety.

The key issue is to reduce the probability of an incident by good safety management. A safety management system (SMS) is a possible structured auditable means of reducing road transport risks. A manager shall be responsible for the SMS of the organisation, and see to the defining of a safety policy and the communication with drivers and staff about it. The aim shall be to bring the risk to as low a level as reasonably possible by acting safely in a structured process. The process shall involve: the identification of risk, the probabilities and potential consequences, the control of preventive measures and the recovering actions in case of an incident. The qualifications and good conduct of the drivers are an important aspect to prevent incidents and management control is needed to preserve that. Also monitoring is

needed to see if the safety policy is sufficient or needs adaptation. The organisation shall have adequate plans and recourses to continually improve the safety. The SMS shall be audited annually and any non-conformances shall lead to adequate actions.

The representative of Belgium points out that small contractors cannot meet to this standard because the costs of an SMS are high. According to AEGPL even contractors in India are certified for ISO 9000 in order to transport dangerous goods for the big fuel companies. There is a tendency for the transporters to act on a professional level.

The representative of France says it is mandatory in France since 1994 for LPG-tanks to be ISO 9000 certified. Small companies can apply to it. The Ministry of Transport however could not measure the result of this requirement. The preventive effectiveness of the measure is not clear. Companies claim a preventive effect, but the statistics do not show this effect. Evaluation on the effect of preventive measures is very difficult.

The representative of Germany says there can be a problem to find good qualified drivers for the transport of dangerous goods and less qualified drivers will do the job.

The representative of the Netherlands says there is a difference between theory and practice and that human conduct will not always follow the ideal standard.

The representative of Belgium says drivers don't want all these controls of their conduct and will prefer to transport regular goods. AEGPL says extra salary can compensate this disadvantage for the driver.

The representative of the United Kingdom says the discussion concentrates on road transport, because for rail transport a safety management system is already mandatory within the EU. The SMS needs to take account of dangerous goods if these are carried.

Presentation by the Fire fighters department of the Italian Ministry of Interior

The representative of Italy presents the organisation of the Italian fire fighters, the way of action in CBRN-incidents (Chemical, Biological, Radioactive and Nuclear) and especially on accidents with LPG-tank-vehicles. There have been few large accidents with LPG in the past years. The Italian number of accidents involving LPG vehicle tanks occurring between 2001 and 2006 show a remarkable decline from 65 to 10 accidents. The cause of the decline could be good driver training or lack of registration of small incidents. The fire fighters use a thermo camera (to check the amount of liquefied LPG in the tank) at CBRN Emergency response in order to decide to intervene and to check if cooling down of the tank-vehicle is effective. The specialist teams for CBRN-incidents have equipment for the draining of damaged road or rail tank-vehicles. The fire fighters participate in international trainings. The average reaction time in Italy for the Fire brigade is 11 minutes.

The representative of Germany asks if the reported incidents are all accidents during transport. The answer is yes.

The representative of Portugal asks what the Italian fire fighters propose to prevent accidents with road tanks that can result in a BLEVE. The Italian fire fighters say the approach risk of a possible BLEVE asks for good information on the physical state of tank-

vehicles and temperature and the condition of the valves. The fire brigade will extinguish the fire and stay in the safety-zone. Information on the number of fire fighting-trucks needed is necessary and experts will be flown over in case of a CBRN-accident.

The representative of the United Kingdom asks what happens when the valves are damaged. The answer is that the Italians have special equipment to drain in case of a damaged tank-vehicle.

The representative of AEGPL says the Italian fire brigade has good technology to fight accidents with LPG because a lot of LPG is transported in Italy.

The representative of the Netherlands asks for the reaction time of the experts. The answer is that the fire truck and the water supply can be present in an average time of 11 minutes and the experts can be present in an average time of one hour. The experts are located in two regions of Italy and can travel by plane to every location in Italy.

Discussions on measures

In Annex 2 the advantages and disadvantages of measures are listed.

In this Annex discussions on advantages and disadvantages of measures and the reason to delete certain measures from the list of measures are reported.

