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Consideration and vote by AC.3 of draft UN GTRs and/or draft amendments to established UN GTRs
Proposal for a new UN GTR

Proposal for a technical report on the development of a new UN Global Technical Regulation on In-Vehicle Battery Durability for Electrified Heavy-Duty Vehicles

Submitted by the Working Party on Pollution and Energy*

The text reproduced below was adopted by the Working Party on Pollution and Energy (GRPE) at its ninety-second session (ECE/TRANS/WP.29/GRSP/92, para. 68). It is based on GRPE-92-44 as reflected in Addendum 8 of the session report. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee (AC.3) for consideration at their November 2025 sessions.

* In accordance with the programme of work of the Inland Transport Committee for 2025 as outlined in proposed programme budget for 2025 (A/79/6 (Sect. 20), table 20.6), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Introduction

1. Owing to the pressing need to reduce emissions of greenhouse gases (GHG) and other air pollutants, the market share of electrified vehicles is expected to grow in the future. A key component of these vehicles is the traction battery that is used to store and deliver energy to power the movement of the vehicle and the systems within it. Improvements in the performance of batteries to deliver increased driving range, reduced charging times and greater affordability are a significant focus for manufacturers and technological developments in this area are expected to accelerate the uptake of electrified vehicles by consumers.

2. The primary motivation for this GTR stems from the recognition that the environmental performance of electrified vehicles may be affected by excess degradation of the battery system over time. Currently, the United Nations Global Technical Regulation No. 22 specifies test procedures and minimum performance requirements for the battery durability of electrified light-duty vehicles. As electrification is also extending to heavy-duty vehicles, such as buses, coaches and trucks, there is a need to consider battery degradation in the context of these vehicles as well. One key difference between light-duty and heavy-duty vehicles is that for several truck categories, a significant share of the energy stored in the vehicle may be used for purposes other than propulsion. For example, for cooling, in the case of refrigerated trucks for the transport of perishable goods or certain medical supplies; or to mix concrete in the case of concrete mixers. Another difference is the greater diversity of powertrain configurations and applications. The present GTR builds on the GTR No. 22 by providing test procedures and minimum performance requirements for the battery durability of electrified heavy-duty vehicles.

3. Loss of vehicle usable battery energy and loss of electric range are both primary concerns for electric vehicles. Loss of electric range could lead to a loss of utility, meaning affected vehicles might be driven less and therefore displace less distance travelled that might otherwise be driven by conventional vehicles. Loss of vehicle efficiency could affect upstream emissions by increasing the amount of electricity needed per vehicle distance travelled. Both can affect not only the utility of the vehicle to the consumer, but also the environmental performance of the vehicle. Loss of environmental performance is of particular concern because governmental regulatory compliance programs often credit electrified vehicles with a certain level of expected environmental benefit, which might not be realized over the lifetime of the vehicle if excess battery degradation occurs.

4. This GTR therefore aims to provide a harmonised methodology to address these concerns by introducing a method by which the health of the battery can be monitored over time and introducing minimum performance requirements for the durability of the battery in an optional annex. In order to address regional considerations, a Contracting Party may optionally elect to enforce Minimum Performance Requirements (MPR*i*) from these tables.

II. Procedural background

5. The Informal Working Group (IWG) on Electric Vehicles and the Environment (EVE) was set up in June 2012 following the approval by WP.29/AC.3 of ECE/TRANS/WP.29/AC.3/32. This document established two distinct IWGs to examine environmental and safety issues related to Electric Vehicles (EVs): the IWG on EVE, reporting to the Working Party on Pollution and Energy (GRPE), and the IWG on Electric Vehicle Safety (EVS), reporting to the Working Party on Passive Safety (GRSP). The proposal was supported by the European Commission, the United States of America, China, and Japan.

6. A second mandate for the IWG on EVE, divided into Parts A and B was approved in November 2014 by AC.3 to conduct additional research to address several recommendations that grew out of the first mandate, and develop UN GTR(s), if appropriate. The second mandate was separate from the IWG on EVS.

7. Part A of the second mandate of the IWG on EVE (ECE/TRANS/WP.29/AC.3/40) included “battery performance and durability” as one of the topics authorized for study and

potential GTR development. Specifically, Part A authorized activity "to further develop the recommendations for future work outlined in the Electric Vehicle Regulatory Reference Guide by: (i) conducting additional research to support the recommendations; (ii) identifying which recommendations are suitable for the development of (a) global technical regulation(s) (GTR(s)) by the World Forum for Harmonization of Vehicle Regulations (WP.29); and (iii) developing a work plan." The work of the IWG on EVE on battery performance and durability under Part A of the EVE mandate was reported to WP.29 in a status report as informal document WP.29-170-31 at the 170th meeting of WP.29, 15-18 November 2016.

