

Economic Commission for Europe

Inland Transport Committee

Working Party on the Transport of Dangerous Goods

110th session

Geneva, 8 - 12 November 2021

10 November 2021

Item 5 (a) of the provisional agenda

**Proposals for amendments to annexes A and B of ADR:
construction and approval of vehicles**

Electrified vehicles for the carriage of Dangerous Goods

Transmitted by the Chair of the Informal Working Group

ELECTRIFIED VEHICLES

for the carriage of Dangerous Goods

WP.15 Informal Working Group Electrified Vehicles

Chairman: Mr. K. de Putter

General

Background – Electrified Vehicles are coming! Battery Electric and Hydrogen Fuel cell vehicles.

Mandate:

- Develop appropriate ADR provisions taking into account; the electrical equipment, prevention of fire risks and other risks caused by fuel.
- Take into account existing UN Regulations (No.13, 100, 122 and 134) when developing proposals
- Deliver proposals for relevant amendments to chapter 9.2 for the 110th session of WP.15.
- Participation – 71 registered participants
- Number of meetings – 3 IWG meetings and 5 subgroup meetings

Challenges

- Design of Heavy Duty (high end) vehicles is still not matured.
- All new systems, lack of experience.
- Basic concerns on Li-ion batteries.
- Pressure to introduce, but what about safety?
- How to construct vehicles to comply with future regulations?

Way of working

of the Informal Working Group

Informal WG meetings

Specialist areas

- **Vehicle Usage** Group
- **Vehicle Construction** Group
- **Hydrogen** Group
- **Load protection** Group
- **Explosives** Group

ADR vehicle categories

Overview

ADR vehicles overview:

- All except AT, FL and EX,
- AT,
- FL,
- EX (EX/II, EX/III, MEMU).

ADR Vehicle categories

Typical properties

All vehicles except AT, FL and EX

- Dangerous Goods in packages and tanks with limited capacity (7.1.2 ADR)
- General requirements for use on the road of the country of registration and 9.1.2 of ADR (braking and speed limitation).

AT vehicles– basic safety-

- Base vehicles for the carriage in tanks and battery vehicles with a capacity of 1000 litres or more and containers 3000 litres or more.
- Requires additional approval and ADR certificate
- Basic requirements for Electrical system, braking system, speed limiting and coupling devices.

ADR Vehicle categories

Typical properties

FL vehicles -Ignition of a flammable atmosphere-

- All requirements for AT vehicles and in addition prevention of risk on heating up, ignition and fire.
- Requires additional approval and ADR certificate.
- Battery Master Switch and Permanently Energized circuits, requirements on prevention fire risk of fuel and engines.

EX vehicles (EX/II, EX/III, Memu's) –heating up of the load-

- All requirements for AT vehicles and in addition prevention of risks on heating up, ignition and fire,
- Requires additional approval and ADR certificate.
- Battery master switch (EX/III and Memu's), , requirements on prevention of fire risk of fuel and engines limitations on voltage..

Other applicable Regulations

- WP.29 UN Regulations
- GTR 13 and 20
- The Phase 2 and further developments
- EU 79/2009/EU

Discussion

- General description of discussions
- Comparison carriage of packed goods
- Comparison to electrified busses
- Example rear view camera's instead of mirrors
- Use of solar panels
- Traction batteries on trailers

Core groups / IWG subgroups

- Presentation: **Vehicle Usage** – Mr. Pinna
- Presentation: **Vehicle Construction** – Mrs. Schmatze
- Feedback kick-off meeting: **Hydrogen** Group

IWG Subgroup: **Vehicle Usage**

Summary

- Group members
- Purpose and scope
- Initial risk analysis
- Open questions
- Other considerations

Vehicle Usage

Group members

■ **Country delegates**

- NL: Representative of the Dutch Government
- NO: DSB (Norwegian Directorate for Civil Protection)
- BE: SPRB (Brussels Regional Public Service)
- UK: DFT (Department for Transport)
- EU: European Commission

■ **NGOs / Companies**

- CEFIC (European Chemical Industry Council)
- MWV (German Mineral Oil Industry Association)
- OICA (International Organization of Automobile Manufacturers)
- EIGA (European Industrial Gases Association)
- IRU (International Road Union Road Transport Association)
- Vervaeke (Transport company)
- Shell (Product supplier)

Vehicle Usage

Purpose and scope

■ **Purpose**

- To identify the concerns and questions by the users of electrified vehicles.