Design and construction of fuel tanks

The representative of France wants to improve this for all fuel tanks in WP.29, because too much combustible material is allowed on trucks. The representative of Belgium says this is a good option to influence the fire-source. The representative of the Netherlands says that the effectiveness of this measure is best when all cars have a better fuel tank, because in an accident any car can engulf a fire. The representative of EIGA points out that tyres are an important ignition-source and that it is very difficult to extinguish a tyre-fire. The representative of Germany says the limit for a fuel tank on a dangerous goods truck is 1500 litres; he suggests that some reduction could be arranged in Chapter 9 of ADR, he is not in favour of limiting 1.1.3.3 of ADR. The representative of France says this limit is purely economical and that a limit of 500 litres could be enough. The general limit for fuel tanks on trucks is a very high limit of 4000 litres. The representative of AEGPL points out that the majority of tank cars don’t have big additional fuel tanks to a total amount of 4000 litres. The representative of Norway says in Norway the transport of LPG by rail has stopped and trucks now transport everything. The expert from TNO says that theoretically a tank with 100 litres of diesel could produce enough heat for a BLEVE and therefore limitation does not prevent a BLEVE.

The representative of the United Kingdom points out that measure B1.7 is already about the limit capacity of fuel tanks.

Avoiding sources of ignition

It was stressed to avoid fires caused by specific overheating parts of equipment (brakes, bearings,). It was also recalled that in case of an accident in practice always a source of ignition is available, because of short-circuiting by defects.

Table C Rail measures

Wagon design

Removed from the list because it is too general and already covered by more specific measures.

Enhanced “Hot box” detection systems

The existing systems are not working very well and improvements are needed. The representative of the Netherlands says that a new system called “Gotcha/Quo Vadis” to detect the condition of the wheels has been implemented on more than 40 spots of the Dutch railway system. A bad condition of the wheels can lead to a “hot box” situation.

Dedicated trains for flammable gases only

The representative of the Netherlands says this measure has the advantages that tanks with other fuels and weaker tanks are not present in an accident with LPG. The representative of France points out that this measure has already been discussed in RID and is considered problematic, because it will lead to a modal shift of transport by rail to road and water. On the other hand it is already done in practice when it is possible to transport a dedicated train with LPG. The representative of Norway says in Norway dedicated trains are not possible with the number of wagons transporting LPG. The representative of Germany does not object to dedicated trains from the Netherlands to Poland, but does not want this as a general measure for all situations. It is not sure that this is better for the safety. The measure is deleted from the list.

On train segregation/protection distance

The representative of the United Kingdom says this measure is no longer active in the UK; there is a wish to move towards simplified arrangements. The measure does not prevent a fire; it only prevents the presence of fuel to the fire. The representative of France says this measure has been discussed several times and that experts are not in favour of it and not only for logistical reasons. A protection wagon can be a bad wagon that is perhaps more dangerous. The representative of Germany remarks that in RID protection wagons are discussed, but not yet a protection distance. The measure can influence the frequency of a fire occurring. The representative of France is of the opinion that a protection distance is practically the same idea as a protection wagon. Every wagon shall be safe enough to be anywhere on the railway. Moreover alternative measures such as crash elements and impact resistance are better than a protection distance.

Selecting/ranking measures

Presentation by the Netherlands

The Dutch proposition for a quantitative method to prioritise the measures has not been accepted in the last meeting in Norway. The Netherlands now suggests a more qualitative method to select measures. The idea is to place the measures in a matrix with a scale for the reduction of risk of a BLEVE and the costs of the measures. A measure in the matrix may not increase an other risk.

The representative of Germany says two matrixes are needed for a hot and a cold BLEVE because a thermal coating has no effect for the prevention of a cold BLEVE.

The representative of France thinks it is difficult to estimate the risk reduction in a rational way.

The representative of the Netherlands says experts on risk reduction can help to make an estimation.

Presentation by AEGPL

The representative of AEGPL suggests to use the bow-tie scheme to classify the measures in preventive, protective and curative measures. The primary aim shall be to avoid an accident by putting barriers before the accident, such as an SMS. The second aim is to prevent a leak or a fire that can cause a BLEVE. The third aim is to take curative measures to avoid a BLEVE after an accident and a fire.

Discussion on selecting/ranking measures

The chairman does not see opposite directions in the two propositions and suggests a combination of the two schemes to select measures.

The representative of the Netherlands says that preventive measures are very important but they can never prevent accidents to happen, because there are many causes that can lead to an accident.