8. At the close of Part A, the IWG on EVE recommended that GRPE and WP.29 endorse the option of extending the mandate of the IWG on EVE to continue active research into the topic of battery performance and durability without committing to the development of a GTR at that time. This was endorsed and work continued on this topic within Part B of the mandate.

9. The IWG on EVE presented a draft status report to GRPE in May 2019 on the research of in-vehicle battery durability and performance. The status report indicated that there was sufficient information to allow a UN GTR for in-vehicle battery durability to be started. The IWG on EVE recommended at the 79th GRPE in May 2019 that the UN GTR on in-vehicle battery durability be developed under a new mandate. The EVE IWG published UN GTR No.22 (In-Vehicle Battery Durability for Electrified Vehicles), in the UN Global Registry on March 09, 2022.

10. Due to the focus of UN GTR No. 22 on light-duty vehicles and developments in the heavy-duty vehicle sector, the EVE IWG has been authorized to begin development of a new standalone UN GTR on in-vehicle battery durability for electrified heavy-duty vehicles, at the 190th session of World Forum for Harmonization of Vehicle Regulations (WP.29), which will be developed in 2 phases:

Phase 1:

(a) Initial draft development and working document submission to GRPE and AC.3 for consideration as a new UN GTR;

(b) Consider alternative test methods including chassis dynamometer testing.

Phase 2:

(a) Continue development of alternative test methods including chassis dynamometer testing;

(b) Consider the need for battery replacement provisions;

(c) Explore the applicability of vehicle group O (trailers and semi-trailers) within the scope of the regulation;

(d) Future amendments as new data and continued research, analysis and testing lead to new developments;

(e) Reconsider the MPRs regarding mileage and lifetime thresholds and consider the appropriateness of energy throughput as threshold, based on the monitoring exercise for energy throughput ;

(f) Consider the need of further segmentation of the MPR thresholds by vehicle category/application;

(g) Consider MPR setting for HDV OVC-HEVs.

III. Development of the GTR

11. Following several years of information gathering and deliberation among the IWG members on the feasibility of drafting a GTR, the new GTR was developed over the course of around 29 IWG meetings over approximately three years, with 50 to 60 attendees participating in the meetings. The meetings and development process are transparent. Documents and reports generated for all of the IWG meetings are posted on the UN website:

https://wiki.unece.org/pages/viewpage.action?pageId=2523151

12. The governing committee of the IWG comprises of two Chairpersons, two Vice-Chairs, and a Technical Secretary. A drafting coordinator is typically appointed for the drafting of specific GTRs. Chairpersons are taken by the representatives of the European Commission and United States and the Vice-Chairs are taken by the representatives of Japan and China. The Technical Secretary is taken by the representative(s) of Canada. For this GTR, the drafting coordinator was a representative of the European Commission.

13. Other members of the group who have contributed to the development of the GTR include representatives from many other Contracting Parties, automotive industry trade association groups, vehicle manufacturers, and technical experts.

14. The main discussions on the development of the GTR commenced at the 54th session of the IWG on EVE and focussed on the format and content of the GTR. A framework for the GTR was soon developed that centered around the concepts of a minimum performance requirement (MPR) for the in-vehicle battery, a readable on-board battery health monitor, an in-use verification procedure for assessment of the health monitor and a data collection process for assessment of durability against the MPR as defined in the GTR No. 22 for electrified light-duty vehicles.

15. The framework established also provided the means by which to collect data for ongoing development of the GTR in a second phase.

16. Early agreement was reached that the GTR should not seek to dictate the algorithm used by the manufacturer in determination of on-board battery health metrics, but instead provide a means to ensure the accuracy of any values through in-use verification. Only one metric, named the state of certified energy (SOCE), would form the basis for assessment within the HDV GTR.

17. The IWG spent a significant amount of time to define new test methods for the assessment of heavy-duty vehicle battery energy, since it was not possible to rely upon existing test procedures for those purposes. Some key difficulties posed by the testing of battery energy in heavy-duty vehicles include: the wide variety of heavy-duty vehicle configurations, the scarcity of heavy-duty capable chassis dynamometers in some regions, the frequent presence of auxiliary devices that perform a significant amount of non-propulsion work, and the frequent presence of multiple batteries or battery configurations.

18. The European Commission Joint Research Centre (JRC) presented a proposal to measure the battery energy using a bidirectional power supply system in a temperature-controlled environment, ensuring proper preconditioning of both the vehicle and the battery while controlling the discharge power such that it is representative of in-service vehicle use. The measurement of the usable battery energy by a discharge at constant power using a bidirectional power supply has been considered as a suitable compromise between the feasibility of the test and its accuracy. A test campaign was carried out by Japan to explore the possibility of this test method and assessing the comparison with dyno test results.

