Informal document **GRVA-16-11**
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Provisional agenda item 8(b)

Minutes of the Informal Workshop of the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) dedicated to Electromechanical Brakes (EMB)

Hosted at the CLEPA offices in Brussels, with remote participation enabled by MS Teams

29-30 March 2023

I. Attendees

In person: 30 experts from 6 Contracting Parties (China, Germany, Japan, the Netherlands, Sweden, the United Kingdom of Great Britain, and Northern Ireland) and 3 Non-Governmental Organizations (CLEPA, CLCCR, OICA)

Remote participants: an additional 30 experts connected online from 2 Contracting Parties (Canada, Finland, Slovakia and Spain) and from 3 Non-Governmental Organizations (CLEPA, CLCCR, OICA).

II. Day 1

A. Opening

1. The meeting was chaired by Mr. R. Damm (Germany, Chair of Working Party on Automated/Autonomous and Connected Vehicles (GRVA)).

2. He mentioned the main reasons for organizing the workshop: he recalled the recurrent presentations at GRVA related to EMB and the lack of time at GRVA formal session to review in detail the subject. A workshop was the opportunity of an in-depth discussion on EMB. He welcomed the participants and noted the participation of Contracting Parties from the 1998 Agreement, he encouraged them to share views and concerns, if any, also when discussions address items related to the 1958 Agreement.

B. Review of the EMB technology

3. CLEPA presented GRVA-EMB-02-Rev.1 with the current requirements for braking systems in UN Regulation No. 13 and explained that the EMB proposal was to insert necessary provisions for the electric energy transmission in the regulation. He also presented the energy layout of braking systems for Internal Combustion Engine (ICE) vehicles, Battery Electric Vehicles (BEV), and Hybrid Vehicles as well as the energy flow comparison between Pneumatic Energy and Electric Energy for brakes.

4. CLEPA listed the benefits expected from EMB:

(a) Energy efficiency,

(b) Improved braking control, and

(c) Elimination of noise emission from pneumatics.

C. Questions and Answers

5. Germany welcomed the clear presentation and advised to revisit the definitions proposed so far in the context of EMB.

6. The United Kingdom agreed with Germany and pointed out that the control transmission requirements in UN Regulation No. 13 for EBS might not be adequate for EMB. He raised some questions: related to the quantification of the energy content available in a reserve, the quantification of the energy fall while/ after braking and potential system failure. He stated that EBS requirements did not provide answers to these questions. He also suggested to revisit definitions.

7. China stated the relevance and importance of EMB as well as their willingness to contribute to the project.

8. Sweden agreed with the United Kingdom and raised some other concerns such as parking brakes. He mentioned that the spring brakes, as the last piece of safety to date when brakes fail, would not exist as such for EMB. He wondered if there would be an equivalent to spring brakes in EMB layouts. Japan also noted the importance of an appropriate safety back-up feature and related requirements. He also noted that while a pneumatic brake system consumed a fixed amount of energy for any single brake application, the consumption of an electric brake system would vary according to the duration of the braking event. He indicated that the regulation would need to consider this point.

9. CLEPA agreed with the concerns raised. He encouraged to think in terms of technology-neutral requirements.

10. CLCCR raised the question of regenerative braking for trailers. CLEPA confirmed that trailers were not covered at this stage.

11. The United Kingdom raised additional questions regarding the possibility to measure the energy content in real time, the ability to issue warnings and the ways to validate systems against pass fail criteria. He also mentioned that work to accommodate electric braking systems in both UN Regulation No. 13 and 13-H was important but no progress had been made within the industry discussions, during the last weeks preceding the workshop.

12. Finland suggested that the group assessed if the EMB systems described would be safe or not.

D. EMB and Periodic Technical Inspection (PTI)

13. Finland asked if there would be solutions to check the braking performance during PTI.

14. Sweden mentioned that CITA was investigating Continuous Technical Inspection. He wondered what the right approach for EMB would be.

15. OICA recalled that heavy vehicles have connection points for checking the brakes at PTI. He recalled that cars do not have such connection points and that other solutions were found to meet the expectation at PTI. He encouraged the group to consider what is really needed for EMB at PTI. He suggested that a simple copy/paste of the pneumatics brakes requirements for PTI would not completely work for EMB.

E. EMB and more generally Brake By Wire

16. CLEPA presented Brake-By-Wire (BBW) for passenger cars (M_1) and light commercial vehicles (N_1). He introduced two types of systems: systems that would only rely on electric energy like EMB or hybrid system relying on Electro-Hydraulic brakes and EMB. He mentioned the missing requirements on the detection and the warning of a single failure within the energy transmission in UN Regulation No. 13-H.

17. CLEPA mentioned full power braking systems regulated as per Annex IV of UN Regulation No. 13-H. The Annex covered hydraulic storage device, only, and did not cover electric energy storage.

18. CLEPA mentioned that these new braking systems would hit the market in 2027/2028.

19. CLEPA recalled the issue that N_1vehicles need to continue to be able to be type-approved according to either UN Regulation No. 13 or UN Regulation No. 13-H, which

would require some form of synchronization between the activities on UN Regulations Nos. 13 and 13-H.

