WLTP DTP Lab Processes subgroup	
Title	Combined solution for vehicle test mass definition, inertia mass step-less approach, vehicle and tire selection
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Working Paper Number	WLTP-DTP-10-02

Introduction

At the 7th DTP meeting (Sept 12-14, 2011) it was agreed in principle to accept the proposal from NL, T&E and ICCT on an improved definition of vehicle test mass as well as the proposal from ICCT to substitute the current step-based inertia class system by a step-less approach. For details on the individual proposals see WLTP-DTP-LabProcICE-091 and the NL proposal. During the DTP8 meeting a combined solution for both proposals was discussed and principally agreed upon. In addition, during the LabProcICE meeting on 22-23 November 2011 a proposal was introduced by T&E to also include vehicle selection criteria for road load determination. This was further discussed at the DTP meeting before the 63rd GRPE session in January 2012. Then, at the LabProcICE subgroup meeting in March 2012 the idea to also include tire selection criteria was raised, as well as a need for better definition of the vehicle selection criteria. During the next LabProcICE meeting this was discussed, and tire selection was decided not to be included. This revised document describes the current view on the combined approach for vehicle test mass, inertia setting, tire and vehicle selection. The approach for the test weight will be validated in the course of the Validation Phase 2 of the WLTP, the validation of the road load procedure with the new proposed elements will be done at a later stage.

Explanation of the approach

The steps described in this paragraph explain the compromise solution which originated from the DTP-07 meeting. Figures 1 and 2 illustrate the approach. Core of the approach is to take into account optional equipment and other load for determining vehicle test weight, as well as mathematically adjusting CO_2 emissions for the actual weight. This is to be carried out along the following steps:

1. From a group of vehicles with identical technically permissible maximum laden mass, engine capacity, maximum net power (where the maximum engine power would define a new type with regard to emissions), type of gearbox, number of gears and maximum number of seating positions the unladen mass (UM) of the empty vehicle including standard equipment is determined.
2. The maximum mass of optional equipment available for the group of vehicles is determined and added to UM. The result is the mass including all optional equipment for the heaviest vehicle (OM_H).
3. To the OM_H a constant weight of 100 kg is added to account for the driver, some luggage and optional equipment installed by the owner, which results in the heaviest reference mass (RM_H).
4. In addition to this reference mass a variable weight is added to account for passengers and additional luggage, taking into account the carrying capacity of the vehicle. For M1 vehicles this variable weight is defined as 15% of the difference between technically permissible maximum laden mass (LM) and the heaviest vehicle reference mass (RM_H). For N1 vehicles the factor is 35%. The sum of RM_H plus variable weight is the test mass of the heaviest vehicle (TM_H).

5. TM_H is used for both CO_2 and non-CO_2-emission measurements as well as for the determination of road load coefficients (refer to the next paragraph). If the mass of optional equipment offered for the group of vehicles is less than 100 kg, then the manufacturer may decide to only use TM_H to determine CO_2 emissions, rendering steps 6 and 7 obsolete. If the mass of optional equipment is less than 100 kg, but the manufacturer prefers to measure both at TM_L and TM_H, then TM_H will be fixed at TM_L + 100 kg[1].
6. To UM a constant weight of 100 kg is added as well as the variable weight for the heaviest vehicle as defined in step 4. The result is the test mass of the lightest vehicle (TM_L), without any optional equipment. It is up to the manufacturer to use a dedicated set of road load coefficients for TM_L (refer to the next paragraph).
7. Based on TM_L and TM_H a linear regression line for CO_2 over vehicle test weight is determined. This relationship is specific for only that group of vehicles. It is allowed to be extrapolated by up to 50 kg. If the manufacturer foresees that future options might add more weight, he may choose to select a test mass up to 50 kg higher than TM_H, in order to allow these options being covered by the type approval. Making use of the determined regression line, CO_2 emissions for all other vehicles within the respective group of vehicles can be calculated.

Vehicle selection for TM_H and TM_L

During the development of the WLTP test procedure it proved difficult to make a representative definition for the installed aerodynamic options during road load determination. While these properties are not strictly related to the vehicle weight, it seems justifiable to assume that a vehicle with a weight close to TM_H is likely to have more aerodynamic options installed that negatively influence air drag. Vice versa, a vehicle at TM_L has no extra aerodynamic options installed. Applying the same approach as the proposal for vehicle test weight the aerodynamic options could be added, leading to the definition of a 'worst case' vehicle at TM_H and a 'best case' vehicle at TM_L. The vehicle selection criteria are proposed to be connected to the test mass definition in the following way:

- *Vehicle selection for TM_H (worst case vehicle)*
  The vehicle selected for road load determination should have a mass (after completion of the road load determination) equal or higher than TM_H and have installed all of the available options that negatively influence the air resistance. Options that positively influence air drag are not installed[2]. Moveable aerodynamic body parts should be fixed in the most unfavourable position[3].
- *Vehicle and tire selection for TM_L (best case vehicle)*
  The vehicle selected for road load determination should have a mass (after completion of the road load test) equal or higher than T*M*$_L$, and have no options installed that negatively influence the air resistance. Options that positively influence air drag may be installed. Moveable aerodynamic body parts should be fixed in the most favourable position, assumed to be the opposite position as used for the road load determination of the worst case vehicle.