■ **Scope**

- Transport
- Loading/unloading



- ADR 4.3
- ADR 6.8
- ADR ???

Vehicle Usage

Initial risk analysis

| Item | Hazard/hazardous situation | Comments | Mitigations - Questions |
|--------------|-----------------------------|--|---|
| Battery pack | Increased temperature | Battery (cells) need a minimum temperature to operate and a maximum for safe use. The pack is provided with a heating system and a cooling system (air). A question is if the heating/cooling system should be operable during loading and discharge operations with flammable substances and explosive atmospheres. | Does the heating or Cooling system need to be operable during handling of a flammable load where an explosive atmosphere may occur? If so, is the installation safe for this use? What are the normal operating temperatures envisaged? |
| | Fire | Fire is prevented by the use of a battery Monitoring system (BMS) that controls the minimum and maximum charge of each cell and temperature. On one side for safety, the other for longevity of the battery pack. However, fires are reported regularly for bicycle battery packs, maybe due to low quality of the BMS. Fire may also occur due to mechanical impact and internal shortcuts in the cells. The effect may be delayed. Duration of the fire can be longer than for “normal” fuels | Battery fires are rare in vehicles in normal use conditions. It seems that te electronics are of a good quality. In the Phase 2 of GTR 13/R 100 more attention is given to thermal runaway. Shall we await Phase 2 for approval of DG vehicles? Trucks use the less critical LPF type cells rather than a more flammable variant used by for example Tesla. A point of attention is the mechanical impact. What measures are taken to assist extinguishing? Other items to be considered: <ul style="list-style-type: none"> • Training of intervention teams / firefighters • Cool down with plenty of water to limit the spread of the disaster between the modules / cells of the battery • Caution monitoring after long extinguishing (several hours) - to limit the risk of the fire re-starting |
| | Sparks (shortcut) | Sparks may occur at the connections to the cells and to the pack itself. | The cells in the battery pack will be protected by a cover and due to R134 connections should not be able to be touched if access it possible without the use of tools. This is not likely to become a problem and no additional are expected to be necessary |
| | Chemical reaction with load | In some cases the battery pack may be compromised by corrosive substances. | A drip free cover would be sufficient.. |

Vehicle Usage

Initial risk analysis

| Item | Hazard/hazardous situation | Comments | Mitigations - Questions |
|---------------------|-----------------------------|--|---|
| High tension wiring | Sparks (damage/short cuts) | The wires (buses) are clearly indicated by colour as high tension. Wires are double insulated and tested for conductivity. (check R100 for in use conductivity checks) | |
| | Chemical reaction with load | Some substances may attack the insulation | Maybe ask for drip free protection when placed under the load area? |
| Inverter | Increased temperature | An increased temperature maybe expected! | What temperatures may be expected? Shielding required? |
| | Sparks (damage/short cuts) | (See high tension wiring) | |

Vehicle Usage

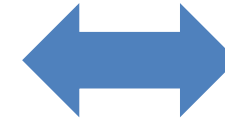
Initial risk analysis

- Other items analyzed
 - Motor(s)
 - Recharging equipment
 - Endurance braking device
 - Hydrogen storage system and devices (not started yet)
 - Pressure lines (not started yet)
 - Pressure regulator (not started yet)
 - Fuel cell assembly (not started yet)
 - Hydrogen refilling equipment (not started yet)

