

## **Economic Commission for Europe**

### **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**

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Item 5 a) of the provisional agenda

**Proposals for amendments to RID/ADR/ADN**

**pending issues**

### **Transport of electric energy systems and lithium ion batteries Comments to ECE/TRANS/WP.15/AC.1/2022/20**

**Transmitted by the Government of France**

#### **Introduction**

1. France would like to thank Sweden for its continued effort to deal with this issue. We believe it is a real issue. The use of electric power systems for the use on workplaces but also in power tools or even small mobility engines should be encouraged as it is cleaner than other fuels. We also agree that currently the regulation is a disadvantage to the use of these systems and batteries in general.
2. However, we believe that the issue is broader and covers more items than batteries in cargo transport units as defined in UN 3536. Power supplies are indeed used on workplaces but also batteries for power tools and they need to be carried. Due to the definition of UN 3536 there is an overlap between small units classified under this entry (smallest possible size 1 m<sup>3</sup>) and big batteries or battery assemblies falling under UN 3480.
3. The exemption system under 1.1.3.6 has been designed at a time where knowledge and experience concerning batteries was not as complete as today and it is particularly unfair compared to other dangerous goods such as flammable liquid that are competing with them. We now have a better idea on how threshold of 333 kg (expressed as mass) is not representing the real risk of these batteries. It is even contra productive as a stronger batteries with more weight in non-energetic part would be penalized in comparison to a lighter one.
4. As our work aims at drafting the 2025 amendments, we are of the opinion that this opportunity should be used to broaden the scope of discussion to get a solid solution that would deal with the issue of transport exemptions for power units and batteries in a more consistent way.
5. The threshold value should be expressed in energy content or capacity (kWh) and on an equivalent risk reasoning similar to the one applied for other type of goods, and not only on the size and type currently in use because these will change over time.
6. The size of batteries accepted in mobility application can be used as an indication, but it should take care of the ones used in heavy vehicles and not only passenger cars (in the same way than the quantity of flammable liquids relates more to the quantity in heavy goods trucks).
7. We see UN 3536 as an equivalent to UN 3528 to UN 3530 when applied to power supply engine and special provision 389 as equivalent to SP 363 in this respect. An exemption should be defined in 1.1.3 and it is better not to change the text of the UN Model Regulations.


### Information about the size of batteries in use in vehicles

8. Currently many electric vehicles are in circulation on the road. The nominal energy of e-car battery varies from 18 kWh for small urban vehicle, up to 100 kWh for a sedan. The table below detail battery energy of different vehicles in 2021.

Brand	Battery	Battery capacity (KWh)	Travel range (mile)	Efficiency (KWh/mile)
Smart Fortwo Electric Drive	Lithium-ion	17.6	65	0.25
Hyundai Ioniq Electric	Lithium-polymer	28.0	124	0.23
Nissan Leaf	Lithium-ion	30.0	107	0.28
Kia Soul EV	Lithium-polymer	30.5	111	0.27
BMW i3	Lithium-ion	33.0	114	0.27
VW e-Golf	Lithium-ion	35.0	120	0.26
Renault Zoe	Lithium-ion	41.0	250	0.26
Tesla Model S-75	Lithium-ion	75.0	249	0.33
Jaguar i-Pace	Lithium-ion	90.0	234	0.36
Tesla Model X- 100	Lithium-ion	100.0	371	0.37

Figure 1 : Review of electric vehicle energy storage and management system: Standards, issues, and challenges Mohammad Kamrul et al. JES, 2021

9. In addition to individual cars, e-buses are also in circulation. For those large vehicles, the battery size is larger and depends on the charging possibilities offered on their road. The tables below show that typical battery nominal energy for this application varies between 100 kWh and 400 kWh. In conclusion, batteries as large as 400 kWh are already in use for mobility applications.



	Battery exchange	Charging at every bus stop	Charging at final destination	One charge per day
Number of cycles / day	3 – 8	150 – 250	5 – 20	1
Size of battery	50 – 200 kWh	5 – 10 kWh	50 – 100 kWh	200 – 400 kWh
Rate of charge	~ 1 C	~ 50 C	~ 5 - 10 C	~ 0,2 C
Rate of discharge	< 1 C	~ 10 C	~ 1 C	< 0,2 C
System Costs	High?	High?	Moderate?	Moderate?

Figure 2 : choice of the battery for e-buses depending on charging possibilities. Source : UITP conference 2018 from RWTH

## Rationale for defining exemption thresholds for batteries based on their capacity

A. Equivalence in term of total combustion energy and expected maximal heat release rate

10. We propose to compare thermal effects in the case of combustion of batteries versus combustion of petrol and diesel. The maximum quantities of those two dangerous goods as specified in table 1.1.3.6 and exempted from provisions laid down in ADR will be used for calculation: 333 L for petrol and 1000 L for diesel.

a) Total energy of combustion

11. Using energy content given in 1.1.3.2 for diesel and petrol (36 MJ/L and 32 MJ/L respectively) we calculate the total energy of combustion for the defined quantities:

**333 L of petrol → 12 000 MJ\***

**1000 L of diesel → 36 000 MJ†**

12. For batteries there is no well-defined value to convert battery electrical energy in term of total combustion energy. Nonetheless, based on numerous tests run at Ineris a value of 90 MJ/kWh can be estimated and covers most of batteries technologies on the market.

