

## Technical report on the development of Amendment 5 to global technical regulation No. 15 on Worldwide harmonized Light vehicles Test Procedures (WLTP)

### I. Mandate

1. Amendment 5 to global technical regulation (GTR) No. 15 was developed by the Informal Working Group (IWG) on Worldwide harmonized Light vehicles Test Procedures (WLTP) in the framework of Phase 2 of the development of GTR No. 15. The Executive Committee (AC.3) of the 1998 Agreement adopted the authorisation to develop Phase 2 of GTR No. 15 at its June 2016 session (ECE/TRANS/WP.29/AC.3/44).

### II. Objectives

2. The definition of a *category 1-1 vehicle* was modified to align with that in Special Resolution No. 1.
3. The definition of an *on-board charger* was introduced.
4. The method of rounding figures was standardised. The GTR also specifies when and how intermediate results may be rounded.
5. The annexes concerning the WLTC, and gear selection and shift point determination for vehicles equipped with manual transmissions were modified to have consistent terminology and for improvement of the text.

Tables were introduced making examples of shifting procedures more understandable.

Lessons learned from the Round Robin Tournament were incorporated into GTR 15. Downshift sequences were modified to improve driveability, and the engine speed range of the power curve was changed in order to make it compatible to the measurement method of the power curve. These improvements were incorporated into the ACCESS tool. The ACCESS gearshift calculation tool was developed by the gearshift and cycle issues task force leader on behalf of the informal working group as an aid for users during the development phase of the GTR. It may also be used as a reference for other calculation tools.

6. The text on permissible wind conditions when using stationary and on-board anemometry for coastdown purposes was rewritten for reasons of clarity.

A manufacturer may, at its option, perform coastdowns at a low temperature.

Coastdowns terminology was improved by introducing terms such as run pairs and referring specifically to vehicle coastdown runs.

The use of split runs was clearly defined.

Due to uncertainty associated with data validation and for practical reasons, the total number of run pairs during coastdown testing shall be limited to 30 including rejected run pairs.

7. In order to reduce the testing burden, the wind tunnel method may be used to test the representative vehicle in case of a road load matrix family if the facilities are approved by a responsible authority.

8. When using the wind tunnel method, every combination of wind speeds used for the determination of road load values shall be validated separately. The aerodynamic force shall be measured at two different wind speeds. These wind speeds depend on the class of test vehicle.

The equations for the calculation of aerodynamic force were modified to take the two wind speeds into consideration. The aerodynamic force shall also be calculated for velocity-dependent movable aerodynamic body parts at the reference speed point concerned.

9. The amount of hydrogen in grams not consumed during testing of fuel cell hybrid vehicles may or may not be taken into consideration. The analysis of specific contaminants depending on the production process were exempted. A vehicle manufacturer will be required to provide the responsible authority reasons for exempting specific contaminants.

10. The frequency at which response factors are to be determined has been defined. The test gases methane and purified air to be used and the recommended response factors have also been reintroduced into the GTR.

11. Dilution flow of a CVS must not be calibrated. This requirement was removed from the table listing CVS calibration intervals as the contribution of the pollutants in the dilution air to the diluted exhaust mass emissions are corrected by the appropriate equation the GTR.

12. The time measurement system of a dynamometer was defined as a certain percentage after a minimum operation time.

13. The response time of a CVS temperature sensor was increased to 1 second or less as 0.1 seconds are not considered to be practical.

14. The equation to correct the weights of the sample and reference filters for their buoyancy in air was corrected.

15. The calibration intervals of measuring instruments was brought up to date to reflect current practice.

16. The extension of the CO<sub>2</sub> interpolation range of vehicles L and H using a mid-vehicle M as applied to EVs and pure ICEs was clarified.

During the development phases of WLTP, testing showed that a range of 30 g/km, and possibly to 40 g/km, was linear and allowed for proper interpolation.

Initially it was established that there were a significant number of families in the range of 30 to 40 g/km CO<sub>2</sub> which had to be separated into two families. The first engineering estimates on the maximum range of interpolation families were too conservative. This led to a high testing burden and to a lack of transparency in the approval process.

Using the concept for EVs as a basis, a proposal was developed for pure ICEs to use a mid-vehicle M to check for linearity and to extend the maximum range of the interpolation.

The restriction will not apply for road load matrix families when the calculation of the road load is based on the default road load.

17. After numerous discussions, the requirement to measure engine oil and coolant temperatures at the start of the Type 1 test remains unchanged from Amendment 4.

18. A manufacturer may utilise an alternative interpolation calculation procedure in the case that the interpolation method creates unrealistic phase-specific CO<sub>2</sub> results or an unrealistic road load curve.

19. New text was introduced regarding the application and calculation of vehicle-specific drive trace indices. The indices for pure ICE vehicles, NOVC-HEVs, NOVC-FCHVs shall be calculated for the applicable test cycle and shall meet specified limits. The indices for OVC-HEVs must also be calculated for the applicable test cycle and shall meet specified limits for the charge-sustaining test. In the case of the charge-depleting test, the indices for OVC-HEVs shall be calculated according to the number of test cycles driven.

For the city cycle test for OVC-HEVs, the drive trace indices shall be calculated depending on the number of cycles driven before the combustion engine starts.

For PEVs, the indices shall be calculated differently depending on whether a consecutive cycle test, a shortened Type 1 test or a city cycle test procedure is being driven. The break-off criteria determines the number of cycles to be taken into consideration for calculation purposes.

20. The post-test processing calculations were extensively modified to improve clarity, to define when intermediate rounding is to be performed, to define when certain results are to be rounded to the nearest whole number, and to highlight when certain steps in the post-processing are not required if the interpolation method is not applicable.

21. The application of REESS charging for electrified vehicles has been more clearly defined.

22. Conditions under which the application of instantaneous voltage may be used were introduced.

### **III. Meetings held by Task Forces**

23. The proposed changes in Amendment 5 to GTR No. 15 listed in section II above were discussed at length and agreed upon by all participants during the following Informal Working Group (IWG) meetings:

- (a) 21<sup>st</sup> IWG, January 2018 (Geneva);
- (b) 22<sup>nd</sup> IWG, April 2018 (Ispra);
- (c) 23<sup>rd</sup> IWG, June 2018 (Geneva);
- (d) 24<sup>th</sup> IWG, September 2018 (Tokyo)

Numerous face-to-face or audio/web meetings of the following task forces were held: New Issues, EV (electric vehicle), Gearshift, CFD (Computational Fluid Dynamics), Drive Trace Indices, Dual Axes, Power Determination, Drafting Subgroup, Reference Gases, and Coastdown Definitions.