[1] A minimum difference of 100 kg between TM_L and TM_H is needed to prevent that the test to test variation in CO_2 measurements would cause unacceptable inaccuracy towards the CO_2 vs. kg relation (slope of the linear regression line).

[2] Please note that the 'worst case' vehicle selected for road load determination not necessarily has the same options installed that as those that are included in the vehicle test mass TM_H.

[3] Examples of these moveable aerodynamic body parts are covers of the air ventilation, headlamp covers, retractable spoilers, etc. They can be either mechanically or electronically adjustable.

Tire selection for TM_H and TM_L

From the range of tires that the manufacturer declares to fit to the production vehicles, a tire for road load determination will be selected from the highest rolling resistance class[4] for both the 'worst case' vehicle at TM_H and a 'best case' vehicle at TM_L.

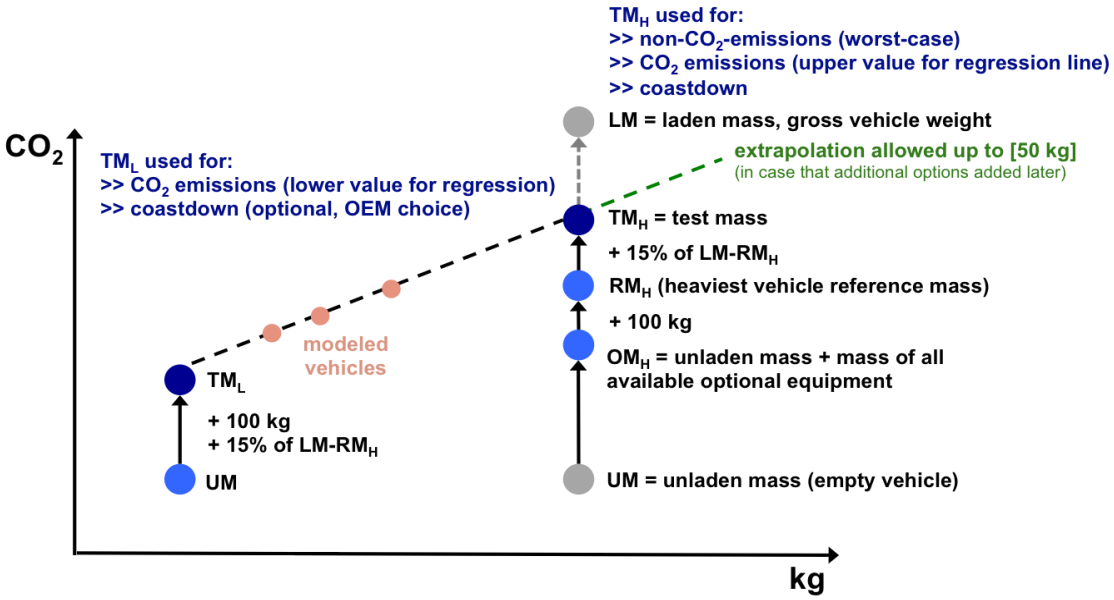

Figure 1: *Illustration of combined vehicle test weight and step-less inertia approach*

Definitions

- *Unladen mass (UM):* The mass of the vehicle in running order without driver, passengers or load, but with the fuel tank 90 per cent full and the usual set of tools and spare wheel on board, where applicable.
- *Standard equipment:* The basic configuration of a vehicle including all features that are fitted without giving rise to any further specifications on configuration or equipment level but equipped with all the features that are required under the regulatory acts.
- *Optional equipment:* All the factory-fitted features under the manufacturer's responsibility, not included in the standard equipment that can be ordered by the customer.
- *Mass of optional equipment:* Mass of the equipment which may be fitted to the vehicle in addition to the standard equipment, in accordance with the manufacturer's specifications.
- *Mass including all optional equipment (OM):* Unladen mass plus mass of all optional equipment
- *Technically permissible maximum laden mass (LM):* Maximum mass allocated to a vehicle on the basis of its construction features and its design performances.
- *Test mass (TM):* Mass of the vehicle used for road load determination, and the inertia that needs to be set at the chassis dynamometer for emission measurements.

[4] Refer to document WLTP-DTP-LabProcICE-064 for the definition of the rolling resistance classes.

Figure 2: Schematic illustration of required steps for the suggested approach