19. In order to ensure the feasibility of the test for all Contracting Parties and for all types of heavy-duty electrified vehicles, even those that do not allow battery discharging through a power supply system, it was proposed and then agreed to adopt three types of tests for the measurement of the usable battery energy, plus an alternative method based on the use of a chassis dynamometer:

(a) Method 1a: Discharge by driving on a test track using characteristic regional speeds;

(b) Method 1b: Discharge by driving on the road;

(c) Method 2: Discharge using a bidirectional power supply system; and

(d) As an alternative to these test procedures, the battery may be discharged using a Heavy-Duty Vehicle (HDV) chassis dynamometer over constant speed and transient cycles.

20. Extensive discussion took place to define the boundary conditions of the test procedures. A breakout group was established to explore options for the test methods used in Part A (Verification of Monitors) lead by representatives from the European Commission's

Joint Research Centre. A pilot phase was organised by manufacturers as part of this process for defining the new test methods.

21. A breakout group was also created to establish definitions for the break-off criterion for the new test methods defined in the GTR. Representatives from the European Commission, the United States, Japan and industry experts worked together closely to determine a solution that also addressed regional regulations, ensuring the GTR is applicable to all regions.

22. Initial drafting of the GTR started in the 58th session of IWG on EVE and an increased frequency of meetings was commenced in recognition of the significant work required on drafting and the novel basis of this GTR.

23. In determining appropriate MPR values for this GTR, the IWG on EVE considered inputs from stakeholders within the IWG and available data sources in order to try and understand the performance of electrified heavy-duty vehicles. A warranty analysis was conducted by the United Kingdom (UK) to understand the current warranty offerings from manufacturers of electric heavy-duty vehicle batteries. The review primarily focused on the UK market, but warranty offerings were generally consistent with typical offerings in other markets. Representatives from the European Commission's Joint Research Centre used the 'Transport tEchnology and Mobility Assessment Platform' (TEMA) to evaluate MPR proposals, comparing against data from literature, before presenting their findings to the IWG.

24. A consensus amongst contracting parties was eventually reached at the 73rd IWG on EVE meeting in mid-2024, which resulted in the establishment of an optional annex with the MPRs based upon SOCE that are included within this GTR. A view was taken that the energy-throughput, the total amount of energy in kWh discharged from the battery, will be monitored during phase 1, in view of a future revision of the lifetime thresholds for confirming the compliance with the minimum performance requirements set over years and kilometres in this current GTR.

25. The collection and monitoring of field data is recognised to be of key importance for the future revision of the MPRs and metrics. It was highlighted by manufacturers that the understanding and estimation of Power Take-Off (PTO) applications, such as, concrete mixer, crane, construction or garbage compaction, etc., currently presents an increased challenge compared to only drive and charge behaviour. A concept related to virtual distance was introduced to cover the V2X, (that is, Vehicle to Grid, to Facility, to Home, to Load), PTO and non-traction purposes of the vehicles, similar to UN GTR No. 22, but adapted for HDVs.

26. Other key areas that the IWG focused on included: the creation of family definitions for both the verification of on-board monitors and the assessment of battery durability, the statistical procedure for assessment of accuracy requirements for the on-board monitors, the handling of vehicles that have been used atypically or for vehicle-to-grid or for PTO applications, and the definition of usable battery energy for the purposes of this GTR.

27. IWG on EVE has kept GRPE up to date on the development of the GTR. This included sharing a first draft of the proposed GTR as an informal document at the 91st session of GRPE in October 2024 (see informal document GRPE-91-20). A second draft was submitted as a working document (ECE/TRANS/WP.29/GRPE/2025/7) to the 92nd session of GRPE in March 2025, together with an informal document (GRPE-92-43) pending agreement on the final provisions of the GTR within the IWG on EVE.

28. Key outstanding issues that needed to be resolved in order to finalise the GTR included:

(a) Agreement on the test room temperature set point and battery temperature monitoring during the test break for the drivers and the soak and charge;

(b) Criteria for vehicle selection during certification and Part A verification;

(c) PTO definition,virtual distance definition and Part C verification method of reported virtual distance;

(d) Finalisation of the boundary conditions for the several test Methods defined in the GTR;

(e) Finalisation of the MPR values for category 1-2, metric discussion and reorganisation of the optional Annex 4.

29. The subject of vehicle-to-grid and/or PTO and/or non-traction purposes was discussed, and an equation was devised to calculate a ‘virtual distance’ value for vehicles designed for this usage, which could be summed with the distance driven to establish a total distance.

30. A finalised version of the GTR is to be presented by the IWG on EVE at the 92nd session of GRPE for endorsement of the proposal to be considered by the WP.29.

31. More detailed discussion of the technical approaches considered by the IWG on EVE can be found in the Technical Background section of this UN GTR.