Vehicle Usage

Open questions

1. What is the minimum and maximum “running” temperature of a Li-ion traction battery.
2. What maximum temperature that may be expected when malfunctioning of the battery.
3. In case of the vehicle being stationary in an explosive atmosphere, needs the battery management system or cooling device be active?
4. If running during handling of a flammable load is the cooling system or BMS safe for an explosive atmosphere?
5. What type of cells will heavy Duty vehicle use (LPF type?)
6. What measures are taken to prevent battery damage due to mechanical impact on a heavy Duty vehicle.
7. In case of a fire due to damage or thermal runaway are there precautions taken to prevent heating up or igniting the dangerous load?
8.
32. What problems were experienced until today by manufacturers when using these types of vehicles for non DG applications?



Vehicle
manufacturers
will be able to
provide answers

Vehicle Usage

Other considerations

- Non-technical items
 - Driver training
 - Use of vehicles
 - Safety instructions
 - Emergency responders
- FL doesn't mean ATEX
- Overhead power lines to drive and charge the electrified vehicles
- Use the experience gained for adapting ADR to LNG/CNG also for H2

IWG Subgroup: **Vehicle Construction**

Summary

1) Approach

- Step 1
- Step 2
- Step 3

2) Due date

1) Approach: Step 1

| System/component | Potential risk for the cargo | Ignition by sparking/ electric arc | Ignition by heat | Existing safety requirement for system/component | Additional safety measure for system/component required? |
|---|------------------------------|---------------------------------------|------------------|--|--|
| HV system (acc. to UN-R 100) | | | | | |
| Electrical circuit (live parts) | | | | | |
| Rechargeable Electrical Energy Storage System (REESS) | | | | | |
| Electrical engine | | | | | |
| Drive engine | | | | | |
| Braking equipment | | | | | |
| Brake inverter, brake resistor, etc. | | | | | |
| Further system/component | | | | | |
| Electrical heater | | | | | |
| Starter battery | | | | | |
| Electrical loading ramp (where applicable) | | | | | |
| Refrigerated body (where applicable) | | | | | |
| Charging | | | | | |
| HV cable, charger, charging inlet, etc. | | | | | |

1) Approach: Step 2

| System/component | Potential risk for the cargo | Ignition by sparking/ electric arc | Ignition by heat | Existing safety requirement for system/component | Additional safety measure for system/component required? |
|---|------------------------------|---------------------------------------|------------------|--|--|
| HV system (acc. to UN-R 100) | | | | | |
| Electrical circuit (live parts) | | Yes / No | Yes / No | | |
| Rechargeable Electrical Energy Storage System (REESS) | | Yes / No | Yes / No | | |
| Electrical engine | | | | | |
| Drive engine | | Yes / No | Yes / No | | |
| Braking equipment | | | | | |
| Brake inverter, brake resistor, etc. | | Yes / No | Yes / No | | |
| Further system/component | | | | | |
| Electrical heater | | Yes / No | Yes / No | | |
| Starter battery | | Yes / No | Yes / No | | |
| Electrical loading ramp (where applicable) | | Yes / No | Yes / No | | |
| Refrigerated body (where applicable) | | Yes / No | Yes / No | | |
| Charging | | | | | |
| HV cable, charger, charging inlet, etc. | | Yes / No | Yes / No | | |

