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and/or draft amendments to established UN GTRs, if any

Technical report on the development of a new amendment to UN GTR No. 21 on the Determination of Electrified Vehicle Power (DEVP)

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 eighty first session (ECE/TRANS/WP.29/GRPE/81) and is based on ECE/TRANS/WP.29/GRPE/2020/12 and GRPE 81-27 as amended by Annex VII of the session report. It is a proposal for a Technical Report on the development of a new UN GTR on the Determination of Electrified Vehicle Power (DEVP). It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Executive Committee (AC.3) of the 1998 Agreement for consideration at its November 2020 sessions. [to be Revised]~~

* In accordance with the programme of work of the Inland Transport Committee for 2020 as outlined in proposed programme budget for 2020 (A/74/6 (part V sect. 20) para 20.37), 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.

** This document was scheduled for publication after the standard publication date owing to circumstances beyond the submitter's control.

Technical report on the development of a new amendment to UN GTR No. 21 on the Determination of Electrified Vehicle Power (DEVP)

A. Introduction

1. Passenger vehicles are commonly assigned a vehicle power rating, which is useful for comparing the performance of different vehicles. Vehicle power rating has also been used for other purposes such as vehicle classification, customer information, insurance, and taxation.
2. Historically, almost every passenger vehicle produced for the consumer market has been powered exclusively by an internal combustion engine (ICE). The vehicle power rating assigned to these conventional vehicles has customarily been the same as the rated power of the engine, as determined by an engine bench test. This is a convenient way to assign a power rating to a vehicle, because the engine power rating may then be applied to any vehicle that uses the same engine.
3. As a measure of real-world vehicle performance, this traditional measure is imperfect, since it does not account for the power lost in the drivetrain between the engine and the road. However, it has become well established and is generally accepted as a useful metric, in part because conventional vehicles have only one engine, and its full rated power is typically available for propulsion.
4. Today, electrified vehicles such as hybrid electric vehicles (HEVs) and pure electric vehicles (PEVs) with multiple drive motors represent an increasing share of the market. A vehicle power rating is not as easy to assign to these vehicles because they combine more than one propulsion source, such as an engine and an electric machine, or multiple electric machines.
5. For these vehicles, the available power depends on how the control system combines the power of each propulsion source when the driver demands maximum power. While it may seem that this would simply be the sum of the rated power of each component, this is not necessarily valid in practice. It will result in an overestimate if, for example, the electric machine is limited by the available battery power, or if the control system limits or reassigns some of the nominal capacity, such as to maintain traction or charge the battery.
6. 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. This intensifies the need for a standard method for assigning a vehicle power rating to electrified vehicles.
7. Electrified vehicles and conventional vehicles are likely to coexist in the market for some time. Many existing regulations and procedures, such as the World Light Duty Test Procedure (WLTP), apply to both conventional and electrified vehicles, and require a power rating as an input. In order to be used equitably for such purposes, a power rating for electrified vehicles should be qualitatively and quantitatively comparable with the traditional engine-based power ratings of conventional vehicles.

B. Procedural background

8. The Informal Working Group (IWG) on Electric Vehicle 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, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) of the

United States of America, the Ministry of Industry and Information Technology (MIIT) of China, and Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

9. 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.

10. The IWG on WLTP had stated a clear demand for an improved procedure for determining a power rating for electrified vehicles. The WLTP test procedure requires a vehicle power rating for the purpose of classifying vehicles into distinct Power-to-Mass ratio classes, and for application of the so-called "downscaling method" that enables the test reference cycles to be adapted for low-powered vehicles.

11. For purposes of rating the motive power of light vehicles, WP.29 currently provides a regulation under the 1958 Agreement, known as UN Regulation No. 85, that can be used for approval of ICEs and electric machines for M and N category vehicles. In many cases it is sufficient to fulfil the needs of WLTP.

12. However, UN Regulation No. 85 merely determines the bench power rating for either an ICE or a single electric machine. The regulation does not establish a method to determine the total vehicle power of a hybrid vehicle, nor for a pure electric vehicle propelled by more than one electric machine. This would call for a vehicle-level test that is able to determine the maximum power output of the system as a whole.

13. Accordingly, Part B of the second EVE mandate included a subtask to develop an amendment to Global Technical Regulation No. 15 to establish a procedure for determining the powertrain performance of electrified vehicles for use with the WLTP test procedure.

14. The IWG on EVE therefore established the subgroup "Determination of electrified vehicle power" (DEVP). The goal was to clarify how an improved technical procedure for the determination of the system power of hybrid powertrains could be realized in an efficient and simple way.