The representative of France thinks both schemes can be helpful to makes choices. The AEGPL scheme does leave the question open if preventive and protective measure can make curative measure unnecessary. Even a burning car next to an LPG truck can cause a BLEVE without an accident, so a BLEVE can be caused by other external factors. Some events can be influenced and some cannot. No measure is 100 % effective.

The representative of UIP points out that both schemes only deal with advantages of measures and not with possible disadvantages; before starting to select and recommend measures there should be a more intensive discussion about the advantages and disadvantages of each relevant measure.

The representative of Norway reminds the working group that this discussion is about the prevention of a BLEVE and all measures that can contribute to that goal. In

preparation of the next meeting every member of the working group will classify the measures of Annex 2 in the suggested schemes. By doing so the discussion can focus on relevant differences in the classification of measures.

The Netherlands will send a new scheme to the working group that also contains the classification in the categories 1 preventive, 2 protective and 3 curative. The Dutch policy includes that low chance/great consequence incidents have to be avoided and that the costs of measures to be taken shall be related to the societal costs of a BLEVE. Every member will send the estimated classification of the measures in the scheme to the Netherlands in preparation of the next meeting. There will also be a possibility for remarks (comment column).

The representative of France asks for background information on the TNO data on European BLEVE accidents and near accidents. France will send information on truck accidents to the working group. TNO will send the asked data to the members.

Next meeting

The chairman says the working group comes closer to a firm proposal for regulations.

The representative of the Netherlands thanks the chairman on behalf of the working group for his contribution and wishes him a very good retirement.

The Netherlands invites the working group for the informal next meeting in the period from 16 to18 June 2008 in The Hague. The Netherlands will also chair the meeting and make the report. If yet another meeting is needed to come to conclusions France is prepared to organise a meeting in Paris in cooperation with AEGPL at the end of 2008.

Annex 2

(Items discussed and changed by the WG at this meeting is in red text)

1. 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	Sun shield
A1. 4	Aluminium foils / balls inside tank to prevent BLEVE
A1. 5	Protection against overfilling
A1. 6	Additional impact protection
A1. 7	Apply normalised carbon steel
A1. 8	Heat treatment after welding
A1. 9	Excess flow valves
A1.10	Use of telematics
A1.11	Sufficient water supply at loading/unloading sites
A1.12	Tank size limitations

Table A2	Road and rail – Organisational measures
	Operational measures
A2. 1	Additional periodic inspection
A2. 2	Routeing
A2. 3	Speed limitation
A2. 4	Safety management system
A2. 5	Journey management / route management
A2. 6	Company control of rule violation
A2. 7	Pre-start alcohol control
A2. 8	Driver health/drugs/alcohol abuse
A2. 9	Maintenance
A2.10	(Near) accident investigation / reporting
A2.11	Emergency planning and preparedness

Table B	Road measures
B1	Technical measures
B1. 1	Accept only single Rigid tank vehicle or semi-trailer for transport of gases
B1. 2	Improve Bumper/Side/Rear impact resistance
B1. 3	Electronic vehicle stability control to avoid overturning
B1. 4	Monitoring systems for tyres / brakes / bearings
B1. 5	Protection of fuel tank
B1. 6	Automatic engine fire extinguisher
B1. 7	Limit capacity fuel tank
B1. 8	Aluminium foils/balls inside fuel tank
B1. 9	Design and construction of fuel tanks
B1.10	Avoiding of sources of ignition
B1.11	Automatic battery master switch
B1.12	Higher integrity (foot-valve) vessel closure; interlocked transfer
B1.13	Non-return valves
B1.14	On Board fire extinguishing equipment
B2	Operational measures
B2. 1	Lane departure warning / distance warning
B2. 2	Collision prevention systems
B2. 3	Defensive driver training

Table C	Rail measures
C1	Technical measures
C1.1	Improve side impact resistance
C1.2	Over buffering /end impact resistance, tank wagons for flammable gases/flammable liquids
C1.3	Crash elements tank wagons flammable liquids/flammable gases
C1.4	Derailment detection
C1.5	Enhanced “Hot box” detection systems
C1.6	Control systems for brakes
C1.7	Recessed valves
C1.8	Impact resistance of wagons
C2	Operational measures
C2.1	On train segregation / protection wagons