20. CLEPA confirmed that there was a fundamental issue to be solved and stressed the need to define requirements ensuring the principles mandated to date: two independent braking circuits, enough energy for delivering the service/secondary braking performance and sufficient energy (potentially in the traction battery) reserved for the braking and steering systems.

21. The group reviewed different possible braking system layouts where the traction battery of an electric vehicle would be part of the energy supply for the braking system as well as provide the energy reserve for one of the two independent braking circuits.

22. OICA mentioned that the main goal for the vehicle testing at the time of the approval was to focus on measuring and assessing vehicle performance (e.g. the deceleration after a given number of brake application) in a given situation (e.g. a disconnection of the energy source), and to check that warnings are given in due time. When it comes to checking internal parameters of the system (e.g. the capacity of a battery) or how the ageing or the temperature are taken into account to guarantee the warnings are given in time, an audited demonstration by the vehicle manufacturer (like Complex Electronics Control System annexes) would be more appropriate.

23. The group reflected on the proposed definitions for energy source, energy supply and energy reserve.

24. The group reflected on the existing performance requirements in fault conditions: the regulation requires enough energy in the reserve so that eight braking applications were possible and so that the ninth braking delivers the secondary braking performance.

III. Day two

25. Following discussion, the group noted that finalizing the three definitions would probably not be the right approach, at this stage. The group noted the content of GRVA-EMB-03, containing a correlation table showing the correspondence between UN Regulations Nos. 13 and 13-H, and GRVA-EMB-04/Rev.1 summarizing the content of the EMB amendment proposals to UN Regulation No. 13 tabled at GRVA (see GRVA-15-17).

A. Traction battery related discussion

26. The group discussed the layouts that include a traction battery being both the energy supply of the braking system and the energy reserve of one of the circuits.

27. The group agreed with the proposal of the United Kingdom to ask a small drafting group to create a model text that describes how the traction battery fits in the braking system.

28. The group noted the need to revisit the definition of an energy reserve.

B. Battery ageing

29. The group noted that UN GTR No. 22 addressed the ageing of traction batteries.

30. The group discussed the current state of discussion among the industry meeting.

31. The group also discussed if the battery should be part of the braking system, from the UN Regulation viewpoint, or if requirements to the board-net would be sufficient. Industry pointed at a risk that describing, as part of the brake approval, all possible variants of traction or low voltage battery arrangements would be impractical and would generate a need for frequent extensions without added value. The type approval documentation should focus on, for example, the mechanisms to secure energy for braking is always enough to pass the performance requirements (e.g. the performance at the ninth braking after the source was

lost), and how the effects of ageing are integrated in the strategy, rather than on the components themselves (e.g. the total capacity of the traction battery).

C. Breakout sessions

32. The workshop was divided in two breakout sessions in the early afternoon.

33. One session included the heavy vehicle braking experts. They reported to the workshop that they reviewed the three definitions and identified that the energy reserve can be the "volume", the "container", or the "energy content". They presented an amended version of the definitions, based on the two following principles: the energy supply is providing energy to the energy reserves; there must be (at least) one energy reserve per brake circuit.

34. The other session included passenger cars experts. They reported to the workshop that they reviewed one of the layouts presented in GRVA-EMB-02-Rev.1, slide 28. Thus, they concluded on the role of the Traction Battery and the DC-DC Converter.

(a) The DC-DC converter is not considered as an Energy Source, but as a part of the supply system. The justification is that the DC-DC converter does not change the energy, but the form of energy (the voltage is changed).

(b) Traction Battery (high voltage battery) provides an Energy Reserve. The justification for this is:

(i) Traction Battery and the Low Voltage Battery hold a residual energy reserve for the safety systems (e.g. braking system, steering system)

(ii) The amount of residual energy, e.g. when the reserve is insufficient to power the traction motors, must be protected

(iii) In case of a breakdown of the Traction Battery, the Traction Battery shall stop to feed the Low Voltage Battery

(iv) In case of a failure of the Traction Battery, every system, which is not explained as a safety system, shall be shut down to protect the residual energy reserve for the safety systems.

35. At the end of the breakout session they concluded on fault and non-fault conditions of the system (e.g. the following use cases: DC-DC converter, Traction Battery or Low Voltage Battery fails).

IV. Next steps and closure

36. The group agreed that an evolution in the working arrangements could accelerate progress. It was also agreed to work in a first step not on the definitions, but on the principles. Thus, the United Kingdom offered to prepare a document exploring on those principles. The workshop discussed the possible forms for a new structure: an ad hoc group, a special interest group, or an informal working group. A decision is expected to be made at the next formal session of GRVA in May 2023. GRVA will receive a report on this workshop. The experts will continue dialogues but keep UN Regulation No. 13 activities separate from the UN Regulation No. 13-H activities for the moment. CLEPA will restart its bi-weekly meetings, keep Contracting Parties engaged and prepare a timeline for discussion at the next GRVA session.