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# E-vehicles and Explosives.

SOME QUESTIONS

# Welcome to Perth

- ▶ Bunuru – season of adolescence. Second summer.
- ▶ Nearly 30 years since we met here last. Third international conference of CIEs.
- ▶ Norway, Sweden, Netherlands, UK, Canada, all the Australian states.

# Introduction

- ▶ Europe has worked through the safety requirements for electric powered vehicles for transporting Dangerous Goods.
- ▶ Have set requirements for FL vehicles.
- ▶ Now considering explosives.
- ▶ United Nations Subcommittee of Experts
- ▶ Energetics Working Group.
- ▶ Other Players
- ▶ Questions and Answers.

# E-vehicles Now – for Dangerous Goods

- ▶ Very European focussed
- ▶ Two Regulatory Groups: WP/15 and WP/29
- ▶ ADR and International Vehicle Standards Regulations.
- ▶ VSR include Regulation 100
- ▶ **R100 is Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train**
- ▶ It is Addendum 99 of an Agreement - Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations.

# WP/29 and Regulation 100

- ▶ Sets general safety provisions for **all e-vehicles**.
- ▶ Protections: electrical shock, contact, isolation, water.
- ▶ Batteries: gas accumulation, failure warnings, low energy
- ▶ Prevention of unintentional movement (of the vehicle)
- ▶ Battery Safety: vibration, thermal shock, cycling, mechanical impact, fire resistance, short circuit protection, Overcharge, over-discharge, over-current, off-gases, thermal events, thermal propagation
- ▶ Test procedures for all the above.

# WP/15 and ADR (Dangerous Goods)

- ▶ WP/15 set up a group to consider the use of e-vehicles to transport flammable liquids and gases.
- ▶ The group included vehicle manufacturers and petroleum companies. (and others)
- ▶ They worked extensively on the properties of the battery systems and the effects of malfunctions
- ▶ Their decisions appear as the 2025 edition of ADR.
- ▶ Requires compliance with R100
- ▶ Plus
- ▶ ...

# ADR and e-vehicles (9.2.4.4)

- ▶ Allowed for FL vehicles subject to:
- ▶ No regenerative system on trailers
- ▶ Isolation Resistance Monitoring (Optional in R100) checks no e-shock to people
- ▶ Additional external signalling if stationary (warns of thermal runaway)
- ▶ Battery subject to risk evaluation (leading move to LIP for example)
- ▶ Cells protected from thermal propagation or alternative measures to protect the load. so we see modular battery packs.
- ▶ Charging inlet protected from overheating.
- ▶ Provision to de-energise the electrical circuits safely within 30 seconds. This is not a battery isolation switch.

# What about explosives vehicles?

- ▶ Now the WP/15 working group is considering what conditions should go into ADR if batteries are used to power EX vehicles.
- ▶ Added some explosives expertise and we followed the trail of those who considered FL vehicles.
- ▶ Also consulted UN Explosives Working Group
- ▶ EWG raised the following questions.

# UN EWG Questions

- ▶ Explosives are currently classified on the basis of hydrocarbon or wood fires. How differently might explosives behave in a lithium batteries fire?
- ▶ More specifically, what are the properties of a lithium batteries fire that may be different from a hydrocarbon or wood fire?
- ▶ Batteries are fitted with safety provisions to prevent ejection of materials, inter-cell propagation.
- ▶ Fixed systems are fitted with fire suppression
- ▶ Hans will expand a lot on this.

- ▶ **Cells and other ejecta may be projected from a battery pack in some adverse circumstances, thus projecting heat and reactive chemicals and electricity into the explosives. How might this be controlled.**
- ▶ Explosives are transported in solid containers. not considered credible that any ejecta would penetrate the container with enough force to initiate explosives. No energy data available.
- ▶ Batteries also in boxes. With pressure relief.

- ▶ **Preferably avoid placing batteries under the load.**
- ▶ Not sure how practical this is. It is not mandatory for diesel fuel vehicles.
- ▶ Could be done with drop-deck trailers. Another option for fire mitigation could be fire barrier and intumescent paint.
- ▶ Replicate steel fire barriers currently required in ADG Code.

- ▶ **Is it necessary to require tyre or running gear monitoring systems on vehicles?**
- ▶ Tyres and running gear present problems already for all vehicles, however the presence of lithium batteries will compound the problems.
- ▶ I believe this is a reasonable requirement for all vehicles. Pass this over to ADR WP/15 to consider for all EX and FL vehicles. Regulators standing by an open door; industry is keen to adopt.
- ▶ Only additional issue may be for regenerative system. the industry is working on this with ways to dissipate the energy. Plus cooling systems for energy dissipation.
- ▶ Regenerative systems not permitted on trailers for FL vehicles
- ▶ ADR already requires fire suppression for the engine compartment and thermal screens over the tyres .

**Electric detonators are still widely used. What might be the impact of a massive discharge from the battery.**

- ▶
- ▶ R100 is the specification for all e-vehicles and it provides comprehensive protections for battery accidental discharge. The electric detonators are carried in metal (faraday cage) boxes with insulated lining. I believe this is adequate protection.

## Could there be a bigger hazard from electro-static discharge if the vehicle is battery powered?

- ▶
- ▶ Must comply with EMC directive. Problem could be from induction potential.
- ▶ Normal protective measures for any ESD should suffice.

## What might be the impact on explosives in metal packagings?

- ▶
- ▶ This is hard to envisage. Many detonators are transported in metal lined (alfoil) packages as a precaution against stray currents. Any more substantial metal packagings are likely to be safer for the explosives.
- ▶ I believe this was driven by military or quasi military considerations, such as ammunition. SAAMI might like to comment.

## Is it possible to monitor the buildup of lithium in the battery?

- ▶
- ▶ This is a function of the BMS. According to UNSW:
- ▶ *there may be some evidence from CT scans (the battery needs to be taken out of the device and then examined). This is non-destructive but you can't really probe 2000 cells from a car in a reasonable amount of time and the resolution required to acquire evidence of lithium.*
- ▶ *Depending on the battery chemistry there are some indicators in the charge/discharge curves that may indicate lithium deposition – there are a few algorithms people are writing and electrochemical techniques that may give insight*
- ▶ *For a graphite anode you can get lithium plating at the anode. Fast charging often increases the likelihood of plating (due to overpotential). If it is a slow gradual lithium growth one can see this in part in lithium inventory loss and the change in the electrochemical charge/discharge curves and performance.*
- ▶
- ▶ bottom line is that it is possible but not practical to monitor the lithium buildup.

# Conclusion

- ▶ Likely to be in European regulations in 2027.
- ▶ Nice to hear at least one Competent Authority in Australia is open to the idea of e-vehicles. That isn't an agreement or endorsement, but it demonstrates an open mind.

Questions?  
For me or EWG