2. Discussion of advantages and disadvantages of the identified measures

Table A1 Road and rail - Technical measures
A1.1 Pressure relief valve
Advantages: - Limitation of the burst pressure (at PRV set point) - Delays burst - Protection against overpressure e.g. in case of overfilling - Some cooling during venting - Less contents in the tank at BLEVE - Warning signal to emergency service
Disadvantages: - In case of overturning limited cooling tank wall in vapour space - Wrenching off in case of accidents? - Potential source of leakage due to malfunctioning (especially in tunnels + flammable gases) + ignition source of fire - Potential negative effects overturning (e.g. torch fire) - In case overturning lower cooling effect but better than no PRV - PRV does not prevent overheating vapour space wall (limited delay time to prevent hot BLEVE) - More than one PRV may be needed? - Risk from vented gas, especially in tunnels (fire + toxicity + etc). Bursting discs will reduce the risk.
Remarks:
A1.2 Complete thermal protection
Advantages: - Protection for at least 100 min (pool fire) 30 min (torch fire) if combined with PRV and other tank features (figures derived from US/CAN standard) - Smaller size of safety valves needed - Sufficient time for safe fire brigade response to pool fire - Cost benefit - Additional mechanical protection for some systems - Improved emergency evacuation - Sunshield not required? - Reduced effect zone due to vented LPG gas
Disadvantages: - Reduced effect if damaged or degraded - Reduced external tank inspection - Water cooling after extinguishing fire hindered - For existing tanks maximum allowed width exceeded - May increase corrosion risk - Efficiency in case of small tanks unknown (torch fires?) - Reduced pay-load increase in trips increase risks - Higher centre of gravity - Rail decrease of pay load due to more wall thickness - Cost benefit - 30 min torch fire not enough for fire brigade response - Reduces the possibility to use thermal cameras during normal emergency actions - Makes use of ultrasonic filling control devices impossible

Remarks:

A1.3 Sunshield
Advantages: - Limits the heat input from solar radiation - Increase in pay load
Disadvantages: - Problems in cooling down tank under fire - Risk of cold BLEVE increases if damaged (because of reduced wall thickness)
Remarks:

A1.4 Aluminium foils / balls inside tank to prevent BLEVE
Advantages: - Redistributes the heat load from outside (cooling effect)
Disadvantages: - Reduces the payload - Uncertainty whether it works in the context of BLEVE prevention - Makes internal inspection of the tank difficult - Difficulties in obtaining contact with the inner walls of the tank - May be a problem with traces of sodium hydroxide in tanks
Remarks: Needs to be checked further if it is suitable for use in liquid gas

A1.5 Protection against overfilling
Advantages: - Reduces the possibility for cold BLEVE
Disadvantages:
Remarks: - Procedural - Electronic control - Mechanical - Already exists in RID

A1.6 Additional impact protection
Advantages: - Better impact strength / puncture resistance
Disadvantages: - Increased weight
Remarks: - Tank / service equipment - Includes measures A1.8, B1.1, B1.3, C1.1, C1.2, C1.3, C1.4

A1.7 Apply normalised carbon steel
Advantages: - Improving impact strength - Improve cold temperature properties of steel
Disadvantages: 1. Impossible to retrofit old tanks
Remarks: Use carbon steel that has been normalized by heat treatment

A1.8 Heat treatment after welding
Advantages: - Removes manufacturing induced stresses in the tank shell - Reduces the likelihood of stress induced cracks
Disadvantages:
Remarks: - Stress relief measure for carbon steel tanks - RID requires that water quenched steels are not to be used for welded tanks

A1.9 Excess flow valves
Advantages: - Prevents the release of the substance if the pipework or valve is sheared
Disadvantages: - Not effective if the pipework or valve is slightly damaged and only has a small leak
Remarks:

A1.10 Use of integrated telematics system
Advantages: - Early information on problems before an accident - Information may be available on the contents - Information on the tank and its equipment - “Pinpoints” the place of accident - Allows for “in-house” fleet management (driver compliance)
Disadvantages: - Overall coverage not readily available today - Overall coverage needs expensive infrastructure (Galileo ?) / maintenance
Remarks: - “In-house”-systems already in use - May be required for other dangerous goods in the near future - Security issues

A1.11 Water supply near loading/unloading sites
Advantages: - Cooling the tank during a fire
Disadvantages: - Needs sufficient delivering capacity from the water supply system (60 m^3 pr. Hour to cool 100 m^2)
Remarks:

A1.12 Tank size limitations
Advantages: - Reduce the consequence of a BLEVE
Disadvantages: - May increase number of road transports - May increase the number of possible leakages - Will increase number of rail transports
Remarks: - Situation vary in Europe today - Optimal size?