1) Approach: Step 2 (example)

| System/component | Potential risk for the cargo | Ignition by sparking/ electric arc | Ignition by heat | Existing safety requirement for system/component | Additional safety measure for system/component required? |
|-------------------------------------|------------------------------|---------------------------------------|------------------|--|--|
| HV system (acc. to UN-R 100) | | | | | |
| Electrical circuit (live parts) | | Yes | Yes | <p>UN-R 100, 5.1.1.2 “For high voltage live parts in areas other than the passenger compartment or luggage compartment, the protection degree IPXXB shall be provided.”</p> <p>ADR, 9.2.2.2.1 + 9.2.2.2.2.</p> | |
| Braking equipment | | | | | |
| Brake resistor | | No | No | UN-R 13 | |
| Further system/component | | | | | |
| Starter battery | | Yes | Yes | <p>ADR, 9.2.2.4 „Battery terminals shall be electrically insulated or the battery shall be covered by an insulating cover. Batteries which may develop ignitable gas and are not located under the engine bonnet, shall be fitted in a vented box.“</p> | |

1) Approach: Step 3

| System/component | Potential risk for the cargo | Ignition by sparking/ electric arc | Ignition by heat | Existing safety requirement for system/component | Additional safety measure for system/component required? |
|-------------------------------------|------------------------------|---------------------------------------|------------------|--|--|
| HV system (acc. to UN-R 100) | | | | | |
| Electrical circuit (live parts) | | Yes | Yes | UN-R 100 , 5.1.1.2 “For high voltage live parts in areas other than the passenger compartment or luggage compartment, the protection degree IPXXB shall be provided.” ADR , 9.2.2.2.1 + 9.2.2.2.2. | <u>Question:</u> ADR does not cover high voltage live parts. For high voltage live parts (dependent where they are located), are there additional requirements necessary, e. g. additional protection according to ADR (9.2.2.2.2.) or is it sufficient to reference to UN-R 100? |
| Braking equipment | | | | | |
| Brake resistor | | No | No | UN-R 13 | No |
| Further system/component | | | | | |
| Starter battery | | Yes | Yes | ADR , 9.2.2.4 „Battery terminals shall be electrically insulated or the battery shall be covered by an insulating cover. Batteries which may develop ignitable gas and are not located under the engine bonnet, shall be fitted in a vented box.“ | No |

2) Due date

| Approach | Action | Due date |
|----------------|--|--------------------------------|
| Step 1: | <ul style="list-style-type: none"> To identify all BEV/Hydrogen/Hybrid systems and components in comparison with an ICE truck (ICE= Internal Combustion Engine). Please consider the entire vehicle. | Mid-Nov/end of Nov 2021 |
| Step 2: | <ul style="list-style-type: none"> To check which systems/components could be a potential risk for dangerous goods as load and whether these systems/components are already covered by UN-R 100/UN-R ... and/or ADR chapter 9.2. | Mid-Dec 2021 |
| Step 3: | <ul style="list-style-type: none"> To decide which of the following possibilities are applicable for the identified systems/components (of the second step) which could cause an ignition of the load: <ol style="list-style-type: none"> For this system/component an additional safety measure is necessary -> which? Or Is it sufficient to reference in ADR to e. g. UN-R 100? Or For this system/component -> ADR stays as it is, no need for action | End of Jan 2022 |
| Step 4: | <ul style="list-style-type: none"> To work out an adjusted structure of ADR chapter 9.2 to integrate these BEV/Hydrogen/Hybrid systems/components -> to consider ADR vehicle categories (FL, AT, EX/II and EX/III) | End of Feb 2022 |

IWG subgroup: **Hydrogen Vehicles**

- Feedback of the kick-off meeting
- Experiences with CNG and LNG
- Dual Failures (leakage of hydrogen and oxygen)
- Properties of hydrogen and oxygen
- Effect due to lay-out of vehicles and tanks.

Open Questions

- Shall AT vehicles also be affected by additional requirements for EV's and hydrogen?
- How should a Battery Master Switch function for traction batteries?
- Combustion Heaters and Electrical ones?
- EX vehicles, shall we delay the introduction for this group until experience is gained?

Proposals and Timeline

Preliminary/indicative proposals

See Annex 1 of INF 14.

Timeline

- As soon as possible
- ADR 2023- ADR 2025
- MA's / national or EU wide allowance based on accepted text.

Request WP.15 to continue.