15. The scope of the work covered light duty vehicles (passenger cars -M1 and light duty vehicles -N1) and aimed to develop a recommendation or regulation for determination of hybrid vehicle system power. It was agreed that the procedure should cover all types of HEV (ordinary HEVs and plug-in HEVs) as well as PEVs with more than one electric machine for propulsion (for example, all-wheel drive configurations driven by an electric machine on each axle, or by wheel hub motors).

16. The IWG on EVE recognized that several organizations, including the Society of Automotive Engineers (SAE), the International Organization for Standardization (ISO), and the Korea Automobile Testing & Research Institute (KATRI), were also studying the issue of hybrid system power determination. The IWG on EVE was therefore able to consider several possible paths forward for which considerable research had already occurred. The IWG received presentations from experts with these organizations and discussed the merits and drawbacks of the methods proposed by each.

17. At the 22nd meeting of the IWG on EVE, the contracting parties reached consensus that the ISO approach presented the best option as a basis to fulfil the needs of the mandate. A drafting group was then formed to draft the amendment to UN GTR No. 15.

18. The drafting group initially focused on converting the draft ISO standard, which was nearing finalization, into an Annex to UN GTR No. 15. The group made substantial progress on converting the document into the proper format and harmonizing its technical details with UN GTR No. 15 where necessary. The IWG also initiated and completed a first phase of validation testing to further evaluate the harmonized procedure as it was developed.

19. During this effort, a clear demand emerged on the part of several contracting parties that the procedure should be developed as a standalone UN GTR, in part so that it could be more easily utilized for purposes outside of the specific context of WLTP. In 2019, the mandate was therefore modified to specify development of a standalone UN GTR rather than an Annex to UN GTR No. 15.

20. Recognizing the need for a reasonable test burden, as well as the increasing diversity of electrified powertrain architectures, the IWG on EVE originally considered the possibility of developing both a “reference” method and a “candidate” method. The reference method would determine system power by means of a vehicle-level test procedure, while the candidate method would derive system power from the results of component-level tests. Initial priority was placed on the reference method over the candidate method.

21. -At this time, the test procedure described herein provides for a reference method but not a candidate method. Development of a candidate method remains a possibility for future attention of the IWG on EVE.

22. Following approval of this GTR by AC.3 in November 2020, the EVE IWG continued work under its mandate to consider possible revisions to this GTR, particularly including development of a family concept and consideration of the need for a candidate method. During 2022 and 2023, a number of suggested revisions were periodically proposed by EVE IWG members and discussed at regular meetings of the EVE. The IWG reached consensus on several revisions.

23. The revisions are as follows:

(a) Due to lack of a clear demand for a candidate method, Annex 3, which was reserved for development of such a method, was deleted from the GTR;

(b) Family concept added under section 7;

(c) To accommodate highly integrated powertrains, additional TP1 method defined which employs distribution ratio of power between two branches of powertrain as reported by onboard signal;

(d) Definitions of system bench were added to section 3, and use of a system bench was allowed in the case of vehicles that are too powerful to be tested on a chassis dynamometer;

(e) Soak area temperature specification adjusted to specify a temperature set point and tolerance, and to accommodate Type 1 soak area target temperature at request of manufacturer;

(f) Engine speed, fuel flow rate and atmospheric pressure allowed to be read from onboard signal to reduce instrumentation requirements;

(g) Intake manifold pressure accuracy revised to better match requirements of R85;

(h) Dynamometer speed accuracy revised to include tolerance based on full scale of the device, which accommodates higher speeds;

(i) Time accuracy revised to 100 ms which was found to be sufficient in development testing;

(j) Accelerator pedal command signal accuracy removed due to insufficient evidence of need and replaced with onboard signal, and

(k) Calculation for TP1 revised to allow 5% tolerance for fuel flow rate and manifold pressure to provide alignment to the COP tolerance of 5% which reflects the test condition better than the 2% from R85.

C. Principle for developing the global technical regulation

22. Discussions among the members of the IWG on EVE identified a number of requirements for a hybrid system power rating:

(a) The system power rating should be comparable to the traditional engine-based power rating of conventional vehicles.

(b) Third-party verification of the power ratings developed by the method, and of any manufacturer-provided inputs to the procedure, should be readily possible.

(c) The test burden imposed by the procedure should be reasonable, so that the cost and the amount of work necessary to certify the power of an electrified vehicle should not be prohibitive.

(d) The procedure should be consistent and repeatable with little variation, to minimize the need for repeated tests and prevent opportunities for selective reporting (or “cherry picking”).

(e) The procedure should be sufficiently robust to evaluate all architectures fairly, including those that currently exist in the market, and those that may reasonably be anticipated to emerge in the future.

23. Additional discussion as to how the IWG on EVE considered these requirements in development of the UN GTR, and discussion of all of the technical approaches considered, can be found in the Technical Background section of this UN GTR.