Table A2 Road and rail - Organisational measures

A2.1 Additional checks during periodic inspection
Advantages: - Makes sure that the critical equipment is working
Disadvantages:
Remarks: - Also includes equipment on the load carrier, e.g. “King Pin”

A2.2 Routeing
Advantages: - Avoid areas of large consequence in case of BLEVE
Disadvantages:
Remarks: - Similarity exists in RID/ADR Chapter 1.10

A2.3 Speed limitation
Advantages: - May reduce the possibility or severity of an accident
Disadvantages: - May create dangerous situations by overtaking of vehicles - Problems with enforcement
Remarks: - Already applied in a few European countries - Has been considered for rail, but not pursued

A2.4 Safety management system
Advantages: - Additional assures that the company follows the regulations plus appropriate safety measures
Disadvantages: - Dependant on the quality of the system as set up
Remarks: - General requirement in Chapter 1.4 for the undertaking to set up the system? - The Safety adviser monitor and reports? - For the goods mentioned in Chapter 1.10? - Goods of Transport Category 0 and 1? - Goods mentioned in RID/ADR/ADN Directive? - Shall this comprise all participants?

A2.5 Journey management / route management
Advantages: -
Disadvantages:
Remarks: - Part of the Safety management system? (AEGPL)

A2.6 Company control of rule violation
Advantages:
Disadvantages:
Remarks: - Part of the Safety management system? (AEGPL)

A2.7 Pre-start alcohol control
Advantages:
Disadvantages:
Remarks: - Part of the Safety management system? (AEGPL)

A2.8 Driver health/drugs/alcohol abuse
Advantages:
Disadvantages:
Remarks: - Part of the Safety management system? (AEGPL)

A2.9 Maintenance
Advantages: - Assures that the vehicle/wagon is properly maintained
Disadvantages:
Remarks: - Introduce provisions for the carrier similar to the ones for the tank-container 1(.4.3.4(b)) and tank-wagon operator (1.4.3.5(b)) in for road tank vehicles. Text regarding vehicle/wagon maintenance will have to be added. - Part of the Safety management system? (AEGPL)

A2.10 (Near) accident investigation / reporting
Advantages: - Catching the incidents makes it possible to implement corrections before a systematic problem escalates into an serious accident
Disadvantages:
Remarks: - SAFEX? - Promote the use of the existing RID/ADR system

A2.11 Emergency planning and preparedness
Advantages: - May reduce the effect of an BLEVE by informing and preparing involved parties beforehand
Disadvantages:
Remarks: - Included in the Safety management plan? - RID has regulations for marshalling yards - Fire brigade education and training has to be dealt with in relation to the emergency planning

Table B.1 Road measures - Technical

B1.1 Accept only single Rigid tank vehicle or semi-trailer for transport of gases
Advantages: - Eliminates domino effects between vehicles of a transport unit with liquefied gases
Disadvantages: - Not possible to transport tank containers on drawbar vehicles - More journeys
Remarks: - Drawbar vehicles used in some countries today

B1.2 Improve Bumper/Side/Rear impact resistance
Advantages: - Lower the risk of puncture
Disadvantages: - Loss of payload
Remarks: - Standard for side impact protection? - Recessed valve gear - Already in place for certain gasses

B1.3 Electronic vehicle stability control
Advantages: - Reduces risk of rolling-over in curves
Disadvantages:
Remarks: - Work already going on in WP.15/WP.29

B1.4 Monitoring systems for tyres / brakes / bearings
Advantages: - Gives early warning of fire hazard - Gives information on disc status
Disadvantages:
Remarks: - Work already going on in WP.15/WP.29

B1.5 Protection of fuel tank
Advantages: - Reduce probability of external fire
Disadvantages:
Remarks: - Should be applied to all vehicles (WP.29)? - Assess in combination with measures B1.8, B1.9, B1.11 - Tank material

B1.6 Automatic engine fire extinguisher
Advantages: - Reduces the possibility of transfer of an engine fire to the load
Disadvantages:
Remarks: - Established technology - May be retrofitted

B1.7 Limit capacity of fuel tanks
Advantages: - Reduces the size of the pool fire - Increases the payload
Disadvantages:
Remarks: - Change 1.1.3.3?