13. Using this value, the range [12 000- 36 000] MJ converts to **[133 – 400] kWh**

b) Heat release rate

14. The total energy of combustion is not the only parameter to be taken into account. Indeed, the heat release rate, in MW, influence strongly the thermal hazard. This value is scenario dependent and could only be estimated. Two leak scenarios were considered for petrol assuming that combustion rate and heat of combustion do not vary strongly between the two products. The main difference between the two products, due to the authorized quantity, is the fire duration.

15. Considering a petrol leak through a 1-inch hole in a tank (height 0.5 m) leads to a steady 11 m<sup>2</sup> oil slick with a combustion rate of 0.66 kg/s.

**For a 0.5 m liquid height in the tank, it results in a 26.4 MW fire.**

16. Considering a petrol leak from a 1-inch hole in a tank (height 1 m) leads to a steady 15 m<sup>2</sup> oil slick with a combustion flow of 0.9 kg/s.

**For a 1 m liquid height in the tank, it results in a 36 MW fire.**

17. For batteries, we propose again to use values based on Ineris tests ran on large batteries packs. For this kind of system, a value of 100 kW/kWh is proposed. This would correspond to a reaction time of 12 minutes, which seems realistic.

18. Using this value, the range [26 - 36] MW converts to **[260 – 360] kWh.**

**In conclusion, considering thermal considerations, the maximum quantities that can be specified is 360 kWh‡.**

\* This energy is below the limit fixed in 1.1.3.2 (a): “The total capacity of the fuel tanks or cylinder for a transport unit [...] should not exceed 54 000 MJ energy-equivalent”

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‡ Considering classical values of current energy density of 250 Wh/kg for a cell and 150 Wh/kg for a system, such energy range would result in a mass range of [1 100 – 2 400] kg of system or [670 - 1440] kg of electrochemical elements.

## B. Other risks to be considered

### a) Extinguishing difficulties and post-accidental pollution

19. Fire involving Li batteries are known to be difficult to extinguish but recommended extinguishing media are similar to other fire (water or water+additives) and a 360 kWh battery fire should not create much more issues than a 1000 L hydrocarbon fire. The only difficulty that could arise is in the case of Li-metal batteries (3090 and 3091) because of the water reactivity of Li-metal.

20. Pollution of water expected as reported by EMPA (Switzerland) about in a study about "Risk minimization of electric vehicle fires in underground traffic infrastructures". They conclude that, concerning electric vehicles, "a technical impairment of typical infrastructure components in underground car parks and road tunnels can be practically excluded. However, the battery specific emissions will lead to contamination which is of toxicological importance especially for decontamination and disposal works". And recommends collecting and pre-treat extinguishing waters. This problem, even if different by nature from hydrocarbons fire, should not lead to worst situations.

### b) Explosive atmosphere

21. Another risk specific to batteries is the possible flammability of gas that, in some accidental scenario can lead to explosive atmosphere formation. In the case of transport in open atmosphere, this risk should be limited. In the case of tunnels, the ventilation should be sufficient to avoid the formation of large explosive atmosphere. Formation of explosive atmosphere can however be considered inside the transport engine itself.

## C. Choice of the threshold

22. Table 1.1.3.6.3 already defines specific maximal total quantity in column (3). It can be 0, 20, 333, 1000 or unlimited depending on the dangerous good classification. Reusing one of these thresholds would ensure coherence in the regulation and facilitate its implementation. Considering the range of equivalence between batteries and fuel calculated previously (up to 360 kWh), **333 kWh would be coherent**. It would be easy to implement because the table itself would not require any change. A new paragraph could be added to specify that the unit mentioned is in kWh instead of liters or kilograms. It would also be relevant to assign UN 3536 to a transport category of 1.1.3.6 which is not the case today because the weight is over 333 kg in any case.

## Proposal

23. We are not yet in the state of drafting a text ready for adoption. However we propose to initiate a work that would consider these issues in a more comprehensive way. It could be based on the following points:

- (a) Include both UN 3536 and UN 3480 and think about the future sodium ion based technology;
  - (b) Work on a suitable exemption under 1.1.3 and preferably under 1.1.3.6;
  - (c) Define and agree on a threshold defined in kWh;
  - (d) Define the scope in terms of exempted object: batteries vs cells (cells should probably be treated differently), batteries "ready for use", size of batteries ...;
  - (e) Check a possible implementation in 1.1.3.1 (c).
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