B1.8 Aluminium foils/balls inside fuel tank
Advantages: - Reduces the possibility of fire on the vehicle in case of an accident
Disadvantages:
Remarks:

B1.9 Design and construction of fuel tanks
Advantages: - Stronger tanks/better constructed tanks reduces the possibility of leakage and subsequent fire.
Disadvantages: - Only concerns the vehicle itself, not other sources of fire.
Remarks: - Connected to the measure B1.5 and B1.7. Better fuel tanks in general or just on DG-vehicles? Or just on LPG/LNG-vehicles? FL-vehicles only?

B1.10 Avoiding sources of ignition
Advantages: - Reduces the risk of a fire.
Disadvantages: - A very general statement which is difficult to quantify
Remarks: Already dealt with in under other issues, but is kept as a reminder

B1.11 Automatic battery master switch
Advantages: - Cuts off electric sources of ignition in an accident situation
Disadvantages: - Could be unsafe if activated during driving
Remarks: - Is safe working systems available on the market? - Must be able to be reset under control to activate safety equipment

B1.12 Higher integrity (foot-valve) vessel closure; interlocked transfer
Advantages: - Keeping the substance in the tank - Vehicle can not travel without the valve closed
Disadvantages:
Remarks: - Makes sure that the valve is closed while moving (self closing)

B1.13 Non-return valves
Advantages: - Prevents the release of the substance if the filling pipework or valve is damaged
Disadvantages:
Remarks:

B1.14 On-Board fire extinguishing equipment
Advantages: - Could prevent escalation of small fire
Disadvantages: - Systems for wheel fire suppression may be unreliable
Remarks: - On board automatic systems for engine fires, see B1. 6

Table B.2 Road measures – Operational

B2.1 Lane departure warning
Advantages: - Reduce the risk of an incident on the road
Disadvantages: - May reduce driver vigilance
Remarks: - Depends on the infrastructure being in place for the lane departure

B2.2 Collision prevention systems
Advantages: - Reduce the risk of an incident on the road
Disadvantages:
Remarks:

B2.3 Defensive driving training
Advantages: - Reduces the risk of incidents
Disadvantages:
Remarks: - Should be part of the safety management system

Table C.1 Rail measures, technical

C1.1 Improve side impact resistance
Advantages: - Reduces the risk of leakage in accidents
Disadvantages: - Loss in payload - May reduce possibility of cooling down the tank
Remarks:

C1.2 Over- buffering/ end impact resistance, tank wagons for flammable / flammable liquids
Advantages: - Reduces risk of leakage in accidents
Disadvantages: - Loss in payload
Remarks: - End impact resistance already introduced for toxic gases

C1.3 Crash elements, tank wagons for flammable gases / flammable liquids
Advantages: - Reduces risk of leakage in accidents
Disadvantages: - Loss in payload
Remarks: - Already introduced for flammable gases

C1.4 Derailment detection
Advantages: - Reduces the risk of accidents escalating
Disadvantages:
Remarks: - Already decided in principle for 2011 for toxic gases - False activations may be a problem under special conditions

C1.5 Enhanced “Hot box” detection systems
Advantages: - Reduces the risk of derailment
Disadvantages:
Remarks: - Already exists in some infrastructure, but needs improvement as to reliable - Various ways of detecting anomalies that could lead to a derailment - Modern wagon related systems will rely on telematics

C1.6 Control systems for brakes
Advantages: - Assures the status of the braking system of the complete train
Disadvantages:
Remarks: - ERA is asked to deal with this problem

Table C.2 Rail measures - Operational

C2.1 On train segregation / protection distance
Advantages: - Introduces “safety distances” between incompatible loads in the train
Disadvantages: - Difficult to arrange logistically - Could lead to increased risk in marshalling yards
Remarks: - Protection wagons was discussed in Committee of Experts of RID and it was decided not to extend existing regulations to other dangerous goods - Could be considered as a transitional measure to obtain the level of safety of C.1 2 and C.1 3 - Does not solve the problem of “incompatible trains”